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SECTION 01000

INTRODUCTION

- A. This Division of the Specifications contains General Requirements relating to the Works as a whole and where the requirements contained herein conflict with the particular requirements contained in Divisions 2...16 of the Particular Specifications, the latter shall take precedence.
- B. In examining the requirements of any section of the Specifications the Contractor shall examine all other sections of the Specifications and the other Documents and the Drawings which affect the work of that section.

References which are made in any of these Documents to certain Sections of the Specifications or certain Drawings do not rule out the need to study and follow all other relevant technical documents which are part of the Contract.

- C. All documents related to this project shall be treated as CONFIDENTIAL. Distribution of these documents is strictly prohibited and the documents are property of the Government of Maldives.
- D. The construction works are to comply with the 'EPA guide lines and Technical specifications' of Republic of Maldives
- E. The current British Standard Specifications and Codes of Practice apply to all construction works and materials.

END OF SECTION

SECTION 01110

SUMMARY OF WORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Description.
- B. Contract.
- C. Inspection and Investigation of Site.
- D. Contractor Use of Site and Premises.
- E. Existing Services.
- F. Protection of Existing Service and Utilities.
- G. Damage to Existing Utilities and Properties.

1.02 DESCRIPTION

- A. The Maldives consist of 1190 low-lying coral islands spread over an area of 90,000km² in the Indian Ocean. Nearly 200 islands are inhabited, around 90 islands are resorts, and the rest are uninhabited. There are 26 geographical atolls which are grouped into 20 administrative atolls.

A large part of the population in the Republic of Maldives lacks the access to safe drinking water and improved sanitation facilities. Rainwater is the main source of potable water in the inhabited islands but it is available only during rainy months of the year. This causes the island population to rely on groundwater for drinking and cooking during dry period, mainly through domestic wells.

Wastewater disposal systems in most of the islands are developed within the plot known as onsite disposal systems (septic tank and soak pits), with rare cases of offsite disposals (near shore outfalls). In densely populated island environments, the construction, operation and maintenance of these systems is complex, mainly due to the short distance between domestic wells and septic tanks/soak pits, and often suffer from poor performance due to various reasons which include the absence of or limited desludging. Some small bore sewer systems (SBSS) have been introduced, but they often malfunction, and usually convey raw sewage directly into the near shore lagoon.

Sanitation facilities are poorly designed and constructed, which results in the contamination of groundwater and lagoon with the sewage effluent .

The island communities have therefore been facing the problem of groundwater contamination due to improper sanitation and over-extraction of groundwater. For a number of years, population and development pressures have led to increasing groundwater extraction, resulting in the depletion of the freshwater lens in many densely populated islands, which in turn has led saline intrusion into the groundwater aquifer. Groundwater resources have also been at risk of bacterial contamination caused by effluent leakage and pollution migration from poorly constructed and maintained septic tanks.

- B. The Government of the Republic of Maldives has received financing from the OPEC Fund for International Development (OFID), and intends to apply part of the proceeds for the following services: **Provision of water supply and sewerage facilities in GDh. Gadhdhoo, Maldives**. This project is consulted by Al Habshi Consultants, Kuwait under the guidance of MEE in the mentioned islands.

- C. The Contract comprises installation of new underground services and construction, completion, commissioning, handover and maintenance of Sewerage system in GDh. Gadhdhoo at Republic of Maldives for Ministry of Environment and Energy, together with all ancillary items except insofar as the Contract otherwise provides including the provision of all labor, materials, constructional plant, temporary works and everything whether of a temporary or permanent nature, required in and for such construction, completion, commissioning and maintenance insofar as the necessity for providing the same is specified in or can reasonably be inferred from the Contract.
- D. Construct a new gravity sewer network with lifting stations, pumping stations, sludge and effluent sea outfall etc complete with all civil and electro-mechanical works.

1.03 CONTRACT

- A. The object of this contract is to construct handover and maintain the reconstruction of sewerage system and water supply system of the Island described above and as specified in the Specification and other Contract Documents.
- B. The Particular Specifications shall be read in conjunction with the other Contract Documents. Specifications given in one Division shall apply to other Divisions unless otherwise stated.
- C. Notwithstanding anything contained herein the Contractor shall be responsible for complying in all respects with such Bylaws and Regulations as may be enforce at the time of execution of the Works.
- D. The Contractor shall provide and do everything necessary for the proper execution of the Works according to the intent and meaning of the Tender and Contract Documents and Drawings, whether the same may or may not be particularly shown on the Drawings or included in the Documents provided that the same is reasonably to be inferred there from.
- E. The Works shall be completed in strict accordance with the Documents and Drawings and any further drawings or instructions issued or approved by the Engineer during the execution of the Works.
- F. The work to be performed under this Contract includes, but is not necessarily limited to, the furnishing of all supervision, labor, materials, temporary works, false-work, plant, machinery, equipment, parts, tools, supplies, transportation, utilities, construction facilities, incidentals and logistic support necessary for the performance and maintenance of the Works, accomplishing the same in a workmanlike manner.
- G. Scope covers for temporary works like maintained furnished office and accommodation for Engineers staff, storage, equipments and stationary, internal travels, supervision and management staff, mobilization and demobilization, tools and equipments, insurance and bonds and the like. The Contractor's and his staff accommodation, equipment, etc., shall not be pay items, however cost of Contractor's staff accommodation, equipment, etc., shall deem to be included in other BOQ Items.
- H. The work comprises of all necessary civil, structural, electrical and mechanical items.
- I. All work shall be executed by skilled tradesman who shall be thoroughly acquainted with all aspects of their trade including any special local customs and modes of operation.
- J. The Contractor shall be deemed to have based his tender on the information in respect of hydrological, physical and climatic conditions of the site and have inspected the site and its surroundings and satisfied himself before submitting his

tender. The Engineer and any person authorized by him shall at all times have access to the works and to the site and to all workshops and places where work is being obtained for the works.

1.04 INSPECTION AND INVESTIGATION OF SITE

- A. The Contractor shall inspect and examine the site and its surroundings and shall satisfy himself before submitting his Tender as to the nature of the ground and sub-soil, the quantities and nature of the Works and materials, tools and equipment necessary for the Completion of the Works.
- C. The Contractor shall note that it may prove necessary to carry out excavation support and ground dewatering in order to construct the Works.
- D. The information and details given on the Drawings are not guaranteed to be accurate or correct and are given for guidance in compiling the Tender. The Contractor shall make his own investigations and enquiries of the various Government Ministries and other Authorities to ascertain the exact positions, sizes, numbers and details of all obstacles to be encountered.
- E. The rates given in the Bills of Quantities and the Schedule of Rates shall include for all costs involved in the negotiating obstacles and no claim will be considered for additional expenses the Contractor may incur on account of any unforeseen obstacle of whatever nature, over and above those which would have been incurred had the existence of the obstacle been known at the time of preparing the construction drawings.
- F. Any excavations needed to determine the exact location and levels of obstacles shall be done by the Contractor, and shall be deemed to be included as part of the rates for general trenching work in the Bills of Quantities.
- G. The Contractor shall take full responsibility of the co-ordination to fit his work with other constructions and utilities on the same site. The Contractor shall make and submit to the Engineer for approval his design on the connections details and adjustments to existing buildings and utilities in accordance with Contractor's inspection on the Site. The elevations and co-ordinates of such connections may not be accurate on the Drawings and are to be checked by the Contractor.
- H. The elevations and co-ordinates used in the Drawings are related to Mean Sea Level, however the Contractor may check before proceeding.
- I. The Contractor shall obtain all further information required as to the risks, contingencies and other circumstances, which may influence or affect the execution of the Works and include the costs thereof in his Tender.

1.05 CONTRACTOR USE OF SITE AND PREMISES

- A. Access to the Site shall be agreed with the Engineer prior to commencement and maintained by the Contractor. Also the Contractor shall be responsible for all damage resulting from the use of this access.
- B. All construction operations and site establishment facilities shall be confined to within the Site Boundaries, unless otherwise agreed with the Engineer.
- C. The Contractor shall be responsible for safeguarding all structures and the like in the vicinity of the Site. Also he shall ascertain from the public utility authorities positions of all existing underground services; maintain and protect or divert as required.

- D. The Contractor shall have full possession of the Site at the location of the works only, and be responsible for arranging his own working space, the storage of materials, setting of all temporary accommodation, etc.; locations are to be agreed with the Engineer. No claim whatsoever will be entertained for any reason regarding the setting or allocation of any working space regardless of the distance.

1.06 EXISTING SERVICES

- A. The Contractor shall notify the Ministries, Establishments, and Departments which have certain services at the Site of Works, at least two weeks before he desires to carry out any work, near, above or under the services of these Ministries and Establishments and he shall submit a detailed programme of each area on which the work shall be commenced and the anticipated date of commencement in addition to a report, signed by the Engineer, the Engineer of the Ministry to whom the services belong and the Contractor's representative, confirming this Notice of Intent.
- B. It should be noted that the Contractor shall not be allowed to work in any area where services are still covered and the Engineer shall have the right to stop the work in any part of the Works where the Contractor fails to take the necessary measures to uncover these services and the Contractor shall not claim for compensation in time or money.
- C. The Contractor shall refer to and comply the current Regulations and Specifications of Public Utilities Authorities before commencing any works adjacent to equipment, plant, cables, etc. The above requirement will not relieve the Contractor of any responsibility for taking every precaution to avoid damage to equipment, plant, cables, etc. and he will be held responsible for the cost or repair of all damage in accordance with the Conditions of Contract and Specifications. Payment for complying with the above requirements will be deemed to have been included in the rate for Works included in Bills of Quantities.

1.07 PROTECTION OF EXISTING UTILITIES AND SERVICES

- A. During construction the Contractor shall provide all protection for existing utilities and services as may be required for his construction operations, including protection for the construction of detours and diversions, as directed by the Engineer and as required by the Regulations.
- B. Protection during construction includes, but not by way of limitation, all labor, materials, equipment and accessories which shall be furnished and installed by the Contractor and such protection shall be considered as a subsidiary obligation under the items in the Bills of Quantities.
- C. In addition to the requirements as specified in the other Contract Documents, the Contractor shall conform to the following requirements.
 - a) Use of all necessary precautionary and protective measures required to maintain existing utilities, services and appurtenances. In particular, the Contractor shall take adequate measures to prevent undermining of utilities and services whether they are presently in service or not.
 - b) Protect existing or new utilities and services when considering necessary and directed by the Engineer. The Contractor shall be responsible for bracing and supporting utilities and services to prevent settlement, displacement or damage to the same. The protection of utilities and services as specified herein, will not paid for separately but shall be considered as a subsidiary obligation to the work under this Contract unless otherwise specified in the Contract Documents.

c) The Contractor shall recover, remove or abandon redundant utility and service lines as required by the Contract Documents and/or directed by the Engineer.

d) The Contractor shall not remove any utility or service line, conduit or structure until he has received written permission from the Engineer.

e) The Contractor shall, at all times during the progress of the Works, afford facilities to properly accredited agents of any Authority for access to all or any of their apparatus situated in or under the Site, as may be necessary for inspecting, reporting, maintaining, removing, renewing or altering such apparatus in connection with the construction of the Works or for any other purpose whatsoever.

Prior to commencing construction and subsequent to the Contractor's determination of the location of the existing utility and service lines and the condition of the adjacent areas, the Contractor shall prepare and submit to the Engineer for his review shop drawings complete with the description of procedure and materials and related data of the Contractor's proposed method of protection for the said lines. Review, comments and approval by the Engineer shall in no way relieve the Contractor of the full responsibility for all protection and precaution required during the Works.

1.08 DAMAGE TO EXISTING UTILITIES AND PROPERTIES

- A. In the event of any damage to utilities or properties as a result of work carried out by the Contractor, his agents, employees, or by the sub-contractors or their agents, employees, the Contractor shall be responsible for indemnification against such damages.
- B. The Employer shall have the right, upon receiving any claims from the party concerned in respect for such damages, to deduct the actual costs charged to the Employer from monies due or becoming due to the Contractor without it being necessary to serve a notice or warning or to take any legal action and the Contractor shall not be entitled to object, refrain from or suspend the work on account of such deduction.
- C. In the event of any damage whatsoever to any existing or relocated utility and/or service lines, the Contractor shall immediately notify the Employer, the Engineer and the relevant utility or Service Ministries, Authorities or Companies. The Contractor shall co-operate with the Employer and the Client of such utility or service and take whatever steps necessary to repair and restore such utility or service all in accordance with the requirements of the Contract Documents. The decision of the Employer regarding responsibility for any damage or interruption of any utility or service shall be final.

END OF SECTION

SECTION 01200
PAYMENT, PROGRAM & MEASUREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES; the following minimum items

- A. Measurement and payment criteria applicable.
- B. Defect assessment and non-payment for rejected work.
- C. Program Development and Adjustments
- D. Cost Loading

1.02 RELATED SECTIONS; This schedule is intended to be used as a helpful indication of the related sections within the Project specifications. It is not necessarily comprehensive or complete and it is the Contractors responsibility to ascertain all applicable sections required to understand the full Scope of Works intended.

- A. Document - General Conditions: Progress Payments and final Payment.
- B. Section 01320 Project Coordination.
- C. Section 01330 Submittal: Submittal Procedures.
- D. Section 01770 Contract Close-out: Final Payment.

1.03 AUTHORITY

- A. Measurement methods delineated in the Principles of Measurement within the Bills of Quantities apply to all work requiring measurement for payment.
- B. Take all measurements and compute quantities for the purpose of interim payments. The Engineer will verify measurements and quantities. Assist by providing necessary equipment and survey personnel as required to enable the Engineer to verify measurements and quantities.

1.04 UNIT QUANTITIES

- A. Measurements of work in place and required by the Contract, supplied by the Contractor and verified by the Engineer, shall determine payment for interim purposes.

1.05 DEFECT ASSESSMENT

- A. Replace work not conforming to specified requirements.
- B. If, in the opinion of the Engineer, it is not practical to remove and replace the work, the Engineer will direct one of the following remedies:
 - 1. The defective work may remain, but the unit sum/price will be adjusted to a new sum/price at the discretion of the Engineer.
 - 2. The defective work will be partially repaired to the instructions of the Engineer, and the unit sum/price will be adjusted to a new sum/price at the discretion of the Engineer.

- C. The authority of the Engineer to assess the defect and identify payment adjustment is final.

1.06 NON-PAYMENT FOR REJECTED PRODUCTS

- A. Payment will not be made for any of the following:
 - 1. Products wasted or disposed of in a manner that is not acceptable.
 - 2. Products determined as unacceptable before or after placement.
 - 3. Products not completely unloaded from the transporting vehicle.
 - 4. Products placed beyond the lines and levels of the required work.
 - 5. Products remaining on hand after completion of the work.
 - 6. Loading, hauling and disposing of rejected products.

1.07 CONTRACT PROGRAMME - GENERAL

- A. CONTRACTOR SHALL BE RESPONSIBLE; for submitting adequate planning data and acceptable cost distribution information for the development and maintenance of the Contractor's Cost Loaded Construction Programme (hereinafter referred to as the Construction Programme) all to the approval of the Engineer as detailed hereinafter.
- B. PROGRAMMING AND REPORTING PROCEDURES; required to be carried out by the Contractor are included in this clause. The Contractor shall develop the Construction Programme by cost loading the activities and sub-activities as shown in his Construction Programme.
- C. CONSTRUCTION PROGRAMME; shall be updated at the request of the Engineer showing actual progress of activities compared with planned progress.
- D. FAILURE OF THE CONTRACTOR; to comply with the requirements of this Clause shall be grounds for recommendation by the Engineer that no further progress payments shall be made until the Contractor is in compliance.
- E. CONSTRUCTION PROGRAMME SUBMITTALS; shall be signed by the duly Authorized representative of the Contractor and these documents, upon approval by the Engineer shall thereupon become incorporated into the Contract Documents for the Project.
- F. PLANNING ENGINEER; The Contractor shall designate a Part time Planning Engineer who shall be responsible for the content and development of the Contractor's Construction Programme using a proprietary project planning software program such as Primavera or similar. This representative shall have direct control and complete authority to act on behalf of the Contractor in fulfilling the requirements of the Construction Programme and such authority shall not be interrupted throughout the duration of the Contract.

1.08 PROGRAMME OF WORKS

- A. SUBMIT FOR ENGINEERS APPROVAL; Within (7) days of signing the contract, the Contractor shall submit the details of Planning Engineer to the Engineer's approval. The qualification and experience of his scheduler or his program Consultant, the scheduler or program consultant must have intensive experience in planning of similar jobs and the Contractor has to submit proof to the required experience as required in Tendering Procedures.

- B. MASTER SCHEDULE; In bar chart format indicating the Contractors proposed work programme shall be submitted to the Engineer within (7) days after approval of the Contractor's scheduler or program Consultant, the Contractor shall submit a master schedule in bar chart format indicating the Contractor's proposed work program. The schedule shall be of adequate detail to indicate all elements of constructions as well as shop drawings submittals, permits, material deliveries and other procurement work items. The approved master schedule shall be used to monitor progress until the detailed Contractor's C.P.M. schedule is approved.
- C. C.P.M. CONSTRUCTION DETAILED SCHEDULE; shall be submitted by the Contractor within 14 days of submitting the Master schedule to show the sequence and interdependence of activities required for complete performance of all items of work under the contract and meeting milestone dates as required. In preparing the Contractor's C.P.M. Construction Schedule the contractor shall comply with the formatting requirements of the Engineer and exercise care to produce a clear legible and accurate logic, activities related to specific physical areas of the project shall be grouped. The logic shall show the following for each work activity.
- 1) Concise description of the Work.
 - 2) Performance responsibility codes
 - 3) Performance location and / or area code
 - 4) Performance trade / division code
 - 5) Duration in calendar days.
 - 6) Manpower assignment to activity of works (Resource Loading).
 - 7) Cash Flow Charts
- D. SUPPORTING DATA; Contractor shall submit the under mentioned supporting data with the submittal of his C.P.M. detailed construction schedule, any changes in this information shall be submitted with successive updates and revisions:-
- The holidays and non-working days observed during the contract period (by date).
 - The planned number of shifts per day.
 - The planned usage of major construction equipment on the site, on a monthly basis.
 - The planned procurement and delivery of local and imported materials.
 - The average weekly manpower usage for each trade of the works.
- E. ACTIVITY DETAILS; The contractor shall provide as a minimum the following schedule information for each activity.
- Activity identifier(s)
 - Activity description
 - Different used codes.
 - Original duration
 - Early and late start and finish dates
 - Total float time.

- F. REPORTS; Contractor shall provide the following schedule reports:
- Total schedule by activity identification
 - Total schedule sorted by total float
 - Total schedule sorted by early start dates
 - Schedule report by areas of work
 - Schedule report by responsibility
 - Summary schedule in form of bar chart sorted and summarized by trade from the detailed schedule.
 - Logic diagrams grouped by work type.
- G. SUBMITTAL REQUIREMENTS; as follows
- Three copies of all reports
 - Three copies of supporting data
 - One DVD back-up
- H. SCHEDULE OF VALUES AND COST LOADED CONSTRUCTION SCHEDULES;
- Within (10) days after obtaining approval of his construction schedule, the contractor may submit for the Engineer's approval a cost loaded schedule i.e. the construction schedule after entering the amount of each activity, based upon the bill of quantities along with detailed schedule of values.
 - The Contractor's cost loaded schedule may be the basis for calculating interim payments pro-rata to the work performed. The cost load construction schedule and the calculation for the interim payment shall employ computerized C.P.M. techniques.
 - The contractor may submit back-up DVD's along with his submittal of cost loaded schedule.
- I. FAILURE OF CONTRACTOR TO PRODUCE AND SUBMIT THE DETAILED C.P.M. CONSTRUCTION SCHEDULE; within (45) days from date of signing the contract shall result in applying a penalty of USD250/- for each day after the mentioned date till he submit the detailed schedule.
- J. FAILURE OF CONTRACTOR TO OBTAIN THE ENGINEER'S APPROVAL TO THE DETAILED CONSTRUCTION SCHEDULE; within (60) days from date of signing the contract, shall result in applying a penalty of USD500/- for each day till approval.
- K. DELAY IN SUBMISSION IN DETAILED C.P.M. SCHEDULE; more than 45 days from signing the Contract but succeeded to submit and obtain approval to the detailed C.P.M. schedule within 60 days after signing the contract, then any amounts deducted as penalties related to his delay in submitting the detailed scheduled shall be returned to the Contractor.
- L. SCHEDULING SYSTEM; The Contractor shall utilize the latest version of "Primavera" scheduling software. An original version of the software shall be made available for the exclusive use of Engineer at site.

- M. UP DATES; The Contractor shall update the detailed approved construction schedule for review in every site meetings or when requested by the engineer, the reports shall include the following information:
- Actual start and finish dates of completed activities.
 - Remaining duration and percentage of completion for all activities not completed.
 - Logic, time and cost data for variation order and approved site work instructions.
 - Interim payment due to the Contractor, based on percentage completion of activities in the approved cost loaded schedule.
 - Contractor's measures to rectify the delays from the planned dates.
- N. ADJUSTMENTS AND REVISIONS; The Contractor shall incorporate into the approved C.P.M. Schedule all approved variations orders and site work instructions as separate activities in their logic sequence of work. No adjustment or revisions to the Contract time shall be shown in the C.P.M schedule until such adjustment or revisions have been approved by the engineer.
- O. DELAY IN SUBMITTING UPDATED OR REVISED SCHEDULE; within 15 days from the date of requesting the same by the engineer, will automatically empower the engineer to recommend the Owner to employ any professional office to do the same on the account of the Contractor.

1.09 VARIATION ORDERS/SITE WORKS INSTRUCTIONS

- A. The Contractor shall incorporate into the Programmes all work related to Variation Orders and Site Instructions. They shall be incorporated as separate activity(s) in their logical sequence of work. Any requests for an extension of time and/or change in milestone date resulting from a Variation Order and/or Site Instructions shall be based on the effect that the variation has on the critical activities in the approved Programme. No change to the Contract Time or to specified Milestone Dates shall be shown on the Programme unless the change has been approved or instructed by the Engineer.

END OF SECTION

SECTION 01310

PROJECT COORDINATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project coordination administrator.
- B. Program and Service Co-ordination.
- C. Construction mobilization.
- D. Coordination of the Site Work.
- E. Arrangements for Site Meetings.
- F. Schedules.
- G. Submittals.
- H. Coordination drawings.
- I. Closeout procedures.

1.02 RELATED SECTIONS; This schedule is intended to be used as a helpful indication of the related sections within the Project specifications. It is not necessarily comprehensive or complete and it is the Contractors responsibility to ascertain all applicable sections required to understand the full Scope of Works intended.

- A. Section 01110 - Summary of Work.
- B. Section 01200 - Program, Payment and Measurements.
- C. Section 01330 - Submittals
- D. Section 01320 – Progress Schedules
- E. Section 01770 - Contract Closeout. Contract Closeout Procedures.

1.03 PROJECT COORDINATION

- A. Project Coordination Administrator - The Engineer or his representative.
- B. The Contractor shall be entirely responsible for the co-ordination and proper execution and completion of the works and this responsibility shall in no way be reduced by the employment of sub-contractors whether approved, nominated or otherwise. The Contractor shall co-ordinate the work of each trade with that of all other trades and shall ensure that all trades co-operate to assure the required and steady progress of all work under the Contract.
- C. The Contractor shall also co-ordinate his work with that of any other contractors, authorities or organizations performing works under separate contracts to ensure no delay, disruption or interference is caused to such other contracts. Unless otherwise agreed by the Engineer, the Contractor shall not be permitted to work in the vicinity of works being executed by any Ministry or its contractor. Where the Contractor delays the co-ordination of the works, he shall hold the Engineer harmless for any consequential claims resulting from such delays.

1.04 PROGRAMME AND SERVICES CO-ORDINATION

- A. The Contractor shall, prior to commencement of the project, prepare a time programme to be approved by the Engineers in which he shall elucidate procedures and measures to be followed and the date of completion of stages of work. The programme shall not be altered without the approval of the Employer.

- B. The Contractor shall notify other Ministries and Authorities whose services might be affected by the Works regarding this programme. He shall also submit fortnightly details of the works contemplated for execution in order to enable the Service Authorities to carry out inspections and/or to indicate their services on the site, and/or to take measures deemed necessary. The Employer shall assist the Contractor to liaise with other Ministries and Authorities with a view to expedite the obtaining of the required details.
- C. The Contractor must also ensure that he obtains any work or excavation permits from the Services Authorities or Companies necessary to allow him to carry out construction works in the vicinity of existing services.
- D. The Contractor shall, prior to carrying out covering up or backfilling, notify the said Authorities with a view to inspecting the site of work and ascertaining the safety of those services and supervising the covering up and backfilling works. Such supervision shall not relieve the Contractor of any responsibility, if it is established that his work had affected the public services.

1.05 PRE-CONSTRUCTION CONFERENCE

- A. A Pre-Construction Meeting will be held at least 15 days prior to the commencement of the Works, to be attended by the Contractor and his major sub-contractors.
- B. The agenda for the Pre-Construction meeting will be provided to the Contractor by the Engineer a minimum of 3 days prior to the meeting. The agenda will include but not limited to:
 - 1. Contractor's organization agreements.
 - 2. Channels and procedures for communication.
 - 3. Construction Schedule, including sequence of critical work.
 - 4. Contract Documents, including distribution of required copies.
 - 5. Processing of shop drawings and other data to be submitted to the Engineer for review.
 - 6. Processing of Site decision and variation/change orders.
 - 7. Rules and regulations governing performance of the work.
 - 8. Procedures for safety and first aid, security, quality control, house keeping, etc.
 - 9. Procedures for reporting and monitoring progress, cost, materials, labour and equipment.

1.06 CONSTRUCTION MOBILIZATION

- A. Cooperate with the Administrator in allocation of mobilization areas of site, for field offices and sheds, for access, traffic, and parking facilities.
- B. During construction, co-ordinate use of site and facilities through the Administrator.
- C. Comply with Administrator's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.

- D. Comply with instructions of the Administrator for use of temporary utilities and construction facilities.
- E. Coordinate field engineering and layout work under instructions of the Administrator.

1.07 PROGRESS MEETINGS

- A. Contractor shall attend regular site meetings as necessary for the proper management and co-operation of the contract. Subcontractors as suppliers are to be informed, when their presence is required.

The scheduling and co-ordination meeting shall be as directed by the Engineer.

- B. Two days before each site meeting submit the following information to the Engineer:
 - a) A list of completed activities.
 - b) A list of current activities, with an estimate of time required for completion.
 - c) A list of any variation in starting dates and durations of outstanding activities from planned dates and times.
 - d) Percentage of completion in every activity.
 - e) The concrete volume cast during the last period and the present total sum of the cast concrete volume.
 - f) Activities the Contractor plans to start during the following period should be indicated.
 - g) Other information required by the Engineer.

1.08 JOB SITE ADMINISTRATION

- A. Do not use the Site for any purpose other than carrying out the Works.
- B. Do not display or permit advertisements to be displayed on site without consent of the Engineer.

1.09 ADJOINING PROPERTY

- A. Take all reasonable precautions to prevent damage to adjoining properties.
- B. Obtain permission as necessary from Client of adjoining property if requiring to erect scaffolding or otherwise use adjoining property, and pay all charges. Clear away and made good on completion or when directed.

1.10 STRUCTURAL FABRIC

- A. Provide and maintain during the execution of the Works all shoring, strutting, needling and other supports as may be necessary to preserve the stability of the buildings, whether new or existing, on the Site or adjoining, than may be endangered or affected by the Works.

1.11 ROADS AND FOOTPATHS

- A. Ensure that no damage beyond fair wear and tear is caused by site traffic to roads and footpaths outside the site boundaries. Adequately maintain approaches to the site and keep clear of mud, sand and debris. Each contractor will be required to

repair damage directly attributable to his work, such as excavation and trenches access the site access road.

1.12 LABOUR RECORD

- A. Provide a daily record to the Engineer in a format to be approved by the Engineer, showing the number and description of craftsmen, laborers and other persons employed on or in connection with the works, including those employed by sub-contractors.

1.13 PLANT RECORD

- A. Provide a monthly record to the Engineer in a format to be approved by the Engineer, showing the type, model and capacity of all mechanical and power operated plant employed on the works. The contractor will not be permitted to remove any plant or material unless written approval is obtained from the Engineer plant record to be submitted daily.

1.14 VISITORS RECORD

- A. Maintain a record of visitors to the Site, and submit at monthly intervals to the Engineer.

1.15 NON-COMPLIANCE

- A. Work which fails to meet the specified levels of accuracy must not be rectified without approval.
- B. Submit proposals for such rectification and meet all costs arising, including effects on other work.
- C. Allow for the possibility that approval will not be given, necessitating removal and replacement of the work.

1.16 DEFECTIVE WORKS

- A. As soon as possible after any part of the work is known or suspected to be defective, submit proposals to the Engineer for further testing, opening up, inspection, making good or removal and re-execution and obtain instructions.
- B. Whenever inspection or testing shows that the work is not in accordance with the Contract and measures (e.g. testing, opening up, experimental making good) are taken to establish the acceptability of the work, such measures:
 - 1. Will be at the expense of the Contractor, and
 - 2. Will be not considered as grounds for extension of time.

1.17 SCHEDULES

- A. Submit preliminary progress schedule in accordance with Section 01320 coordinated with project construction schedule.
- B. After review, revise and resubmit schedule to comply with revised Project schedule.
- C. During progress of work revise and resubmit as directed.

1.18 SUBMITTALS

- A. Submit preliminary shop drawings, product data, samples, etc. in accordance with Section 01330 for review and compliance with Contract Documents, for filed dimensions and clearances, for relation to available space, and for relation to work of separate contracts. Revise and resubmit as required.
- B. Submit requests for interpretation of Contract Documents, and obtain instructions through Administrator.
- C. Process requests for substitutions, and change orders, through Administrator.
- E. Deliver closeout submittals for review and preliminary inspection reports, for transmittal to Engineer.

1.19 COORDINATION DRAWINGS

- A. Provide information required by Administrator for preparation of coordination drawings.
- B. Review drawings prior to submission to Engineer.

1.20 CLOSEOUT PROCEDURES

- A. Notify Administrator when Work is considered ready for Substantial Completion. Accompany Administrator on preliminary inspection to determine items to be listed for completion or correction in Contractor's notice of Substantial Completion.
- B. Comply with Administrator's instructions to correct items of work listed in executed Certificates of Substantial Completion.
- C. Notify Administrator when Work is considered finally complete. Accompany Administrator on preliminary final inspection.
- D. Comply with Administrator's instructions for completion of items of Work determined by Engineer's final inspection.

END OF SECTION

SECTION 01320
PROGRESS SCHEDULES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Format.
- B. Content.
- C. Revisions to schedules.
- D. Submittals.

1.02 RELATIONS SECTIONS

- A. Section 01110 - Summary of Work.
- B. Section 01330 - Submittals: Shop drawings, product data, and samples.

1.03 FORMAT

- A. Prepare Schedules as a horizontal bar chart with separate bar for each major portion of Work or operation, identifying first work day of each week.
- B. Sequence of Listings: The chronological order of the start of each item of Work.
- C. Scale and Spacing: To provide space for notations and revisions.
- D. Sheet Size: Multiples of A4-size.

1.04 CONTENT

- A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
- B. Identify each item by Specification section number.
- C. Identify work of separate stages and other logically grouped activities.
- D. Provide sub-schedules to define critical portions of the entire Schedules.
- E. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.
- F. Provide separate schedules of submittal dates for shop drawings, product data, and samples, and dates reviewed submittals will be required from Engineer. Indicate decision data for selection of finishes.

1.05 REVISIONS TO SCHEDULES

- A. Indicate progress of each activity to date of submittal, and projected completion date of each activity.
- B. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes.

- C. Provide narrative report to define problem areas, anticipated delays, and impact on Schedule. Report corrective action taken, or proposed, and its effect including the effect of changes on schedules of separate contractors.

1.06 SUBMITTALS

- A. Submit initial Schedules within 10 days after date of Client-Contractor Agreement. After review, resubmit required revised data within ten days.
- B. Submit revised Progress Schedules Progress Schedules with each Application for Payment.
- C. Submit the number of copies which Contractor requires, plus 4 copies which will be retained by Engineer.

1.07 DISTRIBUTION

- A. Distribute copies of reviewed Schedules to project site file, Subcontractors, suppliers, and other concerned parties.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections indicates in Schedules.

END OF SECTION

SECTION 01330 SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Submittals procedures.
- B. Construction progress schedules.
- C. Proposed Products list.
- D. Shop drawings.
- E. Product data.
- F. Samples.
- G. Manufacturer's instructions and Certificates.
- H. Construction photographs.

1.02 RELATED SECTIONS

- A. Section 01400 - Quality Control: Manufacturer's field services and reports.
- B. Section 01770 - Closeout: Contract closeout submittals.

1.03 SUBMITTAL PROCEDURES

- A. Transmit each submittal with Engineer accepted form.
- B. Sequentially number the transmittal forms. Resubmittals to have original number with an alphabetic suffix
- C. Identify Project, Contractor, Subcontractor or supplier, pertinent Drawing sheet and detail number(s), and specification Section number, as appropriate.
- D. Schedule submittals to expedite the Project, and deliver to Engineer.
- E. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.
- F. Revise and resubmit submittals as required, identify all changes made since previous submittal.
- G. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

1.04 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit initial progress schedule in 4 copies within 10 days after date of Client-Contractor Agreement for Engineer review.
- B. Revise and resubmit as required.
- C. Submit revised schedules with each Application for Payment, identifying changes since previous version.
- D. Submit a chart with separate line for each major section of Work or operation, identifying first work day of each week.
- E. Submit the following Progress Reports described hereinafter in a form required by the Engineer in 4 copies.

- a) Daily report: The Contractor shall submit this report on a daily basis. The report shall describe the labor force and its allocation, material, equipment to be utilized and describe the work to be carried out during the day.
- b) Monthly report: The Contractor shall submit a detailed report reflecting his monthly progress and status of work. This report shall include a description of problem areas, current and anticipated causes of delay and their estimated impact on progress, together with a description of corrective measures taken or proposed, in addition to staffing and plant levels and materials procurement.
- c) Weather Records
Keep an accurate record of:
 - 1) Daily maximum and minimum air temperature, rainfall and humidity (including overnight).
 - 2) Number of hours per day in which work is prevented by inclement weather. Provide maximum and minimum thermometers at locations relevant to the nature and stage of the work as approved by the Engineer.

1.05 PROPOSED PRODUCTS LIST

- A. Within 30 days of contract award, the contractor must submit to the Engineer in a format approved by the Engineer 4 copies of a complete schedule of all submittals required under this contract and a shop drawing schedule, manufacturer's test certificate, testing, operation and maintenance, etc. Also within 30 days of contract award the contractor must submit to the Engineer a procurement schedule in an approved format providing information on all material that the contractor must purchase under this contract.
- B. For products specified only by reference standards, give manufacturer trade name, model or catalogue designation, and reference standards.

1.06 SHOP DRAWINGS

- A. The drawings issued with these Tender and Contract Documents are issued solely to show the basic principles on which tenders are to be prepared. The drawings are not to be taken as working drawings. Shop, or working, drawings and, where specified, design drawings are to be prepared and submitted by the Contractor in accordance with other sections of the Contract Documents.
- B. Do not scale from Drawings. Obtain from the Engineer any dimensions required but not given in figures on the Drawings nor calculable from figures on the Drawings.
- C. Provide design, coordination, installation, shop and builder's work drawing and other information as appropriate, collectively referred to as 'Shop Drawings'. Allow for completion of all such drawings, etc., checking, inspection by the Engineer and any subsequent amendment(s) re-submission(s) and re-inspection(s) when preparing the master programme for the works.
- D. Produce all drawings, etc. in time to meet the programme. Thoroughly check all drawings, etc. to ensure that the various works, installations and services do not conflict with each other or with the building structure, fabric or finishes, either during construction or in the finished building. Note any such discrepancies or divergences on one copy drawings, etc., date and sign to show that they have been checked then submit to the Engineer with the required number of additional unmarked copies.

- E. The Engineer will note any comments on one copy of the drawings, etc., date and sign to show that they have been inspected, then return to the Contractor. Inspection of drawings, etc. and any comments made by the Engineer will not relieve the contractor, Sub-contractor and/or suppliers or responsibility for compliance with the Contract requirements, design, documentation and checking as appropriate.
- F. Ensure that any necessary amendments to drawings, etc., are made in accordance with any comments of the Engineer and without delay. Unless and until the Engineer confirm that re-submission is not required, obtain copies of amended drawings, etc., check, re-submit to the Engineer ensure incorporation of necessary further amendments all as before.
- G. Produce final version of all drawings, etc., submit the required number of copies to the sub-contractors and suppliers, and keep at least one copy out in accordance with the final drawings, etc.
- H. Metric measurements shall be used in all documents and drawings. If imperial or other units are shown, equivalent metric measurements shall be shown in addition.
- I. Submit one set of sepia transparencies and 5 sets of full-size paper copies of all shop drawings, including detailed fabrication and erection drawings, setting out drawings, diagrammatic drawings and materials schedules, together with relevant samples. Submit shop drawings and product data for equipment in a given system at the same time, with each set bound in a separate brochure. Sepia transparencies shall be rolled and transmitted in mailing tubes. If submitted drawings, etc., differ from requirements of the Contract Documents, each such difference must be the subject of a request for substitution of variation, supported by all relevant information.
- J. Should any amendment to drawings, etc., required by the Engineer or any discrepancy or divergence that he may find be considered to involve or be a variation, notify the Engineer without delay and in any case within 7 days, and do not proceed with ordering, fabrication, erection or installation until subsequently instructed. Claims for the extra cost of such work, if made after it has been carried out, may not be allowed.
- K. Each shop drawings shall identify the Project, Contractor, sub-contractor, fabricator or manufacture and give the date of drawing. They shall be numbered sequentially and each sheet shall indicate the total number of sheets in the set.
- L. Each shop drawing shall be clearly marked to indicate which product or item is being submitted for consideration and each product or item shall be marked for identification with the applicable page and clause number of the Specification and/or the detail and sheet number of the Contract Drawings.
- M. Shop drawings shall include types, gauges and finishes of materials and show the brand name and manufacturer's type identification number where a shop coat of paint is required.
- N. Each set of shop drawings shall include sufficient data to permit a detailed study of the product or system submitted Submit manufacturer's or fabricators pre-printed product literature and data sheets, normally transmitted in booklet or brochure form, in bound and indexed brochures. If brochures contain sheets longer than A4, they shall be bound to allow them to be unfolded for reading without being removed from the binding. Submit 5 copies of shop drawings brochures, 1 of which will be retained by the Engineer.

1.07 PRODUCT DATA

- A. Submit 5 copies 4 which will be retained by the Engineer.

- B. Mark each copy to identify applicable products, model, options, and other data. Supplement manufacturer's standard data to provide information unique to this Project.
- C. After review, distribute in accordance with Article on Procedures above and provide copies for Record Documents described in Section 01770 - Contract Closeout.

1.08 SAMPLES

- A. Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices. Coordinate samples submittals for interfacing work.
- B. Submit samples of finishes from the full range of manufacturer's standard colours, textures, and pattern for Engineer's selection.
- C. Include identification on each sample, with full Project information.
- D. Within 30 days of contract award, submit to the Engineer a complete schedule indicating all the samples the contractor must be required to produce, including the scheduled time of the sample submittals.

1.09 MANUFACTURER'S INSTRUCTIONS & CERTIFICATES

- A. When specified in individual specification, Sections, submit manufacturer's printed instructions for delivery, storage, assembly, installation, adjusting, and finishing, in quantities specified for Product Data.
- B. Identify conflicts between manufacturer's instructions and Contract Documents.
- C. Indicate materials or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

1.11 CONSTRUCTION PHOTOGRAPHS

- A. Each month submit 4 sets of 20 colour photographs to the Engineer.
- B. Photographs: Colour, matte, 120 x 180 mm size, mounted on A4-size soft card stock, with left edge binding margin for hole punch, each set contained in an album, each photograph signed and dated by the Contractor.
- C. Take site photographs from differing directions and interior photographs indicating the relative progress of the Work, 7 days maximum prior to submitting, from directions as instructed by the Engineer.
- D. Identify photographs with date, time, orientation and project identification.

END OF SECTION

**SECTION 01450
QUALITY CONTROL**

PART 1 GENERAL

1.01 SECTIONS INCLUDES

- A. Quality assurance and control of installation.
- B. References.
- C. Field samples.
- E. Inspection and testing laboratory services.
- G. Quality control of on-site construction.
- I. Schedule of quality control plan.
- J. Reports.
- K. Latest Documents.
- L. Testing and Inspection Devices.
- M. Test methods.
- N. Supervisory staff.

1.02 RELATED SECTIONS

- A. Section 01330 - Submittals: Submission of Manufacturer's Instructions and Certificates.
- C. Section 01600 - Materials and Equipment: Requirements for materials and product quality.
- D. Section 01750 - Starting of Systems.
- E. General Conditions of Contract Clause 36.4 – Cost of Tests not provided for

1.03 QUALITY ASSURANCE/CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply fully with manufacturer's instructions, including each step in sequence.
- C. Should manufacturer's instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standard or more precise workmanship.
- E. Perform work by persons qualified to produce workmanship of specified quality.
- F. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

1.04 REFERENCES

- A. Conform to reference standard by date of issue current on date for receiving bids.
- B. Obtain copies of standards when required by Contract Documents.
- C. Should specified reference standards conflict with Contract Documents, request clarification for Engineer before proceeding.
- D. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.05 FIELD SAMPLES

- A. Install field samples at the site as required by Engineer for review.
- B. Acceptable samples represent a quality level for the Work.

1.06 QUALITY CONTROL OF ON-SITE CONSTRUCTION

The Contractor shall provide a control system for the following phases of inspection:

PREPARATORY INSPECTION

This inspection shall be performed prior to beginning work on any particular element of the works and shall include a review of the Contract requirement. The Contractor shall check that materials, products and equipment have been tested, submitted and approved, check that provisions have been made for required control testing, examine the work area to ascertain that preliminary work has been completed, examine materials and equipment to ensure that they conform to shop drawings and data and check that the materials and equipment are in hand.

FOLLOW-UP INSPECTIONS

The Contractor shall perform further inspection as each section, trade or part of the work commence and on a regular basis thereafter to ensure continuing compliance with Contract requirements.

DOCUMENTATION OF QC PROGRAM

The Contractor shall identify the inspections hereinbefore specified and document them in the QC report with a brief description of the subject matter covered and the personnel involved.

1.07 SCHEDULE OF QUALITY CONTROL PLAN

The Contractor shall furnish a schedule outlining the procedures, instructions and reports to be used as follows:

- 1) Quality control organization.
- 2) Qualifications of personnel.
- 3) Authority and responsibility of personnel.
- 4) Schedule of inspections and tests with personnel assigned to each task and duration of each task.
- 5) Test methods.
- 6) Methods of performing and documenting control operations

1.08 REPORTS

Inspection shall be recorded in triplicate and submitted by the Contractor as required by the Engineers approved forms certifying items correctly installed and items found to be defective, for the latter a statement on corrective measures taken shall be duly recorded and submitted.

The Contractor shall also maintain in a format approved by the Engineer a log of all test performed which shall include date of test, type of test and results.

1.09 TESTING AND INSPECTION DEVICES

All measuring and testing devices shall be calibrated periodically against certified standard equipment.

1.10 SUPERVISORY STAFF

A. The minimum qualifications of contractors supervisory site staff shall be as specified and shall be approved by the Engineer prior to assignment of subject staff to the project. The Engineer has the authority to ask the contractor to remove unsatisfactory staff by providing the contractor with written notice of this effect. The replacement of such staff shall take place within 2 weeks of the Engineer notice. The minimum Contractor's staff shall be as follows,

- Project Manager (1 No) -Civil Engineering Graduate with minimum 10 years experience and 5 years in similar projects
- Site Engineer (1 No) - Civil Engineering Graduate with minimum 7 years experience and 5 years in similar projects
- Mechanical Engineer (1 No) - Mechanical Engineering Graduate with minimum 7 years experience and 3 years in similar projects
- Electrical Engineer (1 No) -Electrical Engineering Graduate with minimum 7 years experience and 3 years in similar projects
- Planning Engineer (1 No) - Engineering Graduate with minimum 5 years experience and familiar in M S Project or similar Planning Software
- Site Supervisors (1 Nos.) -Engineering Diploma with minimum 7years experience and 3 years in similar projects
- Quantity Surveyor (1 No) -Quantity Surveying with minimum 5 years experience and 3 years in similar projects
- Land Surveyor (1 No) -Engineering / Surveying Diploma with minimum 5 years experience and 3 years in similar projects

B. No staff shall be changed without the Engineer written consent. The contractor's and sub-contractor's senior site staff shall be fluent in technical English.

END OF SECTION

SECTION 01500
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary Utilities: Electricity, ventilation, telephone service, water, and sanitary facilities.
- B. Temporary Controls: Barriers, enclosures and fencing and protection of work.
- C. Construction Facilities: Access roads, parking, progress cleaning, and temporary buildings.

1.02 TEMPORARY ELECTRICITY

- A. Provide and pay for power service.

1.03 TEMPORARY LIGHTING

- A. Provide and maintain lighting for construction operations.
- B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- C. Maintain lighting and provide routine repairs.

1.04 TEMPORARY VENTILATION AND AIR CONDITIONING

- A. Ventilate and/or air condition the offices and accommodation of Engineers and Contractors staff

1.05 TELEPHONE SERVICE

- A. Provide, maintain and pay for telephone service to field office and Engineer's field office at time of project mobilization.

1.06 TEMPORARY WATER SERVICE

- A. Provide, maintain and pay for suitable quality water service required.

1.07 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide protection for plant life designated to remain. Replace damaged plant life.
- C. Protect non-owned vehicular traffic, stored materials, site and structures from damage.

1.08 SECURITY AND SAFETY

- A. Provide security and facilities to protect Work and existing facilities from unauthorized entry, vandalism, or theft.

- B. Accident Prevention Responsibility: Safety Meetings shall be held at least once a week at the jobsite. The meetings will be convened and conducted by the Safety Co-coordinator. All supervisors and foremen are expected to be in attendance. Each subcontractor will have a responsible representative present to follow through on information and resolutions discussed and adopted at these meetings. The Contracting Officer's Representative, or his designated agent, is encouraged to attend these meetings.

The Agenda for the Safety Meetings will generally include inter alia.

1. Development of timely topics for discussions and dissemination of Safety Bulletins, Signs and Notices.
 2. A review of the Safety Co-coordinator's inspections.
 3. Identification of potential safety hazards in the coming month and discussion and implementation of steps to be taken to avoid the same.
 4. Appointment of Safety Representatives for subcontractors.
- C. All supervisors and foremen are responsible to plan and accomplish their work with due regard for the safety of all individuals on the jobsite. They will be expected to eliminate all possible accident hazards when planning the work under their control. It is expected the subcontractors will observe and correct any accident producing practices before injury occurs. If an accident does occur, they will investigate to determine the cause and take the required corrective action to prevent a recurrence. All accidents shall immediately be reported to the Project Superintendent and to the Engineer.
- D. First Aid and Medical Facilities: First Aid facilities will be provided at the project site as required. A vicinity map indicating routing to emergency facilities will be posted in the first aid station and on the Project Bulletin Board.
- C. In the event of any employee being sent to a doctor for treatment, a release will be obtained from the doctor stating whether (1) the employee is not fit for duty; (2) the employee is fit for light duty; or (3) the employee is fit for duty. A copy of this release will accompany the accident report.
- D. Safety Check List:
1. Prepare Safety Programme.
 2. Post Safety programme on Job Bulletin Board. Prepare and post Fire Prevention Programme.
 3. Analyze job for potential hazards and hazardous procedures.
 4. Establish plan for location of material storage, personal facilities and traffic flow.
 5. Arrange for debris removal.
 6. Establish procedure to obtain Subcontractor Safety Programmes.
 7. Obtain claims forms.
 8. Contract Loss Prevention Department of Insurance Carrier.
 9. Obtain a report form for reporting accidents and injuries.
 10. Establish adequate first aid kit and stretcher facilities.

11. Post chart to signify weekly checks of first aid kits.
12. Conduct a preconstruction survey of surrounding property existing condition, if appropriate.
13. Arrange for watchman service, if required.
14. Verify insurance on subcontractors starting work on site prior to final execution of subcontractors.
15. Obtain safety equipment appropriate to operations:
 - a. Hard hats
 - b. Safety belts
 - c. Goggles
 - d. Ear protection
 - e. Carbon monoxide tester.
16. Arrange for and post, safety posters and warning signs.
17. Establish weekly tool box safety talks.
18. Establish weekly safety meetings.
19. Appoint a safety supervisor and set date for the first safety meeting.

E. Worker Indoctrination

1. Minimum Protective Clothing
 - a) Hard hats are required at all times.
 - b) Protective eye covering will be worn when welding, hammering metal, stone, or concrete, grinding or cutting metal units.
2. Minimum Safety Observances
 - a) Work areas and access ways are to be free of trash, materials, and all tripping hazards.
 - b) Temporary electrical wiring will be protected from damage, be in good condition and protected by ground fault circuit interrupters.
 - c) All accidents are to be reported directly to supervisors, and the Engineer.
 - d) All equipment must meet the Safety Standards, described in these specifications.

1.09 WATER CONTROL

- A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- B. Protect site from puddling or running water.

1.10 PROTECTION OF INSTALLED WORK

- A. Protect installed Work and provide special protection where specified in individual specification Section.

- B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage.

1.11 ACCESS ROADS

- A. Extend and relocate roads as Work progress requires. Provide detours necessary for unimpeded traffic flow.

1.12 PROJECT NAME BOARDS

- A. The Contractor shall erect and maintain Project name board one at each island and shall display the names of project, Client, Consultant, Contractor, Executing Institution, Funding agency, Project cost, Project start/ end dates etc and any other information as per the directions from the Engineer. The language shall be both in Dhivehi and English. The size of board shall be minimum 6 ft x 6 ft and shall be in a format approved by the Engineer. The Project name board shall be erected within 14 days of effective project commencement date.

1.13 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove waste materials, debris, and rubbish from site weekly and dispose off-site.

1.14 FIELD OFFICES AND ACCOMODATION

- A. Contractor shall provide Office and Laboratory buildings with stationary and equipments for Engineer, his supervision and management staff. The minimum floor area of the office facility and the laboratory shall be 100 m². The Contractor shall submit his proposed details, layouts for the office and laboratory buildings to the Engineer for approval before leasing the properties.

The individual office rooms shall have all required furniture's, computers, printers, photocopier, telephone, internet, fax machine, digital camera and shall be maintained throughout the construction period with sufficient consumables separately for Engineer and Contractors staff. The office building for Engineer and his staff shall be provided with a kitchen.

The Contractor shall provide all materials, chemicals, and other laboratory consumables required in the laboratory for conducting the tests during the construction period. The Contractor shall supply one full time experienced Laboratory Technician to the approval of the Engineer.

The Contractor shall provide all services and infrastructure. He shall light, clean and maintain the building and shall provide water, sanitary system and arrangements for refuse disposal. The Contractor shall provide an electricity supply of sufficient power for general use, including air conditioning, and for any electric testing equipment in the laboratory.

The office and laboratory and all furniture, fixings, equipment, services, carpet, etc, all as detailed above, shall be provided complete within 30 days from the date of the Engineer's order to provide the same. The Contractor shall provide alternative accommodation to the satisfaction of the Engineer if he fails to provide as appropriate the properties within the above stated time.

- B. Furnished Accommodation at site exclusively and separately for Engineer and Contractors staff shall be provided by the Contractor and maintained throughout the

construction period. Contractors provided accommodation for Engineer and his own staff shall have separately two bedrooms, one dining/living room, one Kitchen and two toilet with all furniture's, equipments and shall be secured and maintained at all times. The minimum floor area of the Building shall be 100 m². The accommodations shall have adequate electrical, water, sanitation and air conditioning and shall be maintained by the Contractor throughout the construction period

1.15 TELEPHONE

- A. The Contractor shall arrange for the installation, commissioning and maintenance in use of one telephone line to serve the Engineer's office from the public exchange. The Contractor shall ensure that this line has the facility for local telephone calls only. Handsets, Extensions and fax machine shall be provided. On completion of the Works the telephone line rental agreement shall be terminated.

1.16 MOBILE TELEPHONE SET AND INTERNET

- A. The Contractor shall supply, commission and maintain in use one mobile telephone for the sole use of the Engineer' staff. Mobile telephone set shall be portable hand-held cellular types. Sets should have the facility for local calls and data connectivity; local calling facility worth USD 50.00 shall be provided by the contractor per month for the use of consultant and shall be borne by the contractor throughout the construction period. On completion of the Contract the ownership of the mobile telephone shall be transferred to the Employer.
- B. The Contractor shall arrange for provision of internet to serve Engineer's office throughout the construction period. Contractor shall ensure that this internet facility shall be through 3G/4G modem or wireless internet connection with best available data speed with minimum data of 3GB per month per connection. On completion of the works, the internet rental agreement shall be terminated.

1.17 SURVEYING INSTRUMENTS AND INSPECTION EQUIPMENT

- A. The Contractor shall supply, for the sole use of the Engineer, survey and other instruments and equipment. The instruments and equipment shall be new and shall be maintained in a good state of repair. In the event of loss or damage, they shall be replaced by items of a similar nature. On completion of the Contract or at such a time specified by the Engineer, all survey instruments and equipment shall revert of the ownership of the Contractor.

1.18 TRAVELS

- A. All internal travels from the island to the Ministry or Male once a month for the Engineer shall also be provided by the Contractor through the best available means of transportation.
- B. The Contractor shall arrange transports for field visits within the island at any time as required by the Engineer.

1.19 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary above grade or buried utilities, equipment, facilities, materials, prior to Substantial Completion inspection.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

END OF SECTION

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Products.
- B. Source of materials.
- C. Transportation and handling.
- D. Storage and protection.
- E. Substitutions.

1.02 RELATED SECTIONS

- A. Section 01400 - Quality Control: Product quality monitoring.

1.03 PRODUCTS

- A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
- C. Provide interchangeable components of the same manufacturer, for similar components.

1.04 SOURCE OF MATERIALS

- A. The Contractor shall use local materials and products whenever possible providing they comply with the specifications.
- B. The Contractor shall submit within fourteen (14) days of the Date of Enterprise a complete and detailed list of materials and articles proposed for use in the Works together with the names and addresses of manufacturers and suppliers.
- C. Copies of the orders for imported materials together with the supplier's confirmation of such orders shall be deposited with the Engineer as soon as they are available.
- D. Where the source of a particular material is not stated, samples of the materials specified shall be submitted to the Engineer for approval before the placing of bulk orders.
- E. The Contractor will be held responsible to ensure that all proprietary articles and materials incorporated in the Works are fixed and used in strict compliance with the particular manufacturer's instructions.
- F. The Contractor must ensure that all materials purchased will be from a reliable source which will ensure continuity of supply in case of extras and if any damage occurs at all times throughout the periods of the Contract to ensure regular supply and progress of the Works.

1.05 TRANSPORTATION AND HANDLING

- A. Transport and handle Products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to assure that Products comply with requirements, quantities are correct, and Products are undamaged.
- C. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.

1.06 STORAGE AND PROTECTION

- A. Store and protect Products in accordance with manufacturer's instructions, with seals and labels intact and legible.
- B. Provide equipment and personnel to store Products by methods to prevent soiling, disfigurement, or damage.
- C. Arrange storage of Products to permit access for inspection. Periodically inspect to assure Products are undamaged and are maintained under specified conditions.

1.07 SUBSTITUTIONS

- A. Substitutions may be considered when a Product becomes unavailable through no fault of the Contractor.
- B. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- C. A request constitutes a representation that the Contractor:
 - 1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Project.
 - 2. Will provide the same warranty for the Substitution as for the specified Product.
 - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Client.
 - 4. Waives claims for additional costs or time extension which may subsequently become apparent.

END OF SECTION

SECTION 01720

FIELD ENGINEERING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Quality control.
- B. Survey.
- C. Setting Out.
- D. Non-Compliance.

1.02 QUALITY CONTROL

- A. Employ a Land Surveyor at site throughout the construction works acceptable to Engineer.
- B. Maintain a complete and accurate log of control and survey work as it progresses.
- C. Submit Record Documents under provisions of Section 01770.
- D. Verify locations of survey control points prior to starting work.
- E. Promptly notify Engineer of any discrepancies discovered.

1.03 SURVEY

- A. Contractor to locate and protect survey control and reference points.
- B. The Contractor shall verify all measurements and be responsible for their correctness. No extra charge or compensation will be allowed on account of difference between actual measurements and the dimensions given in the Contract Documents. Any differences which may be found shall be submitted to the Engineer in writing for consideration and directives before proceeding with the works.
- C. Site Bench Marks shall be accurately and safely established, maintained and cleared away upon completion of the Works all to the satisfaction of the Engineer. The datum will be that established by Client. The Engineer will indicate the position and value of Bench Marks near the works.
- D. The Contractor shall prepare a plan detailing the location of the Bench Marks and keep up to date throughout the period of the Contract Reproducible copies of the plan so prepared shall be supplied to the Engineer as and when he may require.
- E. The Engineer reserves the right to order levels to be taken at any time considered necessary for the full and proper supervision and measurement of the works.
- F. Before the works or any part thereof are commenced, the Contractor and the Engineer shall together survey and take levels of the Site of the works and agree all particulars upon which setting out of the works shall be based, including existing pipes and services.
- G. Such levels shall be related to the Bench Marks as aforesaid and plotted by the Contractor and, after agreement of the Drawings, shall be signed by the Engineer and the Contractor, and shall form basis of setting out of the works.
- H. Failing such surveys and agreements being prepared and/or signed by the Contractor, the surveys of the Engineer shall be final and binding upon both parties.

- I. The Contractor shall plot these levels and after they have been signed by both the Engineer and the Contractor, the original with three (3) copies will be submitted to the Engineer.
- J. Promptly report to Engineer the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.

1.04 SETTING OUT

- A. After the Contractor is handed the Contract Drawings and after taking over all the existing Permanent Bench Marks, he shall carry out at his own responsibility and expense the setting out of the work, definitions of levels and setting out lines, axes and slopes, all in accordance with the Drawings.
- B. The Contractor shall be responsible for the true and proper setting out of the work in relation to original points, lines and levels of references given in the Drawings and for the accuracy of the positions, levels, dimensions and alignment of all parts of the work, and for any delay or loss resulting from errors made in completing the setting out of the work. The contractor shall protect, preserve and be responsible for all existing bench marks, pegs and boundary marks and shall keep them in place or replace them when necessary or as directed by the Engineer either in their original positions or in some other approved positions.
- C. Setting out shall be approved by the Engineer before commencing the works, but such approval shall in no way relieve the Contractor of his responsibility for the correct execution of the work.

1.05 NON-COMPLIANCE

- A. Work which fails to meet the specified levels of accuracy must not be rectified without approval.
- B. Submit proposals for such rectification and meet all costs arising, including effects on other work. Allow for the possibility that approval will not be given necessitating removal and replacement of the work.
- C. Provide instruments and assistance for checking the setting out and levels.

END OF SECTION

SECTION 01750

STARTING OF SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Starting System.
- B. Demonstration in instructions.

1.02 RELATED SECTIONS

- A. Section 01400 - Quality Control: Manufacturers field reports.
- B. Section 15000 -16000 - System commissioning.
- C. Section 01770 - Contract Closeout: System operation and maintenance data and extra materials.

1.03 STARTING SYSTEMS

- A. Co-ordinate schedule for start-up of various equipment & systems.
- B. Notify the Engineer 7 days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.
- D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Submit a written report in accordance with Section 01400 that equipment or system has been properly installed and is functioning correctly.

1.04 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of Products to employees personnel two weeks prior to date of Substantial Completion and to the Client designated local Islanders
- B. For equipment or system requiring seasonal operation, perform demonstration for other season within 12 months.
- C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Client's and their designated personnel in detail to explain all aspects of operation and maintenance.
- D. Demonstrate start-up, operation, control, adjustment, trouble shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled times, at equipment location.
- E. Prepare and insert additional data in operation and maintenance manuals when need for additional data becomes apparent during instruction.

- F. Submit a comprehensive start-up procedures of the main equipment and systems to the Engineers for comments at least 4 weeks before start-up.
- G. Submit testing and commission procedures for all related systems.
- H. The contractor shall bear all the cost of test material and consumable material during the testing and balancing of the systems

END OF SECTION

SECTION 01770

CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Closeout Procedures.
- B. Final Cleaning.
- C. Adjusting.
- D. Project Record Documents.
- E. Operation and Maintenance Data.
- F. Warranties.
- G. Space Parts and Maintenance Materials.

1.02 RELATED SECTIONS

- A. Section 01500 - Construction Facilities and Temporary Control.
- B. Section 01750 - Starting of Systems
- C. Section 01780 - Operation and Maintenance

1.03 CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's review.
- B. Submit final application for payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- C. Substantial Completion
 - 1. When Contractor considers work is substantially complete, submit written notice with list of items to be completed or corrected.
 - 2. Should Engineer inspection find work is not substantially complete, he will promptly notify Contractor in writing, listing observed deficiencies.
 - 3. Contractor shall remedy all deficiencies and send a second written notice of substantial completion.
 - 4. When Engineer finds work is substantially complete he will prepare a Certificate of Substantial Completion in accordance with provisions of General Conditions.
- D. Final Completion
 - a. When Contractor considers work is complete, submit written certification:
 - 1. Contract Documents have been reviewed.
 - 2. Work has been inspected for compliance with Contract Documents.
 - 3. Work has been completed in accordance with Contract Documents, and deficiencies listed with Certificate of Substantial Completion have been corrected.

4. Equipment and system have been tested, and balanced, and are fully operational.
 5. Operational of systems has been demonstrated to Client's personnel.
 6. Work is complete and ready for final inspection.
- b. Should Engineer inspection find work incomplete, he will promptly notify Contractor in writing listing observed deficiencies.
 - c. Contractor shall remedy deficiencies and send a second certification of final completion.
 - d. When Engineer finds work is complete, he will consider closeout submittals.

1.04 FINAL CLEANING

- A. Execute final cleaning prior to final project assessment.
- B. Remove waste and surplus materials, rubbish, and construction facilities from the site.

1.05 ADJUSTING

- A. Adjust operating Products and equipment to ensure smooth and unhindered operation.

1.06 PROJECT RECORD DOCUMENTS

- A. Maintain on site, one set of the following record documents; record actual revisions to the Work:
 1. Drawings.
 2. Specifications.
 3. Addenda.
 4. Change Orders and other modifications to the Contract.
 5. Revised Shop Drawings, Product Data, and Samples.
 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Client.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
 1. Manufacturer's name and product model and number.
 2. Product substitutions or alternates utilized.
 3. Changes made by Addenda and Modifications.
- F. Contractor shall prepare Record Drawings for the Works. These Record Drawings shall show all works constructed or installed in the Contract together with all existing detail to form a complete pictorial record of the finished work. The details to be shown on the Drawings, the drawing format and standard sheet and drawing block layout

shall be agreed with the Engineer before production of the Record Drawings commences.

The Drawings shall be prepared in A1 (594 x 840 mm) & A3 (297 x 420 mm) sizes and each drawing shall be to a high standard of draughting and finish and a sample drawing shall be submitted to the Engineer for approval before draughting of the Record Drawings commences. Once approved the sample will be used as a reference standard for overall quality of draughting and finish of the Record Drawings.

With the approval of the Engineer top quality copies of certain of the Contract or Construction Drawings may be used, with the necessary updating, as Record Drawings. The copies shall be produced by the Contractor and shall be subject to the approval of the Engineer. Should the Engineer decide that any of the copies produced are unsatisfactory for use as the base for a Record Drawing, and then the Contractor shall not use such copies for the Record Drawings but will produce new drawings in accordance with these specifications.

1.07 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance documents in accordance with 01730.

1.08 WARRANTIES

- A. Provide duplicate notarized copies.
- B. Execute and assemble transferable warranty documents from Subcontractors, Supplier, and Manufacturers.
- C. Provide table contents and assemble in '4 Ring' binder with durable cloth cover.
- D. Submit prior to final Application for Payment.

1.09 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification sections.
- B. Deliver to site and place in location as directed; obtain receipt prior to Final Payment.

END OF SECTION

SECTION 01780

DATA OPERATION AND MAINTENANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Format and content of manuals.
- B. Instruction of Client's personnel.
- C. Spare Part List.
- D. Schedule of submittals.

1.02 RELATED SECTIONS

- A. Section 01330 - Submittals.
- B. Section 01400 - Quality Control: Manufacturer's instructions.
- C. Section 01600 - Material and Equipment: Systems demonstration.
- D. Section 01770 - Contract Closeout: Contract closeout procedures.
- E. Individual Specifications Sections: Specific requirements for operation and maintenance data.

1.03 FORMAT

- A. Prepare data in the form of an instructional manual.
- B. The requirements contained herein are in addition to all shop drawing submission requirements stated in other sections of the specifications. The contractor shall include the provisions for all items required under this clause in all purchase orders and sub-contract agreements. Data shall be presented on European A4 size or American 8-1/2 by 11 inch sheets to the greatest possible extent. Foldouts will normally be limited to the European A3 or American 11 by 17 inches. Paper shall be of 80 gram and of good quality. Light sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. Note, caution, and warning indications shall be clear and well labeled. Reference to features and elements of equipment, such as operational limits of time, speed pressure and temperature shall be clear, complete and compatible with authoritative published documents. Where equipment functions as a system, the documentation shall be collected, indexed, referenced and submitted as a system. All information specified hereinafter shall be submitted in the English & Dhivehi language except as stated or otherwise noted hereinafter.
- C. Binders: Minimum binder size should be '4 rings' to accept either American 8.5x11 inch or European A4 size paper. The cover should be water resistant and rigid with printed front and insert index on the spine. Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS list title of project and separate building, identify subject matter of contents.
- D. Arrange content by systems under section numbers and sequence of table of contents of this project manual.

- E. Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- F. Text: Manufacturer's printed data, or typewritten data.
- G. Drawings: Provide with reinforced punched binder tab. Bind in with text, fold larger drawings to size of text pages.
- H. All posted operating notices (plans/schematics) will be dual language (English and Dhivehi). Dhivehi must be over English, operating notices are to be posted in main operator areas. These notices are to have a protective cover of ten (10) mil clear vinyl plastic.

1.04 CONTENTS, EACH VOLUME

- A. Table of Contents: Provide title of project; names, addresses, and telephone numbers of Engineer, sub-consultants, and contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.
- B. For each product or system list names, addresses and telephone number of subcontractors and suppliers, including local source of supplies and replacement parts.
- C. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- D. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use project record documents as maintenance drawings.
- E. Type Text: As required to supplement product data, provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01400.
- F. Warranties and Bonds: Bind in copy of each.

1.05 MANUAL FOR MATERIALS

- A. Building Products, Applied Materials, Include product data, with catalog number, size, composition, and color and texture designations. Provide information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- C. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
- D. Additional Requirements: As specified in individual produce specification sections.

1.06 MANUAL FOR EQUIPMENT AND SYSTEM

- A. The Contractor shall furnish all data for the operation and maintenance of equipment furnished under this contract. This data shall consists of manufacturers brochures, manufacturer's operation and maintenance manuals, service and repair manuals,

catalogues, service bulletins, instruction charts, performance surveys, diagrams, drawings, valve schedules, circuit breaker schedules, balancing reports descriptive information, illustrated parts lists and other information as necessary to support the operation and maintenance of the item of equipment, assemblies and systems. Identical equipment within a single major system will require only one submittal of data. The contractor shall furnish five (5) copies of all O&M data to the Engineer.

- B. Data Requirements-Data submissions shall include all information for the description, control, operation and maintenance of each mechanical and electrical component of the system as well as complete instructions for the operation, testing and troubleshooting of the respective systems as applicable to include but not be limited to the following items:

a) System Data:

1. Narrative description of principle of operation.
2. System diagrams showing point-to-point connections, sequence of operation and systems flow.
3. Electric single line and three line diagrams in sufficient detail to define system and operation of related parts.
4. Checkout procedures.
5. Systems tests and test validations.
6. Operating procedures: Start-up, normal operation, emergency operation and shut-down.

b) Equipment Description:

1. Name, make, and model no.
2. Component and assembly drawings.
3. Control diagrams and sequences of operation.
4. Performance characteristics including performance curves for full range of operation and capacity requirements.

c) Installation Instructions.

d) Adjustment and Alignment.

e) Checkout Procedures.

f) Tests and Test Validations.

g) Preventive Maintenance Procedures.

h) Corrective Maintenance Procedures.

1. Troubleshooting procedures.
2. Repair and maintenance procedures.

i) Special tools and equipment, special test equipment, special hazards, or safety precautions.

- C. Preventive Maintenance: An effective procedure shall be submitted for each piece of equipment and system where applicable, whose operation will be enhanced by preventive maintenance. This procedure shall include, but not to be limited to periodic checks, adjustments, inspections, lubrications, and cleaning. A schedule shall be furnished for each piece of equipment listing manufacturer's recommended maintenance routine of specific tasks to be performed at specified intervals such as daily, weekly, monthly, quarterly, or the number of operating hours. Caution alerts or signal shall be indicated where certain actions may damage or jeopardize the operation of a piece of equipment such as "DO NOT OVER LUBRICATE" or "factory adjusted".
- D. Troubleshooting: This information shall describe the general procedure for locating malfunctions and shall give in detail the specific remedial procedures and techniques required for their repair. The data presented is that which is normally furnished by the manufacturer in maintenance, service and repair manuals, and is intended to isolate the most common equipment deficiencies and indicate their expeditious repair.
- E. Repair and Replacement: Information shall consist of specific topics in instructions, in a step-by-step fashion for repair and replacement of defective items. Included shall be all information required to accomplish the repair or replacement, and all tools, special equipment, and materials which might be required shall be identified. The information is normally included in manufacturer's repair and service manuals.
- F. Special Items: Any information of a maintenance and repair nature covering warranty items, etc., which have not been discussed elsewhere.
- G. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- H. Include test and balancing reports as specified in Section 01400.
- I. Additional Requirements: As specified in individual product specification sections.
- J. The Consultant reserves the right to determine whether the above specified information as furnished by the Contractor is adequate and complete and to require such additional submittals by the Contractor as necessary to insure that adequate information has been furnished to provide the satisfactory operation and maintenance of the various items of equipment and to fulfill the intent of the specifications.

1.07 INSTRUCTION OF CLIENT PERSONNEL

- A. General: The Contractor shall be responsible for the instruction and training of operating and maintenance personnel as specified below. Unless otherwise indicated the operating and maintenance instructions shall be given for a minimum of ten (10) working days on each complete working system.
- B. Operation and Maintenance Training: The Contractor shall provide competent instructors for training of personnel designated by the Engineer/Client to operate mechanical and electrical building system and equipment, perform the required preventive maintenance to minimize breakdown and to perform the necessary repairs when malfunction or break-down, of equipment training for the periods specified, which shall be completed prior to acceptance of a system or equipment, as applicable. The instructor(s) shall have no other duties during the period of training. Classroom instruction shall not exceed fifty percent (25%) of the total training time, with the balance devoted to on-the-equipment demonstration and familiarization.
- C. Arrangements: The training shall be for not less than the periods of time specified, five (5) days per week, and eight (8) hours per day, subject to approval by the Engineer. Each individual training session shall be presented one time only, and shall

be scheduled in a manner acceptable to the Engineer. The operating and maintenance manual data, as specified to be furnished in these specifications, shall be used as the base material for training.

- D. Scheduling: The Contractor shall contact the Engineer for the purpose of preliminary planning, scheduling, and coordination of training, to maximize effectiveness of the training program for available operating and maintenance personnel. The outline shall contain sufficient detail to provide a broad indication of the type and scope of training to be given. It shall include by not be limited to:
- a) A list of subjects to be presented.
 - b) Estimated amounts of classroom and on-the-equipment instruction for each subject.
 - c) A list of minimum qualifications for instructors.
 - d) Discussions concerning the types and amounts of visual aids, reference materials, tools and test equipment, mock-up and other training materials that will be employed during training.
- E. Plan: The Contractor shall submit five (5) copies of his proposed training plan to the Engineer for approval not later than thirty (30) calendar days prior to start of any training, training and instruction plan which shall include the following:
- a) A weekly outline showing overall form and design of training presentation.
 - b) A day-by-day schedule showing time intervals, the major and subordinate subjects to be covered in each, the name of the instructor(s) and qualification summary of each, and identification of related handouts.
 - c) Summary of the number of hours of classroom and on-the-equipment training.
 - d) A list of reference materials to be provided by the Contractor of the trainees.
 - e) A list and description of the training materials to be used, such as text, visual aids, mock-up, tools, etc. The Contractor shall be responsible for furnishing all training materials except the following:

The Client will provide space, chairs, and tables for classroom training. The Contractor will provide necessary sets of O&M manuals and other material.

1.08 SPARE PART LIST

- A. Spare Parts Information: The Contractor shall furnish spare parts information and purchasing catalogs for all equipment furnished under this contract. The information shall be complete legible, organized, and submitted by system in five (5) copies, and shall include:
- a) A list of spare parts, special tools, and supplies, for each item of equipment, which are either normally furnished at no extra cost with the purchase of the equipment, or specified hereinafter to be furnished as part of the contract.
 - b) A complete list of spare parts and supplies recommended by the manufacturer to assure efficient and continuous operation of each item of

equipment for a period of two (2) years after completion and acceptance of the entire work under this contract.

- c) The list shall show the recommended minimum stockage level for reordering and shall identify all long lead items. A long lead item is defined as any item of equipment which cannot be ready for delivery in less than six months after receipt or order. The lists shall include the following information for each recommended spare part:

1. Manufacturer's Part Name.
2. Manufacturer's Name and Address.
3. Manufacturer's Part Number.
4. Manufacturer's Drawing Number Showing Part.
5. Next Higher Assembly.
6. Equipment Symbol Keyed to Contract Drawings.
7. Recommended Number of Spares.
8. Net Unit Price.
9. Quantity installed per Assembly.
10. Lead Time.
11. Shelf Time.
12. Peculiar cleaning, calibration, packaging and preservation requirements.
13. Name and address of authorized spare parts representative and spare parts stocking source nearest to the project site. Alternative sources of procurement.

- f) All parts and components data identity shall be based upon the true manufacturer. Nameplates of other manufacturer's or fabricators are acceptable providing the true source identity remains intact and unobliterated. Any deviation from true source identity shall be subject to the written approval of the Engineer. When spare parts are recommended and established by the manufacturer in the form of kits, these repair kits shall be listed in the recommended spare parts lists.

- B) Special Tool and Test Equipment List: The Contractor shall furnish to the Engineer five (5) copies of recommended list of all special tools and test equipment. The special tools and test equipment shall cover all items required for the successful operation and maintenance during a ten year equipment life. In compiling the special tools and test equipment list, the Contractor shall indicate all special tools and test equipment items that require calibration, including frequency and method.

Tool list shall include all tools required. Test equipment lists shall include all equipment required for acceptance testing and calibration. The Contractor shall supply five (5) copies of all vendor-supplied catalogs and instructions for operation and maintenance of the tools and test equipment furnished under this contract.

- C. Submission of Preliminary Parts List: The Contractor shall submit one (1) copy of his Preliminary Parts List with recommendations for spares within the time frame set forth above. This list is subject to the Engineer's review and written approval. The Engineer may revise the listing as to quantities of recommended spares as a condition of approval. The Engineer reserves the right to order all, none or any portion of additional spare parts from the manufacturer's complete parts list and the Preliminary Parts List.
- D. Resubmittals: Any resubmittals or additional submittals of equipment lists, spare parts lists or associated information shall be made within thirty (30) calendar days from notice by the Engineer and all costs associated with the submissions shall be borne by the Contractor.
- E. Final Parts List: The Final List shall be submitted not later than sixty (60) calendar days prior to contract completion date, in the five (5) copies and shall be annotated "Final" on each sheet.

1.09 SUBMITTALS

- A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of work. Engineer will review draft and return one copy with comments.
- B. For equipment, or component parts of equipment put into service during construction and operated by Client, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes in final form 15 days prior to final inspection. Copy will be returned with Engineer comments. Revise content of documents as required prior to final submittal.
- D. Submit five (5) copies of revised volumes of data in final form within ten days after final inspection.

END OF SECTION

SECTION 02200 SITE PREPARATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Preparation of the site of works by removal of all hindrances, obstructions, any existing structure(s) unwanted (above or below Ground level, clearance of existing growth and debris (leveling /grading + or - 15cm) and disposal in legal manner in full compliance with Municipality rules and regulations. Diversion, removal and blocking of existing services as directed by Engineer.
- B Backfilling by proper means as approved by Engineer the voids and cavities as a result of execution of item A above.

1.02

- ❖ RELATED SECTIONS elsewhere in this document are not necessarily comprehensive or complete and it is the Contractor's responsibility to ascertain all applicable sections required to understand the full scope of works intended.

A. Information available to tenderers: Soils Investigation Report, Topographic survey drawings.

B. Section 02315 - Excavation

1.03

- ❖ EXISTING CONDITIONS; any material, existing structures, services (above or under ground) or growth now on site and not designated to remain on site to be removed by the Contractor

PART 3 WORKMANSHIP

3.01 Access:

- A Prepare areas required for access to site and execution of work.

3.02 Site Clearance:

- ❖ PLANTS, TREES AND SHRUBS TO BE RETAINED; verify with the Engineer before commencing site clearance which plants, trees, shrubs, hedges, areas of scrub etc are to be retained and protected and,
 - A Identify, mark, protect and preserve all such plants and shrubs, as directed through out the whole duration of the work
 - B Erect temporary fencing as specified in work section 01500 prior to the commencement of site operations, and maintain it in good condition until the Engineer's permission for removal is obtained.
- ❖ SURFACE VEGETATION CLEARANCE; cut and clear away long grasses, weeds, brambles, saplings etc and grub up stumps and major roots without unduly disturbing top soil.
- ❖ TREE REMOVAL; for removal of trees, consider the following
 - A Grub up main roots, fill voids left by removal.

- ❖ STUMP REMOVAL; remove stumps and roots over 100mm diameter to a depth of 500 mm. Do not use explosives.
- ❖ BURNING ON SITE; will not be permitted

3.03 Existing Services

- ❖ TEMPORARILY DIVERT/ REMOVE/ BLOCK; all existing services as necessary encountered during excavation and:
 - A If required reinstate on completion
 - B Divert as required.
 - C If not required, obtain necessary instructions from the Engineer.
 - D Block as instructed by Engineer.

3.04 Existing Structures

- ❖ REMOVE; by dismantling all unwanted structures (below and above ground level).
- ❖ BACKFILL; by proper means (to obtain required density) as approved by the Engineer.
- ❖ DISPOSE OFF; all debris in the designated area to be disposed off.

3.05 Protection

- ❖ BENCH MARKS; to be protected from damage or displacement.
- ❖ MAINTAIN DESIGNATED SITE ACCESS; on the Site layout plans for vehicular and pedestrian traffic.

END OF SECTION

SECTION 02240 DEWATERING

PART 1 GENERAL

1.01 SECTION INCLUDES

- C Provision of all labours, materials, plant, equipment and appliances and performance of all necessary operations required to execute the work of this section.
- D The design provision of installation, maintenance, operation for the required duration and subsequent removal of Systems for;
1. Reducing the hydrostatic pressure and lowering the water table within and around the main and if required, the other excavations, for instance those for the building and septic tanks, water pipes, sewer, manholes, lifting stations, STP works, R.O. Plants works, such that:
 - a) There is no water seepage through the sides of the excavations into same.
 - b) Any dewatering required within and around the main excavation to lower the water table below the levels indicated on relevant drawing is to be carried out by the Contractor at no extra cost to the Owner
 2. Controlling surface water.
 3. Collecting and disposing of discharge water generated by the operation of the other systems.

1.02 RELATED SECTIONS; elsewhere in this document, are not necessarily comprehensive or complete and it is the Contractors responsibility to ascertain all applicable sections required to understand the full scope of works intended.

A	Section 02260	Shoring
B	Section 02315	Excavation
C	Section 02316	Backfilling

1.03 REFERENCE; The minimum standards for products specification in this section shall be relevant BSI standards including but not limited to the following. Except as otherwise specified herein, perform work in accordance with the specification codes and standards cited there in and addenda and supplements.

BS 6031	Code of Practice for Earthworks
BS 8004	Code of Practice for Foundations.

1.04 METHOD STATEMENT

- A Within 14 days from the commencement date of contract, submit an outline method statement indicating the proposed method to be employed for site dewatering. Base the proposals on the information contained in the site investigation report or summary of the same included with the tender documents.
- B Prior to commencing the work carry out a detailed investigation to identify the exact requirements

for dewatering and submit to the Engineer a fully detailed method of dewatering to be employed.

- C Where required by the Engineer, submit drawings indicating details of the method of dewatering to be employed

1.05 PERFORMANCE REQUIREMENTS

- ❖ EXTEND OF DEWATERING; Ensure site dewatering provides for the construction of the works in the dry.
- ❖ STABILITY OF FOUNDATION; Control ground water in a manner that will;
 - A. preserves the strength of the foundation materials;
 - B. not causes instability of the excavation slopes;
 - C. not results in damage to existing structures.
- ❖ DISPOSAL OF WATER; dispose of water from the site in a manner which will not cause damage, pollution, siltation or other hazards.
- ❖ MODIFICATION OF DEWATERING METHOD; Obtain the agreement of the Engineer to modify the dewatering system as necessary, and as the work progresses, to provide the amount of control needed continuously and without interruption for the duration of the dewatering to ensure that no damage is caused to adjacent properties and structures.

The accuracy of the data contained therein cannot be guaranteed. The borehole logs and related information depict subsurface soil and groundwater conditions at the specific locations and dates indicated. Soil conditions and water levels at other locations and times may differ from conditions occurring at the specific borehole locations.

The Contractor shall visit the site to make such inspections as he deems necessary and reach his own conclusion regarding the nature of the ground and the conditions likely to be encountered.

Any claim resulting from site conditions, nature of soil or obstacles encountered will be considered invalid.

1.06 REGULATORY REQUIREMENTS

- ❖ CONFORM TO; applicable regulations and codes.
- ❖ OBTAIN NECESSARY PERMITS; in connection with disposal of water.

1.07 SUBMITTALS

- ❖ SHOP DRAWINGS SHOWING;
 - A. Type of dewatering, surface water control and discharge water collection/ disposal systems proposed.
 - B. Proposed arrangements, locations and depths of the elements of the Systems
 - C. Equipment and materials to be used and procedures to be followed.

D. Standby equipment, standby power supply. Note that standby provisions are to be provided as required to ensure continuous uninterrupted operation of the Systems

E. Measures to be taken to prevent damage due to settlement of buildings, structures, paving, other constructions and services outside the excavation but within the area affected by dewatering.

- ❖ CALCULATIONS FOR THE DESIGN; of the dewatering system.
- ❖ METHOD STATEMENT; for dewatering procedures
- ❖ PERMITS FOR DISPOSAL OF WATER; shall be submitted to Engineer prior to installing the system.

1.08 EQUIPMENT

- ❖ DEWATERING EQUIPMENT; provide all equipment necessary for the site dewatering and install, operate and maintain in good working order for the duration of the works

Installation to include:

- A. Gravity flow measures including ditches, pipes, temporary drains, sumps and other diversions and interception works.
- B. pumps (including standby pumps for use in periods of maintenance or the breakdown of the main pumping facility), pipe work and other associated equipment.
- C. Well points, including screens and filters.
- D. Measuring devices and / or instruments as follows shall be installed.
 - 1. for monitoring drawdown level i.e. standpipes / piezometers.
 - 2. For measuring the quantities of water removed from site.
 - 3. for monitoring movement of existing buildings.

PART 3 WORKMANSHIP

3.06 Examination:

- ❖ EXAMINE THE SITE; the surrounding vicinity, including structures and the data on subsurface conditions for determination of the procedures and equipment required to perform the work of this section.
- ❖ CONDUCT SURVEY AND DOCUMENT CONDITIONS OF BUILDINGS; within area likely to be affected by de-watering, prior to commencement of operations, and photograph existing conditions identifying irregularities.

3.07 Preparation:

- ❖ COMPLETE SUBMITTALS; and obtain required approvals before commencing the works.
- ❖ EXAMINE THE WORKS: and advise the Engineer in writing of any conditions detrimental to the execution of the work of this Section. The absence of any such notification will be taken to constitute the Contractor's acceptance of preceding work by others and existing conditions.

3.08 Installation

- ❖ INSTALL THE DEWATERING SYSTEMS; in accordance with shop drawings and approved method statement. Keep the Engineer advised of any changes made to accommodate field conditions and on completion of the dewatering systems installation, revise and resubmit as-built shop drawings to reflect same.
- ❖ OPERATE THE DEWATERING SYSTEMS; as necessary to lower the ground water level in excavations to provide stable dry conditions for the substructure constructions. Continue dewatering in any area and below any level until the weight of the reinforced concrete constructions thereon adequately and safely, by a margin of at least 50%, balances the hydrostatic pressure generated by the ground water at its anticipated normal level. The Engineer will determine the timing of the termination of operation for each part of the dewatering system. The temporary filling of pits with sand etc., at the Contractor's expense including subsequent sand removal and cleaning, will be considered as a means of permitting earlier termination of localized dewatering to low levels.
- ❖ SURFACE WATER AND SUBSURFACE OR GROUNDWATER; to be prevented from flowing into the excavations or flooding the project site and surrounding area. Do not allow water to accumulate in excavations.
- ❖ PIEZOMETRIC LEVELS IN THE SUBGRADE SOILS; directly beneath any point within the exposed excavation limits shall be maintained at least 0.60 meters below the final excavation level to prevent soil disturbance, the development of excessive unbalanced seepage gradients, and potential loss of bearing support. Install devices to monitor groundwater levels during this period to demonstrate compliance with these requirement.

3.09 Monitoring & Recording

- ❖ DRAWDOWN LEVELS: Check drawdown levels in stand pipes/ piezometer and submit records to the Engineer at weekly intervals.
- ❖ WATER DISCHARGE QUANTITIES: Submit to the Engineer at weekly intervals, records from the previous week indicating quantities of water discharge and periods when pumping occurred.
- ❖ EXISTING STRUCTURES; monitor at an agreed frequency and record the effects off the site dewatering on existing structures. Submit records to the Engineer.

3.010 Removal

- ❖ DEWATERING SYSTEMS OR PARTS THEREOF; to be removed upon completion of operation.
- ❖ CLEAN AND MAKE GOOD; to the satisfaction of the Engineer any items disturbed by the dewatering system installations, operations and removals.

END OF SECTION

SECTION 02260

SHORING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Provide shoring in accordance with the requirement of the Works.

The extent of shoring work includes, but is not limited to the following:

- 1) Shoring necessary to protect trenches, manholes, lifting station, treatment facility and the sides of excavation for construction below ground level and the like.
- 2) Maintenance of shoring.
- 3) Extracting and removing all shoring materials installed.

- B. Type of shoring includes, but is not limited to the following:

- 1) Soldier 'H' piles.
- 2) Ground anchors.
- 3) Timber lagging.
- 4) Any other requirement as directed by the Engineer.

1.02 RELATED SECTIONS

- A. Section 01010 - Summary of work
B. Section 02315 - Excavating
C. Section 02316 - Backfilling

1.03 QUALITY ASSURANCE

- A. Regulations: Comply with local codes and ordinances of governing authorities having jurisdiction.

1.04 SUBMITTAL

- A. Submit under provision of Section 01300.
- B. Submit drawings for the shoring system together with construction techniques and all relevant structural design calculation to the Engineer for review and approval.

1.05 SITE CONDITIONS

- A. Before starting work, check and verify governing dimensions and elevations with the Engineer, jointly survey condition of adjoining properties. Take photographs, as directed by the Engineer, recording any prior settlement or cracking of structures and pavement. Prepare a list of such damages, verified by dated photographs, and signed by the Contractor the Engineer and others conducting the investigation.
- B. Survey adjacent structure, establishing exact elevations or fixed points to act as bench marks. Clearly identify bench marks and record existing elevations. Locate datum level used to establish bench mark elevations sufficiently distant so as not be affected by movement resulting from excavation operations.

- C. During excavation under this Contract, re-survey bench marks weekly. Maintain accurate log of surveyed elevations for comparison with original elevations. Promptly notify the Engineer if changes in elevations occur or if cracks, sags or other damages are evident. Propose remedial work and execute as approved by the Engineer.

1.06 EXISTING UTILITIES

Protect existing active sewer, water, electricity, telephone, cable and other utility services and structures where necessary due to installation of shoring. Co-ordinate with Island Office and comply with their requirements for protection.

PART 2 PRODUCTS

2.01 MATERIALS

General: Provide suitable shoring materials which will support loads imposed. Materials shall be as selected by the Contractor and approved by the Engineer. Such approval shall not absolve the Contractor from his responsibility to provide adequate shoring accordance with the requirement of the Contract.

PART 3 WORKMANSHIP

3.01 SHORING

- A. General: Protect the site from caving in and unacceptable soil movement and install shoring to all faces of excavations as required.
- B. The Contractor must take his own queries, and submit to the Engineer for approval his own design for the shoring system he proposes to use together with all relevant calculations.
- C. The shoring system shall be adequately anchored to resist earth and hydrostatic pressures.
- D. Bore holes to their final levels, erect soldiers or 'H' piles in the bored holes, align to true line and level, and encase bottom portion of the piles below excavation level with concrete. Where shoring is to be later removed wrap the end of the 'H' piles in a suitable approved material to facilitate their withdrawal.

END OF SECTION

SECTION 02315

EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Description: Perform earthworks in accordance with the drawings and specification. Determine the extent of excavation based upon the requirements of the chosen procedures and methods.
- B. NATURE OF EXCAVATION
 - 1) Include for excavating in any type of soil encountered.
- C. EXISTING CONDITIONS AND PROTECTION
 - 1) The Contractor shall be deemed to have visited the site prior to submitting his tender, examine the site, records of existing utilities and construction, to determine all conditions under which the work will be performed.
 - 2) Obstruction, old construction, etc., of which no records are available, may be encountered. Make enquiries and formulate conclusions as to the extent of any such obstructions, old construction, etc., and remove all materials of any nature to the designed subgrades indicated or specified.
 - 4) Before excavating near existing utilities, notify the Utility Owner, coordinate protective work and comply with the Utility Owner's requirements. Safeguard and protect from, damage or movement any existing services, utilities and utility structures uncovered or encountered which are to remain in service.
 - 5) The Contractor shall indemnify and save harmless the Employer against any damage whatsoever caused to any structures, services adjacent to or under the Site, due to the Contractor's construction activities.
- D. SAFETY AND AVOIDANCE OF NUISANCE
 - 1) Perform all work in such a manner as to ensure the safety of the Works, the public and adjoining sites and so as to cause as little inconvenience as possible to the public and adjoining Owners, and allow in the Tender for all necessary precautions to that end.
 - 2) Provide temporary and strong barriers around the edges of excavations as safety measure.

1.02 RELATED SECTIONS

- A. Section 01025 - Measurement and Payment: Requirements applicable to unit prices for the work of these Sections.
- B. Section 01400 - Quality Control: Inspection of bearing surfaces.
- C. Section 01500 - Construction Facilities and Temporary Controls: Dewatering excavations if any and water control.
- D. Section 02240 - Dewatering
- E. Section 02260 - Shoring
- F. Section 02316 - Backfilling.

- G. Section 02318 - Trenching: Excavation for utility trenches.

1.03 FIELD MEASUREMENT

- A. Verify that survey bench mark and intended elevations for the work are as indicated.

1.04 SUBMITTAL

- A. Submit information and full details regarding the procedures proposed for excavating over the area of the site, for the review and approval of the Engineer.
- B. Submit shop drawings detailing temporary works relating to excavations including barriers, accesses, lighting, etc...

PART 2 PRODUCTS

(NOT USED).

PART 3 WORKMANSHIP

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Locate, identify, and protect utilities that remain, from damage.
- C. Notify utility authorities and to remove utilities.
- D. Protect bench marks, existing structures, fences, sidewalks, paving, curbs and others live services lines those are to be retained from excavating equipment.

3.02 EXCAVATION

- A. Underpin adjacent which may be damaged by excavation work.
- B. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- C. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- D. Stockpile excavated material in area designated on site and remove excess material not being reused, from site.

3.03 FIELD QUALITY CONTROL

- A. Field inspection will be performed under provisions of Section 01400. Quality control.
- B. Provide for visual inspection of bearing surfaces.

3.04 PROTECTION

- A. Protect excavation by methods required to prevent cave-in or loose soil from falling into excavation.

END OF SECTION

SECTION 02316

BACKFILLING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Site filling and backfilling.
- B. Fill on trenches and like.
- C. Fill for over-excavation.

1.02 RELATED SECTIONS

- A. Section 01025 - Measurement and Payment:
- B. Section 01400 - Quality Control and 01410 - Testing Laboratory Services: Compaction testing.
- C. Section 02315 - Excavating.
- D. Section 02318 - Trenching: Backfilling of utility trenches.
- E. Section 03300 - Cast-in-Place Concrete: Concrete materials.

1.03 REFERENCES

- A. AASHTO T180 - Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop, ASTM or other approved equal test or procedure designated in the specification.
- B. ANSI/ASTM D1556- Test Method for Density of Soil in Place by the Sand-Cone Method.
- C. ASTM D2167 - Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

PART 2 PRODUCTS

(NOT USED)

PART 3 WORKMANSHIP

3.01 PREPARATION

- A. Compact subgrade to density requirements for subsequent backfill materials.

- B. Cut out soft areas of subgrade not capable of in situ compaction. Backfill with relevant Type of fill and compact to density equal to or greater than requirements for subsequent fill material.
- C. Scarify and proof roll subgrade surface to a depth of 150 mm to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

3.02 BACKFILLING

- A. Backfill areas to contours and elevations with relevant specified materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
- C. Employ a placement method that does not disturb or damage other work.
- D. Maintain optimum moisture content of backfill materials to attain required compaction density. Backfill against supported foundation walls pits. Do not backfill against unsupported foundation walls, pits and the like.
- E. Remove surplus backfill materials from site.

3.03 TOLERANCES

- A. Top Surface of General Backfilling: Plus or minus 25 mm from required elevations.

3.04 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 01400 .
- B. Compaction testing will be performed in accordance with
 - 1. The following AASTHO T 180 Standards:-
 - a. Sampling: T-2, T-86
 - b. Sample preparation: T-87
 - c. Sieve analysis: T-11, T-27, T-88
 - d. Liquid limits: T-89
 - e. Plastic limit and Plasticity index: T-90
 - f. Moisture content: T-93, T-217
 - g. Moisture density relationship: T-180
 - h. Sand equivalent: T-176
 - i. Specific gravity: T-100
 - j. Sand core density: T-191
 - k. Rubber balloon density: T-205
 - l. Classification: M-145.
 - 2. Carry out moisture density tests on representative samples prior to placing.
 - 3. Carry out gradation of materials prior to placing as the work proceeds.
- C. Frequency Tests:
 - 1. Carry out site density tests of materials as the work proceeds and as follows:

a. General Fill:

1. One test whenever there is a change of gradation or placement conditions.
2. Execute site density tests for compaction at a minimum depth of 100 mm below compacted surface.
3. Execute a full compaction test or a one point compaction test in conjunction with each site density determination.
4. Execute a gradation test with each site density test and whenever there is an apparent change in material being placed.
5. Execute the following site density tests and laboratory moisture density tests to evaluate compaction achieved:
 - a. One test for every 200-400m³ of back-fill in trenches or surrounding structure.

D. If tests indicate work does not meet specified requirements, remove work, replace.

3.05 PROTECTION OF FINISHED WORK

A. Protect finished Work under provisions of Sections 01500. Construction facilities.

END OF SECTION

SECTION 02318

TRENCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavating trenches for utilities, backfilling and compaction, carting away of excess unused/unuseful soil resulted during construction to dumping area.

B. Compacted fill from top of utility bedding [to subgrade elevations].

C. Backfilling and compaction.

1.02 RELATED SECTIONS

A. Section 01025 - Measurement and Payment:

B. Section 01400 - Quality Control and 01410 n.

C. Section 01500 - Construction Facilities and Temporary Controls:

1.04 REFERENCES

A. AASHTO T180 - Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop.

1.05 DEFINITIONS

A. Utility: Any buried pipe, conduit, or cable.

1.06 FIELD MEASUREMENTS

A. Verify that survey bench mark and intended elevations for the work are as shown on drawings.

1.07 COORDINATION

A. Coordinate work under provisions of Section - 01039.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. Fill Type: Suitable soil fill material as tested and verified.

B. Concrete: Lean concrete of grade K-140 with a compressive strength of 140 fg/sq.cm.

PART 3 WORKMANSHIP

3.01 PREPARATION

A. Identify required lines, levels, contours, and datum.

- B. Protect bench marks, existing structures, fences, trees, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.
- C. Providing all temporary work, scaffolding, shoring, strutting, bridgeways & open works as may be necessary and required for the proper, safe and efficient construction & finalizing of works.
- D. Maintain and protect above and below grade utilities which are to remain. The Contractor shall be responsible for any damages occurred to the existing roads, mains, cable, due to negligence including safety to persons & property, during the execution of works. The cost of the providing, placing & removing the temporary works shall be included in the price bid for the work.

3.02 EXCAVATION

- A. Excavation Of Trenches: Pipe trenches shall be excavated to the required depth and in a manner that provides a uniform and continuous bearing and support over the whole length of the pipe including the necessary extra excavation at joints. The width of trench for the various sizes of pipes and in any type of ground shall be equal to the diameter of pipes plus 40 cm. with a minimum width of 50 cm. overall. This is for constructional purposes only.

Trenches shall be of such extra width when required to permit the convenient placing of timber supports, sheeting and bracing and handling of pipes. The stated width of any trench shall not be exceeded without the approval of the Engineer.

Separate excavations shall be carried out for chambers, manholes and other appurtenances.

The sides of trenches shall have a gradient adapted to stability of the soil of excavations must be made between steel sheet piling or with timbering.

The Contractor shall ensure that the trench between the joints is properly prepared to take the pipes. The bed of the trench shall be leveled with care and even to grade so as to provide continuous contact of the trench bottom with the pipe. Any prominent piece of rock and other substance shall be removed.

- B. Excavation to Grade: The trench shall be excavated to the depth required so as to provide uniform and continuous bearing and support for the entire length of pipe on solid and undisturbed bed at every point between joints.

The excavation for Infrastructure works such as Manholes, Gullies, lift station, chambers, etc. shall be excavated to the length and width and the exact depths as indicated on the drawings or required for the construction of such works.

All the Infrastructure works shall be constructed on undisturbed ground or thoroughly compacted ground. Excavation shall be carried out mechanically or manually as per the site conditions/or as directed by the Engineer, but the final shaping and trimming of the subgrade shall be done by hand.

Hand excavation must be done at the areas where cables, water, etc. lines cross the trenches or are close by the trenches. The Contractor shall be solely held responsible for making good all damage to road surfaces and private lands caused by the use of mechanical excavators. If due to negligence or error an excavation has been done to a level lower than as shown on the drawings, the Contractor, at his own cost, shall fill in the void so formed to the proper level with approved material in layers not exceeding 15 cm,

thick which shall be thoroughly compacted by tamping/as directed by the Engineer. The finished subgrade shall be prepared accurately by means using hand tools. If the Engineer considers that concrete is necessary for this filling, then the Contractor shall perform the same.

- C. Excavation in Poor Soil and Refilling to Grade: The Contractor shall be required to examine the nature of soil strata below the indicated levels. The fact shall be reported in writing to the Engineer before starts constructing any concrete structure, pipe laying or other works.

Where the bottom of the trench at subgrade level is found to be unsuitable or to include ashes, cinders, any of refuse, vegetating or other organic material, or large pieces or fragments of inorganic material which in the judgment of the Engineer should be removed, the Contractor shall excavate and remove such unsuitable material to the width and depth ordered by the Engineer. Before the pipe is laid or the concrete placed, the sub-grade shall be made up by back-filling with an approved material in layers not exceeding 15 cm thick. The layers shall be thoroughly compacted by tamping as directed by the Engineer so as to provide a uniform and continuous bearing and support of the structure and of the pipe at every point between joint holes. The finished subgrade shall be prepared accurately by means of hand tools.

- D. Braced and Sheeted Trenches: Open-cut trenches shall be braced and sheeted as may be necessary to protect property, traffic or the work or to prevent caving and harmful sinking. The Contractor shall be responsible for any damage done to roads, mains cables, pipes, sewers, etc. by the execution of the work. When close sheeting is required, it shall be so driven as to prevent adjacent soil from entering the trench either below or through such sheeting. Where sheeting and bracing are used, the trench width shall be increased accordingly.

The Engineer reserves the right to order the sheeting to be driven to the full depth of the trench or to such additional depths as may be required for the protection of the work. Where the soil in the lower limits of a trench has the necessary stability, the Engineer, at his discretion, may permit the Contractor to stop the driving of sheeting at same designated elevation above the trench bottom. The granting of permission by the Engineer, however, shall not relieve the Contractor in any degree from his full responsibility under the Contract.

Trench bracing must be removed when the backfilling has reached the respective levels of such bracing. Sheeting must be removed after the backfilling has been completed or has been brought up to such an elevation as to permit its safe removal.

The cost of furnishing, placing and removing the sheeting and bracing shall be included in the price bid for the work.

- E. Removal of water from Excavation: The Contractor shall at his own expense, provide, maintain dewatering machinery such as engine, pumps, pipework, chutes and other things necessary to keep sub-soil or accumulated water at a level below the bottom of the permanent works for such periods as the Engineer may direct. After raising the water herein referred to, the Contractor shall at once convey it away in such a manner as not cause any nuisance or injury. All sumps or wells which may be required for the purpose of keeping the works dry shall be sunk, clear thereof and shall be filled in afterwards.

If pumping is necessary it shall, when of importance for the maintenance of the plant, be carried out continuously and should not be stopped without permission from the Engineer. Pumping must be done in such a way that fine grained material is not washed

out and carried away. If necessary, a drainage filter should be arranged in order to prevent washing away of fine grained material.

The water level may not be allowed to rise above newly cast concrete in conduits, manholes, joints etc. until the concrete has acquired the necessary strength and water tightness.

The Contractor shall ensure that all pipes and structures when laid or constructed are secured against floating by backfilling or by some other approved means. The required suitable number or Contractors Personnel shall be at site all times to take action necessary in the event of flooding.

The Contractor must obtain the fullest possible information on the variations in water course that may affect the work, and carry on work in accordance with the information.

- F. Disposal of Excavated Material: All excavated material shall be piled in a manner that will not endanger the work or any building, structure or property and that will avoid obstructing the use of entrances, sidewalks, driveways, manholes and all other utility controls and cause the minimum of obstruction to traffic generally. Any damage resulting from Contractor's own expense, all as directed by the Engineer.

3.03 BACKFILLING

Soil underneath, around and over concrete works shall be compacted to the same density of the surrounding soil or a minimum of 90% of AASHO T-180 density, whichever is greater. All compaction shall be done in layer not exceeding 15 cm. in thickness and fills shall be brought up simultaneously on all sides of the structure. All surplus suitable and approved excavated material shall be used for filling works within the project limits and in layers not exceeding 15 cm. and compacted as per specifications and any unsuitable surplus material shall be removed to an approved dumping area from the site of work all as directed by the Engineer.

Excavations shall be backfilled without unnecessary delay, after pipes, manholes have been inspected and approved by the Engineer. Necessary precautions shall be taken during backfilling to ensure that pipes and manholes are not damaged. Any space left by the withdrawal of timbering shall be properly filled immediately.

All backfill material shall be free from cinders, ashes, refuses, vegetable or organic matter, boulders, rocks or stones or other material which in the opinion of the Engineer is unsuitable.

Backfilling shall, unless otherwise stated, be of the same material as was excavated from the trench provided that, in the opinion of the Engineer, it is suitable for backfilling.

3.04 TOLERANCES

- A. Plus or minus 25 mm from required elevations.

3.05 FIELD QUALITY CONTROL

- A. Compaction testing will be performed in accordance with AASHTO T180.
- B. If tests indicate Work does not meet specified requirements: Then remove Work, replace, compact, and retest.

- C. Frequency of Tests: At the rate of at least one specimen per 100 meter run or 1000 meter square, whichever is less.

3.06 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01500. - Construction Facilities.
- B. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION

SECTION 02510

WATER DISTRIBUTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SCOPE

- A. Water from the deep well is pumped to a GRP storage tank in the grade level by a submersible pump. The water from the deep well will be saline at 37,500 ppm TDS. The water is fed to the Reverse Osmosis Plant for treatment. The treated water is directed to the GRP floor mounted tank and then it is transferred and stored in an elevated Reinforced Cement Concrete storage tank.
- B. Fresh water to the island residents is fed from the elevated Reinforced Cement Concrete tank, through a network of pipes. The network consists of 100 mm diameter mains and 80 mm sub mains and branch pipes. The piping material is uPVC confirming ASTM Standards ASTM D-1785 schedules 40, Class II with 6 bar pressure minimal.

1.03 DEFINITIONS

- A. uPVC: - Unplasticized Polyvinyl chloride plastic.

1.04 SUBMITTALS

- A. The following shall be submitted in accordance with NFPA 24 and Section 01334 Shop Drawings, Product Data and Samples:
 - 1. Preconstruction Submittal
 - a. Waste Water Disposal Method: The method proposed for disposal of wastewater from hydrostatic tests and disinfection, prior to performing hydrostatic tests.
 - 2. Product Data: Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell and spigot joints. Include information concerning gaskets with submittal for joints and couplings.
 - a. Water distribution fittings, joints, valves and couplings
 - b. Water service line piping, fittings, joints, valves and couplings
 - c. Water meters and accessories
 - d. Valve boxes
 - e. Backflow preventers and assemblies

3. Test Reports

- a. Bacteriological Disinfection: Test results from commercial laboratory verifying disinfection.
 - b. Satisfactory Installation: A statement signed by the Contractor firm stating that the installation is satisfactory and in accordance with the contract drawings and specifications, and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance. Device test results will be attached to the statement.
4. Certificates: Certificates shall attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within 3 years of the date of submittal of certificates on the same type, class, grade, and size of material as is being provided for the project.
 - a. Water service line piping, fittings, joints, valves, and coupling
 - b. Shop-applied lining
 - c. Lining
5. Operation and Maintenance Instructions: The manufacturer's installation and operation instructions and maintenance recommendations for each material or procedure to be utilized:
 - a. Water meters;
 - b. Valves and accessories;
 - c. Backflow preventers;
 - d. Protective enclosures
6. An affidavit shall be provided that all gate valves and associated materials comply with the requirements of AWWA Standard C509 and C515.
7. Preliminary as-built plans prior to commissioning.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with ASTM F 645 for selection, design, and installation of PE water piping.

D. NSF Compliance:

1. Comply with NSF 14 for plastic potable-water-service piping.

2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport:

Ensure that valves are dry and internally protected against rust and corrosion.

1. Protect valves against damage to threaded ends and flange faces.
2. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves. Rig valves to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.07 PROJECT CONDITIONS

Interruption to the residents: Works shall be carried out with minimum interruption to the residents.

1.08 COORDINATION

Coordinate water pipe to the sanitary pipe work.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

PLASTIC PIPE

- A. Unplasticized Polyvinyl Chloride (uPVC) Pipe shall be new pipe and conforming to the requirements of ASTM Standards ASTM D-1785 schedules 40, Class II with 6 bar pressure minimal.

FITTINGS AND SPECIALS

- A. All fittings, including push on, mechanical joint, flanged, and restrained joint, shall be new gray iron or ductile iron fittings conforming to ANSI/AWWA C110/A21.10 or new ductile iron compact fittings conforming to ANSI/AWWA C153/A21.53 (latest revision) and shall be compatible with the type and pressure class of pipe used.
- B. Mechanical joint restraints shall conform to the requirements of ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53 (latest revision), be compatible with the type and pressure class of pipe used, and UL approved for sizes 4-12 inch, and conform to ASTM F1674 for larger sizes.

JOINTS

- A. PVC pipe joints, fittings, and couplings shall be as specified for PVC pipe. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendations, and as approved by the University's Representative.
- B. Ductile-Iron Pipe Jointing
 - 1. Mechanical joints shall be of the stuffing box type and shall conform to AWWA C111.
 - 2. Push-on joints shall conform to AWWA C111.
 - 3. Rubber gaskets and lubricants shall conform to the applicable requirements of AWWA C111.
- C. Isolation joints shall be installed between non-threaded ferrous and nonferrous metallic pipe, fittings, and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.
 - 1. Sleeve-type couplings shall be used for joining plain end pipe sections. The two couplings shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

VALVES

- A. Gate Valves 50mm and 62.5mm: shall be American Flow Control Series 2500, Mueller 2360 (62.5mm only), or equal product. Gate Valves 75mm through 300mm: shall conform to AWWA Standard Specification C509 and be American Flow Control Series 2500, Mueller 2360, or equal product. All valves shall be iron body, bronze mounted, double-disc, parallel seat gate valves. Gate valves shall be resilient seat, with non-rising stem opening counter-clockwise with O-ring stem seal and flanged or mechanical joints as required for the type of pipe used. The working pressure rating of gate valves shall be a minimum of 1724KPa. Buried valves shall have a 50mm square operating nut, shall be bituminous coated and extensions to place operating nut within 150mm of top of valve box. Tapping valve shall be cast iron, 1379 KPa working pressure, and mechanical joint, with O-ring seals, non-rising stem, Mueller H-667, Kennedy, or equal. The interior and exterior of the body and bonnet shall be coated with fusion bonded epoxy per ANSI/AWWA C550. The body bonnet bolts and nuts shall be stainless steel.

- B. Backflow prevention devices shall be from, and installed in accordance with the University of Southern California – Foundation for Cross-Connection Control and Hydraulic Research (USC-FCCCHR) list. Backflow preventers shall have an insulated, lockable, blanket type cover that shall be provided for all reduced pressure principle devices less than 200mm and all double check devices less than 200mm. All devices that are ferrous metal shall be painted. Domestic devices shall be painted ICI Devoe, DC5517, Hunter Green Semi-Gloss or equal and fire service shall be painted ICI Devoe, DC9000, Safety Red Semi-Gloss or equal. Fire Department connections shall be painted ICI Devoe, Devflex-659 Semi-Gloss 4206, White or equal, with 14 oz of black added per gallon. Installation of backflow assemblies shall not be considered complete until tested by a certified tester, and the certification supplied to the University's Representative.

2.02 INSTALLATION

- A. The minimum ground cover for water mains shall be maintained between 0.6 to 0.9 meters.
- B. Thrust blocks shall be installed on all bends and branches where pipes do not possess adequate tensile strength. The design must withstand the highest of:
- Maximum test pressure under design conditions
 - Maximum surge pressure under design conditions,
 - Maximum test or surge pressure under possible future up rating
- C. Where the PE pipes are installed where the soil is too weak, to resist thrust from a realistically sized thrust block, proprietary ties and restraints will be used.
- D. The effects of temperature variation shall be considered and in particular any loss of strength and expansion/contraction of the pipe, requiring provision for support and restraint in the service tunnel.
- E. uPVC pipe is likely to suffer a reduction in strength relative to its original rated working pressure at elevated temperatures. The life expectancy of the uPVC pipe may be affected and the Contractor shall obtain technical recommendations of the pipe supplier and supplied to the Engineer.
- F. For buried underground pipe work, the ground conditions, cost of bedding and any protection required shall be considered.
- G. Sluice valves shall be installed on all branch connections and on the delivery side of the main line tees.
- H. Line valves on pressure pipelines shall be flanged Ductile Iron for the line pressure and maximum different pressures across them.
- I. Valves on underground pipe work shall be in chambers. Valve spacing shall suit operational requirements for draining the main and disposing its contents.
- J. Air Valves shall be installed at all high points, at accessible locations, sited off-line if necessary. They shall be located to give easy access for maintenance.
- K. Wash out valves shall be installed at all low points. The outlet shall be above any possible flood level to prevent contamination of the main. To comply with environmental requirements, wash outs may not be permitted to have a direct discharge to a water course. Wash outs shall be installed on the inverted branches to buildings off the primary ring main.

2.03 GATE VALVES

- A. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, stainless steel stem or bronze stem, and stem nut.
- 1) Standard: AWWA C509 or BS 5163:1986
 - 2) Minimum Pressure Rating: 1380 kPa
 - 3) End Connections: Mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.
 - 5) Maximum Pressure Rating: 1600 KPa

2.04 CHECK VALVES

- A. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.
- Standards: UL 312 and FMG approved.
Pressure Rating: Maximum 1600 KPa

2.05 AIR RELIEF VALVES

- A. Description: Hydro mechanical device to automatically release accumulated air.
- Standard: AWWA C512.
- a. Pressure Rating: 2070 kPa
 - b. Body Material: Ductile Iron.
 - c. Trim Material: Stainless steel
 - d. Water Inlet Size: 150 mm
 - e. Air Outlet Size: 80 mm

3. WORKMANSHIP

3.01 PIPING INSTALLATION

- A. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
- B. Install PE pipe according to ASTM D 2774 and ASTM F 645.
- C. Bury piping with depth of cover over top at least 900 mm in vehicular roads and 600 mm for non vehicular roads.
- D. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
- E. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

3.02 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
- PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.

- Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.03 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 - 1. Concrete thrust blocks.
 - 2. Locking mechanical joints.
 - 3. Set-screw mechanical retainer glands.
 - 4. Bolted flanged joints.
 - 5. Heat-fused joints.
 - 6. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
- C. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
- D. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.

3.04 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

3.05 CONCRETE VAULT INSTALLATION

- A. Install precast concrete vaults according to ASTM C 891.

3.06 PROTECTIVE ENCLOSURE INSTALLATION

- A. Install concrete base level and with top approximately 50 mm above grade.
- B. Install protective enclosure over valves and equipment.
- C. Anchor protective enclosure to concrete base.

3.07 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
- C. Increase pressure in 350-kPa increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 kPa. Slowly increase again to test pressure and hold for

1 more hour. Maximum allowable leakage is 1.89 L per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

- D. Prepare reports of testing activities.

3.08 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping.
- B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel.

3.09 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
Purge new water-distribution piping systems.
- B. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow standing for 24 hours.

- C. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
- D. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
- E. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- F. Prepare reports of purging and disinfecting activities.

END OF SECTION

SECTION 02520

WATER SUPPLY WELLS / TUBE WELLS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section specifies the drilling, casing, developing, sealing and test pumping of Saline Water Wells / Tube wells.

1.02 RELATED SECTIONS

- A. Section 02510 - Water Distribution
- B. Section 15400 - Plumbing Systems

1.03 SUBMITTALS

- A. Prepare daily shift records and submit them.

1.04 REGULATORY REQUIREMENTS

- A. Except where these specifications are more stringent, all aspects of Contractor's drilling, construction, and development of the well, and abandonment, shall comply with applicable State and Local codes.

1.05 PROJECT CONDITIONS

- A. The contractor shall be familiar with the geological and hydrological condition of the island.

PART 2 – PRODUCTS

2.01

2.02 MATERIALS

A. Casing

1. New, black welded steel: ASTM A53 and API 5L, bearing factory markings of conformance.
2. Size, Weight and Wall Thickness; Conform to the following unless mentioned otherwise in drawings:

SIZE (Inches)	WEIGHT (Lbs. per Ft.)	MINIMUM WALL THICKNESS (Inches)
10.75 (273.1mm)	28.06 (42.09 kg/m)	0.250 (6.4 mm)
8.625 (219.1mm)	22.38 (33.57 kg/m)	0.250 (6.4 mm)
6.625 (168.3mm)	17.04 (25.55 kg/m)	0.250 (6.4 mm)

3. Lengths
 - a. 5 feet minimum lengths
4. Joints
 - a. Electric arc welded.
5. Finish
 - a. Protecting coatings for both faces against injurious effects from high salt water concentration water contact

B. Well Screen

1. Construction
Continuous slot type with closed, bail bottom
2. Material
Screen shall be constructed of one of the following.
 - 1) Stainless Steel - ASTM A240 Type 304
 - 2) Stainless Steel - ASTM A240 Type 304 L.
 - 3) Stainless Steel - ASTM A240 Type 316
3. Diameter
Telescopic size to fit casing in which it is to be installed
4. Slot Size and Length
Manufacturer's standard, slot size to be determined and designed by the Engineer through sieve analysis of the soil samples and developing soil particles distribution curves at site during drilling of tube-well.
5. Packer
Self-sealing, stainless steel using a V-shape, flexible neoprene ring, and mounted on heavy metal ring which can be threaded or welded to top of screen.

C. Access Port

1. Non-galvanized steel coupling with removable pipe plug; or Weldolet by Bonney Forge Inc., Mount Union, PA; or equal. Provide 1-1/2 inch diameter opening.

D. Sanitary Seal

1. Bolted, sanitary type, with rubber gasket and grommets holes for all pipes with power and control cables passing through it

E. Drilling Water

1. Suitable for domestic consumption

F. Cement Grout

1. Mix Proportions
 - a. Portland cement with a maximum of 6 gallons of water per sack of cement, Up to 5 percent Bentonite clay, by weight, may be added
2. Cement
 - a. Type II or III Portland cement

3. Water
 - a. Suitable for domestic consumption
- G. Bentonite**
 1. Commercial Bentonite, fine grained, impervious, with at least 50 percent Bentonite and 0.5 mm maximum size of remaining portion
- H. Sample Containers**
 1. Resealable bags, or plastic or waxed cardboard containers with sealing lid; 1 quart in size
- I. Drilling Fluids**
 1. A commercial agent used to aid in removal of cuttings. Bentonite may be used only with approval of the Engineer.
- J. Gravel Pack**

Gravel packing material shall be to uniformity coefficient near 2.5 or as per actual design.
- K.** During pumping test, the Contractor shall provide equipment for the following water sample tests at site for water quality analyses of the borehole wells:
 - pH
 - EC
 - Temperature
 - Taste
 - Odour
 - Color
 - Sand contents
- L.** The Contractor shall be responsible to test the following parameters of the water samples collected during boreholes drilling from the laboratory.
 - Turbidity, colour, pH, Ca, Mg, Na, HCO₃, SO₄, NH₃, Cl, Mn, Fe (arsenic), F, TDS, EC, Hg, Cd, Hardness, M-Alkalinity, K and bacteriological tests.
 - All chemical tests to be done within 24 hours after collection of water samples in plastic bottles each of one liter capacity properly marked.
 - Special bottles well sterilized will be used for bacteriological tests.

PART 3 – WORKMANSHIP

3.01 PREPARATION

- A. Exercise precautions to prevent foreign materials and surface water from entering drilled hole.
- B. The Contractor shall protect the adjacent terrain and surface water from siltation and contamination. Construct a settling basin to contain the drilling fluid, cuttings and compounds and provide a means to filter sediment prior to discharging excess water.

3.02 CONSTRUCTION

A. Drilling

- (a) The contractor shall employ his reverse circulation to drill the holes of size and depths indicated in the design. The contractor shall provide all equipment for the execution of this work.
- (b) The contractor shall make his own arrangement for water required for drilling purposes and also for ancillary excavation. He shall also arrange for the drilling mud and mud pump etc., where required. Any precautions or steps required to control caving of the bore hole shall also be the responsibility of the contractor.
- (c) Contractor shall also make arrangements of first aid facilities available during any accident. All care and precautions should be taken and it should be ensured that there shall be no accidents while drilling the borehole. Proper dress and equipment like gumboots, helmets and tentage for drilling shall be provided to the workmen at site.

Sample Collection

- (i) The contractor shall take samples (not less than 500 gms) of stratum at his cost at every 3 m or often where the Stratum changes and shall preserve these samples with care at the site for the inspection of Engineer or his authorized representative. In addition at least 1 kg of samples of all the aquifer materials in proper sample boxes or bags is handed over to Engineer free of cost for mechanical analysis. All such samples along with 2-kg sample of gravel if being used be sent to the laboratory for testing and design of screen and gravel pack size. Particular of tube well No. etc, should invariably be given along with samples.
- (ii) Tube well/ dug well water samples are also to be collected and sent to laboratory of tube well department for their chemical analysis.

Water sample for analysis should be collected in 2 liters bottle made of glass, polyethylene or hard rubber, where transportation is expected, glass containers should be avoided as much as possible. Bottle should be thoroughly washed and rinsed before collecting the water samples.

In case of tube wells, the pump should run at least for 10 minutes before the sample is obtained for test.

Sample should be sent to laboratory for analysis as soon as possible within 24 hours but not later than 60 hours.

The sample container should be marked with unwashable paint, well No. and sample number. The position of the well under test should be marked on the mazmuli map showing the proper well No. with a map, showing well No. name of village and name of owner of tube well.

The log details of the well should also be prepared along with the assembly details and it should be sent to the tube well organization for record.

- (iii) Rock samples of tube wells or collected rock sample from any specific area of ground water interests should also be sent to laboratory for petrological tests.

Lowering of well assembly

The contractor shall have to ensure that the slotted pipe strainers are lowered in the well at the places indicated in the design. The lowering of the assembly should be done by the contractor in the presence of the person duly authorized by the Engineer for this purpose. The contractor shall see that the joints in pipes are rigid, water tight and free from kinks. Immediately after lowering the assembly the contractor shall furnish a chart showing the aquifer positions in the bore and the location where slotted pipes or strainers have been placed. This chart shall be signed both by the contractor and the Engineer. This chart will also show the positions of joints in well assembly. the contractor will be entitled to payment for the well assembly and/ or its lowering only on his producing this chart along with his bill.

Development

- (I) The contractor shall develop the well with his own equipment by such methods as would extract maximum practical quantity of sand, drilling and unwanted fine material in order to bring the well to maximum yield per m of draw down and to sand free condition. Compressed air, surge block or pump may be used for development work. This work must be done in a manner that does not cause undue settlement and disturbances of the strata's above the water bearing formation.
- (II) The well shall be developed either by surging and agitating or by over pumping and backwashing with an airlift and high velocity jetting, etc. Any other acceptable method may also be adopted. This development process shall be continued until the stabilization of sand and gravel pack has taken place.

The development of the tube well by over-pumping should be done at 15% to 25% higher discharge than the expected discharge from the tube-wells.

The final discharge should be free from sand with a maximum tolerance of 20 parts of sand in one million parts of water by volume after 20 minutes of starting the pump.

- (III) The development shall be carried out for the period as may be decided by the Engineer and will be so certified both by the Engineer and by the contractor after the development is completed.

B. Temporary Surface Casing

- 1. Furnish, install, and remove all temporary surfaces casing necessary to support the walls of the larger well bore where the grout surface seal is to be placed.

C. Plumbness and Alignment of Wells

- 1. Where Submersible Pumps are to be installed
 - a. Plumbness
 - 1) Drill well vertical. Axis of well shall not deviate from vertical by more than casing inside diameter for each 100 feet of depth.

- b. Alignment
 - 1) Alignment shall be such that a 20 foot plummet will pass all sections of the well easily.
- 2. Where Line Shaft Turbines are to be installed
 - a. Plumbness
 - 1) Drill well vertically. Axis of well shall not deviate from vertical by more than 1/2 of the casing inside diameter for each 100 feet of depth.
 - b. Alignment
 - 1) The casing alignment shall be such that a 40 foot plummet will pass all sections of the well easily.

D. Grouting

- 1. Utilize cement grout to shut off unsatisfactory water horizons or to stabilize caving formations. Place grout utilizing a grout pump and tremie.

E. Minimum Length of Permanent Casing

- 1. The contractor shall determine the actual depth to which the permanent well casing shall extend; however, the casing will extend no less than 18 feet below the ground surface. Provide centering guides to keep the permanent well casing centered in the oversize drill hole.
- 2. The permanent well casing shall extend from 12 inches above the top of the well slab to the following depths as applicable:
- 3. The permanent well casing shall extend from 18 inches above the ground surface to the following depths as applicable:
 - a. If drill hole passes through sound, unrevised, consolidated rock formation, case a minimum of 5 feet into the rock formation. If an unconsolidated formation exists below the rock formation, continue the permanent well casing or well screen to the bottom of the formation or to the bottom of the well, whichever is deeper.
 - b. If drill hole passes through unconsolidated formations and no significant clay lenses, case a minimum of 5 feet below static water level. Continue the permanent well casing or well screen to the well bottom.
 - c. If drill hole passes through unconsolidated formation with a significant clay layer, case a minimum of 5 feet into clay layer. If an unconsolidated formation exists below the significant clay layer, continue the permanent well casing or well screen to the bottom of the formation or to the bottom of the well, which ever is deeper.

F. Grout Surface Seal

- 1. Construct the grout surface seal in the presence of the Engineer.
- 2. The annular space between the permanent well casing and the drill hole shall be completely filled and sealed with cement grout to comply with applicable State regulations and the following:

- a. Diameter of upper drill hole: Drill the annular space a minimum of 4 inches in diameter larger than the nominal diameter of the permanent well casing and at least 18 feet below the ground surface.
3. Temporary Surface Casing Removal
 - a. Remove all temporary surfaces casing necessary to support the walls of the larger well bore while placing the grout surface seal.
4. Grout Surface Seal Placement.
 - a. Construct grout surface seal by placing or forcing grout from the bottom upward between the permanent casing and the open hole or temporary surface casing.
 - b. Slowly remove the temporary surface casing as the annular space is filled with grout. Alternately, the temporary surface casing may be removed immediately after the grout has been placed, but not later than 1/2 hour after initial introduction of grout into the hole.
 - c. Complete the surface seal by topping off the fresh grout after settlement occurs and within 1/2 hour after initial placement of the grout surface seal.

G. Permanent Casing Installation

1. Joints
 - a. Weld casing segments to form continuous, watertight casing in area to be cased. Prepare and weld casing as follows:
 - 1) Cut casing ends square.
 - 2) Bevel end to be joined.
 - 3) Align casing segments.
 - b. Join segments together using electric arc welder. Use sufficient number of passes to completely fill slot formed. Proportion placing of weld material to provide a minimum of 3 full passes within the slot area. Remove slag from welded area between passes.
2. Access Port
 - a. Weld access port 6 inches below finish top of the permanent casing.

H. Well Screen

1. Install by the pull back method.

I. Perforating

1. Perforating of casing will be allowed in lieu of installing well screen only for coarse grained permeable aquifers or in gravel packed wells when withdrawn waters are free of sand, silt, and turbidity and only if ordered in writing by the Engineer.
2. Perforation Placement

Determine depth and length of perforated segment and advice the Engineer.
3. Perforate casing in place in the hole. Place cement grout plug in bottom of casing prior to perforating.

4. Demonstrate perforator on casing in the hole above the cut-off line.
 - a. Perforator Type
 - 1) Holte Manufacturing Casing Perforator producing slots 1/8 by 1 inch long; or other approved method.
 - 2) Torch-perforate casing only if ordered in writing by the Engineer.
 - 3) Torch slots 1/4 inch wide by 12 inches long, at 120 degrees. Stagger tops of adjacent slots 6 inches.

J. Develop the well using the following methods:

1. Development by Surging
 - a. After the well screen has been installed or the casing has been perforated, develop well by surging.
 - b. Do not use surge block inside the screen or opposite casing perforations. Surge by natural drilling action of the drilling machine, Start surging at a slow rate and gradually progress to a maximum rate. Continue surging until no more fines can be brought into the well or until ordered to stop by the Engineer.
2. Development by Air Jetting
 - a. Development of completed well, with screen in place, performed by air jetting method. Development shall start at the bottom of the screen or perforations gradually working toward the top, so that all fines are pulled through the screen and forced out of the well. Continue development (may require more than 1 pass) until no more fines can be brought into the well or until ordered to stop by the Engineer.
3. Continuous Development and Multi Step Tests
 - a. Development

Development will be carried out with raw hiding method for 18 hours using turbine pump till water is cleared of sand in 6 steps each of 3 hours, the table of development is given below:

Discharge	Hours
25% of design discharge	3
50% of design discharge	3
75% of design discharge	3
100% of design discharge	3
125% of design discharge	3
150% of design discharge	3

- b. Multiple Step Test

Step test will follow development of 12 hours in 6 steps each step of 2 hours.

Discharge	Hours
25% of design discharge	2
50% of design discharge	2
75% of design discharge	2
100% of design discharge	2
125% of design discharge	2
150% of design discharge	2

- c. Recovery to the original level for 12 hours or up to 90% recovery.
- d. Aquifer Test of Production Well

This test will be carried out for 72 hours

Schedule of Measurement of Water Levels during Development, Step Test and Aquifer Tests

a)

Time	Elapsed	Interval
1 st Hour	0-10 Minutes 10-30 Minutes 30-60 Minutes 1 Hour	1 Minutes 2 Minutes 5 Minutes
2 nd Hour	60-120 Minutes 1 Hour	10 Minutes
3 rd Hour	120-180 Minutes 1 Hour	20 Minutes
4 th Hour to 7 th Hour	180 – 360 Minutes 3 Hours	30 Minutes
8 th Hour and Beyond	360 – 420 Minutes and Beyond	1 hour

- b) Same schedule given above shall be followed during recovery period.

Supervision and Reporting

Part-1

- The drilling and testing shall be supervised properly by the Hydro-geologist having 8 to 10 years experience in similar field.
- The results of the drilling and testing shall be recorded and completed by the Contractor and submitted in the form of a report which will include:
 1. Daily job record
 2. Drilling record, geological time log and casing program etc.

Part- II

- Pumping test report
- Water analysis report

- Water observation data
- Data analysis for aquifer parameters i.e. safe yield, co-efficient of permeability, Horizontal Conductivity etc.

K. Capping

1. Upon completion of well, weld a 3/16 inch steel plate, approximately 1/2 inch larger in diameter than casing OD, over the cut off casing top. Spot weld in 4 places around casing.

3.03 FIELD QUALITY CONTROL

A. Test Equipment

1. Provide the following equipment for the test:
 - a. A 20 foot long plummet of well casing of the next smaller size than the installed well casing, with a support ring or hook on one end.
 - b. A 1 foot plummet with an outside diameter 1/4 inch less than the casing inside diameter; a 1/8 inch wire cable or other suitable line long enough to reach the full depth of the well, and a suitable tripod or support for suspending the cable at a point 10 foot 0 inches above and centered in the top of the casing.

B. Alignment may be tested using either Procedure 1 or Procedure 2

1. Procedure 1
Lower 20 foot long plummet down the well, If the plummet passes all sections of the well easily, alignment of the well is satisfactory.
2. Procedure 2
 - a. Lower the 1 foot long plummet down the well, measuring the offset from true center of the cable at the top of the casing at 10 foot intervals down the well.
 - b. The calculated centerline of the well casing is the product of the measured offset times the depth divided by the distance from the top of the casing to the support point (10 foot 0 inches).

$$\text{Calculated Centerline} = \frac{\text{Measured Offset} \times \text{Depth}}{\text{Support Length (10 foot 0 inches)}}$$

- c. Plot the calculated centerline against depth to obtain a graph of the position of the centerline of the well casing.
- d. Use this graph to determine whether a 20 foot plummet, 1/2 inch smaller than the inside diameter of the actual well casing will pass the points of misalignment. Draw a straight line from 10 feet above to 10 feet below the point of misalignment; this corresponds to the centerline of the 20 foot plummet. Measure the maximum right angle deviation from the centerline of the plummet to the calculated centerline of the well casing. If this offset were less than 1/4

inches, the plummet would pass freely; if it is more than 1/4 inch, the plummet will not pass the point of misalignment.

C. Sampling of Penetrated Material

1. Sampling Interval
Sample at every change of material or at 25 feet intervals within the same material
2. Sampling Procedure for Reverse Rotary Methods
Remove drilled material from hole. Drill 1-1/2 feet into formation being sampled. Force drilled material out into a clean tub. Allow to settle and obtain representative sample.
3. Sampling Procedure for Cable Tool Method
Bail hole clean, Drill 1-1/2 feet into formation being sampled. Remove sludge with sand pump or flat bottom bailer. Discharge into clean tub. Allow to settle and obtain representative sample.

D. Pumping Test

1. Supply all pumps and equipment required and perform a quantitative pumping test on the completed well after the depth has been accurately measured by the Engineer. The test shall be performed in the presence and under the direction of the Engineer. During the pumping test, the drawdown in feet below static level and the pumping rate shall be measured at least every 2 minutes until drawdown stabilizes and every 10 minutes thereafter.
2. Test Procedure.
Pumping test shall be performed as follows:
 - 1) Test pump at appropriate pressure. If the water level stabilizes at less than 50 percent of the static water depth, continue pumping for an additional 4 hours.
 - 2) If the drawdown is greater than 50 percent of the static water depth, reduce the pumping rate. If the water level stabilizes at less than 50 percent of the static water depth, continue pumping for an additional 4 hours.
 - 3) If the drawdown at above pressure is greater than 50 percent of the static water depth, reduce the pumping rate until the water level stabilizes. Continue pumping for an additional 4 hours.
 - 4) After completion of pumping, record water level recovery every 5 minutes until static water depth is reached.
3. Measuring Equipment
 - a. Measuring equipment shall consist of the following:
 - 1) Flow Rate: Weir box, orifice, water meter, or other device satisfactory to Engineer for measuring flow of water.

- 2) Flow Control: Gate valve on pump discharge for controlling rate of water flow from pump.
- 3) Drawdown Depth: Provide airline complete with pressure gauge 3-1/2 inch minimum diameter, reading directly in feet. Provide tire pump. Terminate air line approximately 3 feet above pump intake.

3.04 CLEANING AND DISINFECTION

- A. Clean and disinfect the well upon completion of well development. Disinfection may be done prior to test pumping.
 1. Cleaning
Thoroughly clean the well by removing all foreign substances and if required, swab with alkalis to remove oil and grease.
 2. Disinfection
 - a. After cleaning, disinfect the well with chlorine solution of sufficient strength to provide a 50 mg/l chlorine residual in all parts of well.
 - b. Disinfect as follows:
 - 1) Dump concentrated chlorine solution into well
 - 2) Agitate well water from top to bottom with a bailer or other method approved by Engineer for at least 30 minutes.
 - 3) After agitating, wash the walls of the casing above water level thoroughly with water bailed from the well.
 - 4) Leave chlorine solution in the well for a period of at least 12 hours.
 - 5) Test chlorine residual. If less than 10 mg/l remain, repeat disinfection process.
 - 6) After disinfection, pump well at desired yield for a minimum of 30 minutes, or until no chlorine residual remains.
- B. Bacteriological Test Samples
Samples of water will be collected by the Engineer for testing of bacteriological quality by the Government after cleaning and disinfection is complete.

3.05 ABANDONING WELL

- A. Plugging Well
 1. If Engineer orders the well to be abandoned, plug the well in accordance with State regulations and standards to within 5 feet of original ground as casing is removed. Fill remaining hole to original ground with native topsoil.
- B. Removing Casing
 1. Contractor shall undertake removal of the casing when directed in writing by the Engineer. Removal operation shall continue until successful or until ordered to stop in writing by the Engineer. Every practical means shall be used to remove the casing including hydraulic jacks or other methods approved by the Engineer. Permanent casing removed shall become the property of the MHTE and shall be used in other wells, if any, remaining to be drilled under this Contract. If the casing cannot be used

for this Contract, the Contractor, at the option of the MHTE, shall take possession of the casing and reimburse the MHTE at 50 percent of the Contractor's invoice price for the casing.

PART 4 - MEASUREMENT AND PAYMENT

Drilling

Measurement will be of the linear meter of depth of open hole measured from bottom of the hole.

Casing-In-Place

Measurement will be of the linear meter of permanent casing furnished and installed including protecting coatings in both faces.

Well Screen

Measurement will be of the linear meter of well screen, including length of fittings, installed at the depth specified and shown on drawings.

Perforating

Measurement will be of the linear meter of casing perforated.

Pea Gravel

Measurement will be the depth of gravel packed in linear meters.

Well Development and Sample Testing.

Measurement will be per job.

Plugging Well

Measurement will be of the linear meter of well plugged including all required materials.

Grouting

Measurement will be the depth of the casing in linear meter.

Pumps

Measurement will be as completed item including providing and installation of two nos. of Multistage, Submersible Raw Water Pumps with required capacity and pump testing.

- ❖ The cost of unit rates related to tube wells as mentioned above and as itemized in the BOQ shall include, but not limited to, following as required where individual quantities are not provided in the Bill of Quantities:

1. Equipment Move-in and Move-out of all personnel, equipment, and materials necessary to complete the project and standby time of all personnel and equipment.

2. Surface Seal including drilling and all material used in the surface seal except permanent casing.
3. Drive Shoe
4. Removing Casing if required
5. Any required Testing

END OF SECTION

**SECTION 02530
SANITARY SEWERAGE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Sanitary Sewer Systems (Gravity)
- B Pressure Sewer
- C Sea Outfall

1.02 RELATED SECTIONS

- A General Requirements
- B Sections – 02240, 02260, 02315, 02316, 02318

1.03 QUALITY ASSURANCE

- A Regulations: Comply with local codes and ordinances of governing authorities having jurisdiction.
- B Pipes and Fittings: - Manufacturer's name and country of origin marked.
- C Welding equipment and procedures - conform to manufacturers' recommendation.

1.04 SUBMITTAL

- A Submit under provision of Section 01300.

1.05 REFERENCES:

- A "Solid Wall ASTM 3034 SDR 35" for UPVC Sewer and "ASTM D 3350 PE3408 SDR 11" for Force main and for Sea Outfall
- B ASME B16.5 Pipe flanges and flanged fittings
- C ISO 4435:2003 Plastics piping systems for non-pressure underground drainage and sewerage - Unplasticized poly(vinyl chloride) (PVC-U)
- D ISO 6455:1983 Unplasticized polyvinyl chloride (PVC) fittings with elastic sealing ring type joints for pipes under pressure; Dimensions of laying lengths.
- E ISO 9691:1992 Rubber; recommendations for the workmanship of pipe joint rings; description and classification of imperfections
- F ISO/TR 7073:1988 Recommended techniques for the installation of unplasticized poly(vinyl chloride) (PVC-U) buried drains and sewers
- G ISO/TR 7074:1986 Performance requirements for plastics pipes and fittings for use in underground drainage and sewage
- H BS 4346-3, Publication date:1982-08-31 Joints and fittings for use with unplasticized PVC

pressure pipes - Specification for solvent cement

I BS 5481:1983 Specification for unplasticized PVC pipe and fittings for gravity sewer

J ISO 8770/8772; DIN 8075/19535/19537; BS/6367/5572/6437/5114 UNI EN 1519 for HDPE pipes

1.06 SCHEDULING OF WORKS:

- A Schedule Work to minimize interruptions to existing services and maintain existing flows during construction.
- B Submit schedule of expected interruptions for approval and adhere to approved schedule.
- C Notify Engineer 24 hours minimum in advance of any interruption in service.
- D Provide pumps and temporary pipe of sufficient capacity for bypass.

1.07 DELIVERY, STORAGE AND HANDLING:

- A Store products in shipping containers and maintain in place until installation. Avoid exposure to the direct sun light.
- B Handle and store pipe, valves and fittings in such a manner as to avoid shock and damage and as per manufacturer's recommendations.
- C Provide temporary end caps and enclosures on piping and fittings. Maintain in place until installation.
- D Protect piping system from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- E Do not use chains or cables to pass through pipe bore
- F Store pipe in a manner to maintain its concentricity and straightness

PART 2 PRODUCTS

2.01 UPVC Sewer pipe:

Unplasticized Polyvinyl Chloride pipe with rubber seal joints shall conform to Solid Wall ASTM 3034 SDR 35.

2.02 Fittings:

PVC or polypropylene bell ended with locked-in rubber gaskets including repair couplings, appropriate to the type and size of pipe used.

2.03 All flanged joints are to conform to ASTM D4024, Class 150.

2.04 Flange backing rings are to be polypropylene (30% fiberglass reinforced with steel core or 316 stainless steel rated PN16 stainless steel bolts, nuts and washers. All bolts, nuts and washers are to be 316 stainless steel.

2.05 Protective Coating:

For valves: anti-corrosion petrolatum mastic, Coatings paste and tape.

2.06 Force main and Outfall:

High density polyethylene (HDPE) pipe to ASTM. Sizes shall be as indicated in the drawings. All pipes shall be Class PN 06.

Pipe joints shall be Thermal butt fusion welded, except flanged joints where indicated. Flanged joints shall be HDPE/PP (30% fiberglass reinforced with steel core) and HDPE/HDPE flanges designed for PN16. Blind flanged connections shall be ANSI C207 ductile iron, with flanges drilled to ANSI B16.5.

2.07 Gate Valves:

To AWWA C509 standards, PN16 and as follows:

- Body: cast iron with flange joint ends to ANSI B16.
- Mechanism (AWWA C509): wedge disk with resilient rubber seat ring and machined seating surface, non-rising spindle, and O-ring seal.
- Direction of opening: counter-clockwise.
- Provide entering disk.
- Provide two (2) valve keys for each Island.

2.08 Valve Boxes:

Valve boxes to AWWA C500 and as follows:

- Cast iron, slide type, adjustable for depth of pipe below finished grade.
- Covers marked sewer.
- Lugged to prevent turning and rolling of cover

2.09 Ballast Block Fastenings:

- Fastening bolts: stainless steel threaded rod to ASTM A-193, size indicated, complete with flat plate washer as shown on drawings.
- Fastening straps: 316 stainless steel, complete with rubber pipe protection
- Pipe protection: 5 mm thick rubber sheet.
- Anchor rod sleeves: 25 mm dia. PVC pipe, cast into concrete.
- Lifting hook: 15 mm dia. mild steel bar, cast into concrete

PART 3 WORKMANSHIP

3.01 Preparation:

- A Clean pipes, seals and appurtenances of accumulated debris and water before installation. Carefully inspect materials for defects. Remove defective materials from site.
- B Obtain Engineer's approval of pipes and fittings prior to installation.
- C Provide proper implements, tools, pipe lubricants and facilities approved by the Engineer, for the safe and convenient prosecution of the work.
- D Take every precaution to prevent foreign material from entering the pipe.

3.02 Trenching

- A Do trench excavation and backfilling work to Section 02200.

3.03 Pipe Bedding

- A Place sand bedding material to depth indicated; in uniform layers.

- B Shape bed true to grade to provide continuous uniform bearing surface for pipe exterior. Do not use blocks when bedding pipe.
- C Shape transverse depressions in bedding as required to make joints.
- D Lay the pipe over this bedding to required slope.
- E After installation of pipe, place more sand bedding material to a minimum thickness of 5cm around the pipe. Backfill the trench and compact as per section 02200. The minimum thickness of the bedding material shall be 100mm below the pipe and 300mm above the crown of the gravity as well as pressure pipe.
- F For pipes with backfill cover less than 900mm in case of vehicular lane and less than 600mm in case of non-vehicular lane, concrete encasement, having thickness of 100mm below and 150mm above crown of pipe shall be provided.

3.04 Pipe Laying (Gravity line)

- A Carefully lower pipes to trench. Do not drop or dump materials into the trench.
- B Lay and join pipes, fittings and valves as specified herein and according to manufacturer's published instructions.
- C Lay pipe and fittings on prepared bed, true to line and grade indicated, within following tolerances:
- D Horizontal Alignment: 50 mm
- E Vertical Alignment: the lesser of 12 mm or one half the rise per pipe length.
- F Commence laying at outlet and proceed in upstream direction, if bell and spigot pipe is used, bell ends of pipes are to face upgrade.
- G Prevent entry of bedding material, water or other foreign matter into pipe. Use temporary watertight bulkheads when pipe laying is not in progress.
- H Where laser-leveling equipment can be used, confirm elevation and pipe gradient with Engineer.
- I Where above equipment cannot be used, measure elevation and record every bell end or coupling/joint of pipe placed in trench.
- J Marker tapes shall be placed above the pipes in trenches.

3.05 Pipe Laying (Force main)

- A Carefully lower pipe into the trench in such a manner as to prevent damage to external and internal finish.
- A Do not drop, roll or dump materials into trench.
- B Firmly and accurately, set pipe to line and elevation on bedding material to the depth shown on the Drawings.
- C Check profiles at the commencement of work. Confirm grades and depths. Any variation shall be made only at the order of the Engineer. Set line of pipe by offset centerline. Set elevation by a method approved by the Engineer.
- D Start laying pipe at lowest pipe and lay upgrade unless approved otherwise by the Engineer. Ensure pipe maintains a positive upward slope.
- E When laying pipe in wet conditions, Engineer must be present and confirm final invert. Do not lay pipe when trench conditions or weather are unsuitable.
- F Temporarily support all pipe during assembly and install fittings in a manner to ensure pipe is not strained during jointing procedure. Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
- G Whenever it is necessary to cut pipe to fit into pipeline, do this work, and provide materials at no extra cost to the Contract. No extra compensation will be considered for cutting of pipe or for

placing cut pipe in the pipeline.

- H Block ends of pipe at end of each workday. Ensure no foreign material enters pipe.

3.06 Pipe Laying (Outfall)

- A Decide the route of outfall before start of outfall construction.
- B Place ballast blocks along the route at definite intervals as shown in drawings.
- C HDPE pipe sections as specified, including protection and joint certification.
- D Whenever it is necessary to cut pipe to fit into outfall, provide materials and do work at own expense. No extra compensation will be given for cutting pipe or placing cut pipe in outfall.
- E Provide rubber protection sheet at ballast block locations. Attach collars in such a manner that pipe is not overstressed. Tighten bolts to achieve snug, non-slip fit, without causing undue deflection.
- F Launch pipe according to manufacturer's recommendations. Protect floating assembled pipeline from damage, and provide adequate anchorage.
- G Sink pipeline in designated location. Control pipe location and rate of sinking to avoid overstressing pipe and joints.
- H After pipeline has been lowered to the seabed, inspect to ensure it is located properly.
- I Check if joints in reef section are satisfactory, ballast collars are properly located and set in seabed and pipe is resting on seabed as indicated on drawings.

3.07 Thrust Blocks

- A. Contractor shall calculate the thrust, design and construct thrust blocks so as to ensure the integrity of the line. Piping/directly buried valves shall be supported by concrete thrust blocks at all changes of direction, size or elevation.
- B. Provide concrete thrust blocks at each change of direction and at terminal points and when specified as shown on the drawings. The concrete for the thrust blocks shall conform to the requirements of Construction Specification 03300, Cast in place Concrete. The thrust block cavity shall be hand dug into undisturbed soil or previously placed compacted backfill. The cavity shall be formed with soil or wood to hold the freshly placed concrete without displacement until an initial set has occurred.
- C. When excavation beyond the designated trench widths and depths as shown on the drawings occurs at locations where installation of concrete thrust blocks is required, the contractor shall install an alternative thrust block provision. The concrete thrust block shall have a thickness of one pipe diameter and a contact face area that shall be formed against the pipe as shown on the drawings. Backfill shall be placed on all sides of the thrust block and to the sides of the excavation. It shall be compacted as specified for initial backfill. Backfilling and compaction shall be completed to the pipe centre line and around all thrust blocks as required to assure restraint to the pipeline

3.08 Pipe Jointing for UPVC pipes

- A Install gaskets in accordance with manufacturer's published instructions.
- B Align pipe carefully before joining. Do not use excessive force to join pipe sections.
- C Support pipes as required to assure concentricity until joint is properly completed. Keep pipe

joints free from mud, silt, gravel or other foreign material.

- D Avoid displacing gasket or contaminating with dirt, petroleum products, or other foreign material. Remove, clean, reinstall and lubricate gaskets so disturbed.
- E Where deflection at joints is permitted, deflect only after joint is completed. Do not exceed maximum joint deflection recommended by manufacturer.
- F Cut pipe as required for fittings or closure pieces, square to centerline, and as recommended by manufacturer.
- G Make watertight connections to manholes and structures as recommended by manufacturer.
- H At structures, ensure joint is correctly aligned or provide flexible joint not more than 300 mm from outside face of structure, or as otherwise indicated.
- I For pressure mains provide thrust blocks for change in directions and pipe ends. Thrust block size calculations shall be approved by concerned engineer prior to installation. Thrust block concrete shall be with minimum 20MPa compressive strength.
- J Ballast concrete shall be with a minimum compressive strength of 25MPa.

3.09 Pipe Jointing for HDPE pipes:

- A Assemble and join outfall pipe sections into one continuous pipe length by the thermal butt fusion welding process as recommended by the pipe manufacturer. Perform jointing by qualified personnel in accordance with manufacturer's requirements using pipe jointing equipment approved by pipe manufacturer.
- B Proper protection should be provided for the jointing equipment as required by the manufacturer to maintain suitable ambient conditions while jointing is in progress.
- C Provide a joint certification for each joint made including recording the conditions under which jointing took place.
- D Flanged joints: Allow pipe lengths to be joined to cool to ambient soil temperature before joining.
- E Align pipes properly and install so one face is in compression against other.
- F Do not use bolts to pull pipe ends to overcome gap or misalignment.
- G Leave flanged joints exposed for minimum hours. Retighten bolts before pressure testing.
- H Pipe passing through sleeve across reef is to be a single pipe length.

3.010 Protective Coating:

- A Coat collar type couplings and bolts and for other areas where required with protective coating, in accordance with manufacturer's instructions.
- B Transport and store coating materials between 5°C and 30°C.
- A Ensure surface to be coated is free of loose coating, soil or other foreign matter.
- B Apply priming paste to areas after surface preparation is completed.
- C Apply mastic to irregular surfaces to ensure smooth surfaces and no air pockets.

3.011 Pipe Cleaning

- A Prior to testing, clean gravity sewer to remove foreign materials and to be verified by the Engineer.
- B Test all sanitary gravity sewers for water tightness. All tests to be made in the presence of Engineer.
- C Provide all labor, equipment and materials required to perform hydrostatic and leakage tests.
- D Before testing ensure that all relevant open ends are blanked off with watertight plugs or caps.

- E Discharge test water through newly laid pipeline if a suitable outfall exists or otherwise in accordance with the Contract and applicable environmental regulations.

3.012 Ex-filtration test:

- A Fill section with water to displace air from main and service connections. Fill and maintain nominal head on PVC pipe for a period of 24 hours before testing to allow steady state.
- B Add water to establish test head of 3 m over either crown of pipe, measured at highest point of section, or level of static ground water, whichever is greater. Do not exceed net internal head of 8.13m.
- C Maintain test head for 1 hour.
- D Measure and record volume of water required to maintain head during test period.

3.013 Infiltration test:

- A Conduct infiltration test instead of ex-filtration test where level of static ground water is 760 mm (30") or more above crown of pipe measured at highest point of section. No increase in infiltration rate will be allowed if head exceeds 760 mm (30").
- B Install watertight plug at upstream end of section.
- C Discontinue dewatering minimum of 3 days before taking test measurements.
- D Place 90° V-notch weir, in invert of main at downstream end of section. Add water until flow is observed through notch.
- E Measure and record total volume of flow for one hour.

3.014 Hydrostatic Testing

- A All tests to be as directed by the Engineer and made in the presence of the Engineer.
- B Notify Engineer at least 24 hours in advance of all proposed tests.
- C Test using clean freshwater. If using a potable water supply, either continuously separate with an air cap or provide a level of protection equal to or greater than double check valve.
- D Provide labor, equipment, materials required to perform hydrostatic, and leakage tests. Equipment used to be approved by the Engineer before use.
- E Backfill prior to testing
- F Open all valves in test section.
- G Expel air by slowly filling main from the low point with clean water. Pipeline to remain filled for not less than 24 hours prior to pressure test.
- H Gradually increase water pressure inside pipe until it reaches 1035 kPa or 1.5 times working pressure, whichever is the greater, measured at the lowest point in the test section.
- I Upon reaching test pressure, close inlet valve and monitor pressure. The test is deemed successful when test pressure is maintained for a 2-hour period with no addition of fluids. No leakage will be allowed.

3.015 Should testing or inspection disclose repeated non-conformance, locate and repair defective pipe or joint to the approval of the Engineer.

3.016 Re-test to determine success or otherwise of remedial measures applied to pipe work. These re-tests are to be repeated at no extra cost to Contract until results show that remedial measures have been successful.

- 3.017 In the event the Engineer suspects the sanitary gravity sewer no longer complies with requirement of the test, the Engineer may order additional testing. Should the length of pipeline prove defective, the Contractor shall repair or make good the defect at no extra cost to Contract.
- 3.018 Cost of additional testing to be at no extra cost to Contract if test proves a defect.
- 3.019 However, if this testing shows pipe to be satisfactory, cost of second test will be borne by Employer.
- 3.020 Upon completion of testing of each section remove all ancillary equipment and plug holes. Do not backfill around test plugs until inspected by Engineer.

END OF SECTION

SECTION 02631 FIBERGLASS MANHOLE

PART 1 GENERAL

1.01 SECTION INCLUDES

- 2.1.1. Fiberglass Manhole

1.02 RELATED SECTIONS

- 2.2.1. General Requirements
- 2.2.2. Sections – 02240, 02260, 02315, 02316, 02318

1.03 QUALITY ASSURANCE

- 2.3.1. Regulations: Comply with local codes and ordinances of governing authorities having jurisdiction.

1.04 SUBMITTAL

- 2.4.1. Submit under provision of Section 01300.

2.01 REFERENCES:

- 2.4.2. ASTM D-3753 latest edition- Fiberglass reinforced polyester manhole.
- 2.4.3. BS EN 7158 – Plastic inspection chambers
- 2.4.4. BS EN 124 – Gulley tops and Manhole tops
- 2.4.5. ISO 6455:1983 Unplasticized polyvinyl chloride (PVC) fittings with elastic sealing ring type joints for pipes under pressure; Dimensions of laying lengths.

PART 2 PRODUCT

- 2.02 Fiberglass reinforced polyester manhole shall be manufactured from commercial grade polyester resin or other suitable polyester or vinyl ester resins with fiberglass reinforcements. Manhole shall be a one-piece unit manufactured to meet or exceed all specifications of ASTM D-3753 latest edition.
- 2.03 Resin: The resins used shall be a commercial grade unsaturated polyester resin or other suitable polyester or vinyl ester resin.
- 2.04 Reinforcing Materials: The reinforcing materials shall be commercial Grade "E" type glass in the form of continuous roving and chop roving, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.
- 2.05 Interior Surfacing Material: The inner surface exposed to the chemical environment shall be a resin-rich layer of 0.010 to 0.020 inch thick. The combined thickness of the inner surface and interior layer shall not be less than 0.10 inch (2.5 mm)
- 2.06 Wall Construction Procedure: The manhole wall shall be constructed in a way that insures continuous reinforcement and uniform strength and composition. The Manhole shall be

completely factory fabricated and delivered to site as a single unit. Seams shall be fiber glassed on the inside and the outside using the same glass-resin jointing procedure. Field joints shall not be acceptable by anyone except the manufacturer.

- 2.07 Exterior Surface: For a UV inhibitor the resin on the exterior surface of the manhole shall have gray pigment added for a minimum thickness 0.125 inches.
- 2.08 Stub outs and Connections: Stub outs shall be factory fabricated as per site conditions. Installation of SDR PVC sewer pipe shall be performed by sanding, priming and using resin fiber-reinforced hand layup. The resin and fiberglass shall be same type and grade as used in the fabrication of the fiberglass manhole.
- 2.09 Manhole Bottom: Manhole bottom shall have resin fiber-reinforced bottom. Deeper manholes shall be provided with fiberglass channel stiffening ribs. All fiberglass manholes with a fiberglass bottom will have a minimum 3-inch anti-flotation ring. Manhole bottom shall be a minimum of ½ inch thick.
- 2.010 Fiberglass enclosed invert and bench area: Manholes shall be provided with a fiberglass enclosed invert and bench area. The invert shall be formed using a non-corrosive material and completely enclosed in a minimum 1/4 inch layer of fiberglass chop.
- 2.011 Height Adjustment: Fiberglass manholes must have the ability to be height adjustable with the use of a height adjustment ring. Height adjustment can be made as a field operation without the use of uncured resins or fiberglass layups. Fiberglass manholes must maintain all load and soundness characteristics required by ASTM D3753 after height adjustment has occurred.
- 2.012 Fillers and Additives: Fillers, when used, shall be inert to the environment and manhole construction. Sand shall not be accepted as approved filler. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used to meet the requirements of this standard. The resulting reinforced-plastic material must meet the requirements of this specification.

PART 3 MANUFACTURING

- 3.01 Manhole cylinders, man-way reducers, and connectors shall be made from glass fiber-reinforced polyester resin in a way that insures continuous reinforcement and uniform strength and composition.
- 3.02 Interior Access: All manholes shall be designed so that a ladder or step system can be supported by the installed manhole.
- 3.03 Man-way Reducer: Man-way reducers will be concentric with respect to the larger portion of the manhole diameters through 60 inches. Larger manholes may have concentric or eccentric man-way reducer openings.
- 3.04 Cover and Ring Support: The manhole shall provide an area from which a grade ring or brick can be installed to accept a typical metal ring & cover and have the strength to support a traffic load without damage to the manhole.

PART 4 REQUIREMENTS

- 4.01 Exterior Surface: The exterior surface shall be relatively smooth with no sharp projections. Handwork finish is acceptable if enough resin is present to eliminate fiber show. The exterior surface shall be free of blisters larger than 0.5 inch in diameter, de-lamination or fiber show.
- 4.02 Interior Surface: The interior surface shall be resin rich with no exposed fibers. The surface shall be free of cracks, de-lamination, and blisters larger than 0.5 inch in diameter and wrinkles of 0.125 inch or greater in depth. Surface pits shall be permitted if they are less than 0.75 inch in diameter and less than 0.0625 inch deep. Voids that cannot be broken with finger pressure and that are entirely below the resin surface shall be permitted if they are less than 0.5 inch in diameter and less than 0.0625 inch thick.
- 4.03 Repairs: Any manhole repair is subject to meet all requirements of this specification.
- 4.04 Manhole Length: Manhole lengths shall be in 6-inch increments +/- 2 inches.
- 4.05 Diameter Tolerance: Tolerance of inside diameter shall be +/- 1% of required manhole diameter.
- 4.06 Load Rating: The complete manhole shall have a minimum dynamic-load rating of 16,000 lbs. when tested in accordance with ASTM 3753 8.4. To establish the rating the complete manhole shall not leak, crack, or suffer other damage when load tested to 40,000 lbs. and shall not deflect vertically downward more than 0.25 inch at the point of load application when loaded to 24,000 lbs.
- 4.07 Stiffness: The manhole cylinder shall have the minimum pipe-stiffness values shown in the table below when tested in accordance with ASTM 3753 8.5.

LENGTH - FT	F/AY - PSI
3 - 6.5	0.75
7 - 12.5	1.26
13 - 20.5	2.01
21 - 25.5	3.02
26 - 35	5.24

- 4.08 Soundness: In order to determine soundness, apply an air or water pressure test to the manhole test sample. Test pressure shall not be less than 3.0 psig or greater than 5.0 psig. While holding at the established pressure, inspect the entire manhole for leaks. Any leakage through the laminate is cause for failure of the test. Refer to ASTM 3753 8.6.
- 4.09 Chemical Resistance: The fiberglass manhole and all related components shall be fabricated from corrosion proof material suitable for atmospheres containing hydrogen sulfide and dilute sulfuric acid as well as other gases associated with the wastewater collection system.

PART 5 PHYSICAL PROPERTIES

Hoop Direction	Axial Direction
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a. Tensile Strength (psi)	18,000	5,000
b. Tensile Modules (psi)	0.6×10^6	0.7×10^6
c. Flexural Strength (psi)	26,000	4,500
d. Flexural Modules (psi)	1.4×10^6	0.7×10^6
e. Compressive (psi)	18,000	10,000

PART 6 TEST METHODS

- 6.01 All tests shall be performed as specified in ASTM 3753 latest edition, section 8. Test method D-790 and test method D-695.

PART 7 QUALITY CONTROL

- 7.01 Each completed manhole shall be examined for dimensional requirements, hardness, and workmanship. All required ASTM. 3753 testing shall be completed and records of all testing shall be kept and copies of test records shall be presented to customer upon formal written request within a reasonable time period.

PART 8 SHIPPING and HANDLING

- 8.01 Do not drop or impact the fiberglass manhole. Fiberglass manhole may be lifted by inserting a 4"x4"x30" timber into the top of manhole with cable attached or by a sling or "choker" connection around center of manhole, lift as required. Use of chains or cables in contact with the manhole surface is prohibited.

PART 9 WORKMANSHIP

- 9.01 Fiberglass Bottom: Concrete may be used to form bench area and invert. In addition, concrete may be used on top of anti-flotation ring and around the reducer section as required for buoyancy.
- 9.02 Concrete Bottom: Lower manhole into wet concrete until it rests at the proper elevation, with a minimum of 4 inches of fiberglass manhole inserted into the wet concrete below flow line and then move manhole to plumb. The concrete shall extend a minimum of one foot from the outside wall of the manhole and a minimum of 6 inches above incoming lines. On the inside concrete shall form the bench and an invert area and to a minimum of 4 inches above incoming lines. If required by engineer concrete may be used around reducer section for buoyancy.
- 9.03 Backfill Material: Unless shown otherwise on drawings and approved by the engineer, crushed stone, or pea gravel shall be used for backfill around the manhole for a minimum distance of one foot from the outside surface and extending from the bottom of the excavation to the top of the reducer section. Suitable material chosen from the excavation may be used for the remainder of the backfill. The material chosen shall be free of large lumps or clods, which will not readily break down under compaction. This material will be subject to approval by the engineer.

9.04 Backfill Procedure: Backfill shall be placed in layers of not more than 12 loose measure inches and mechanically tamped to 95% Standard Proctor Density, unless otherwise approved by the engineer. Flooding shall not be permitted. Backfill shall be placed in such a manner as to prevent any wedging action against the fiberglass manhole structure.

9.05 MARKING and IDENTIFICATION

Each manhole shall be marked on the inside and outside with the following information:

1. Manufacturer's name or trademark
2. Manufacturer's factory location
3. Manufacturer's serial number
4. Total length
5. Tag number as in shop drawing

END OF SECTION

SECTION 03100
CONCRETE FORMWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formwork for cast-in place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

1.02 RELATED SECTIONS

- A. Section 03200 - Steel Reinforcement.
- B. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCES

- A. ACI 301 - Structural Concrete for Buildings.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.
- C. ACI 347 - Recommended Practice for Concrete Formwork.
- D. ANSI/ASME A17.1- Safety Code for Elevators, Dumbwaiters, Escalators, and Moving Walks
- E. PS 1 - Construction and Industrial Plywood.

1.04 DESIGN REQUIREMENTS

- A. Design and construct formwork, shoring and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line and dimension.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.
- C. Product Data: Provide data on installation requirements.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 347, 301, 318.
- B. Maintain two copies of each document on site.

1.07 REGULATORY REQUIREMENTS

- A. Conform to applicable ACI 347 code for design, fabrication, erection and removal of formwork.

1.08 FIELD SAMPLES

- A. Provide under provisions of Section 01400 and Coordinate with requirements stated in Section 03100 and 03300.

1.09 COORDINATION

- A. Coordinate work under provisions of Section 01039 Coordination and meetings.
- B. Coordinate this Section with other Sections of work which require attachment of components to formwork.
- C. If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from Engineer.

PART 2 PRODUCTS

2.01 WOOD FORM MATERIALS

- A. Form Materials: At the discretion of the Engineer.

2.02 FORMWORK ACCESSORIES

- A. Form Ties: Removable type, galvanized metal, cone type, with waterproofing washer, free of defects that could leave holes larger than 25 mm in concrete surface.
- B. Form Release Agent: Colourless mineral oil which will not stain concrete, or absorb moisture, or impair natural bonding or colour characteristics of coating intended for use on concrete.
- C. Corners: Fillet or Chamfer, rigid plastic wood strip of suitable size.
- D. Flashing Reglets: Galvanized steel or rigid PVC, 0.8 mm thick, longest possible lengths, with alignment splines for joints, release tape sealed slots, anchors for securing to concrete formwork.
- F. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
- E. Water Stops: - Polyvinyl chloride water stops in accordance with B.S. 2571 and U.S. Corps of Engineers CRD - C 572 - 74 to the required width with maximum possible lengths, ribbed profile, preformed corner sections, heat welded jointing.

PART 3 WORKMANSHIP

3.01 EXAMINATION

- A. Verify lines, levels and centres before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

- A. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

3.03 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301 ACI 347.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to over stressing by construction loads.
- C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- D. Align joints and make watertight. Keep form joints to a minimum.

3.04 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items which will be cast directly into concrete.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.
- D. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Install water stops continuous without displacing reinforcement. Heat seal joints watertight.

3.06 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.

- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

3.07 FIELD QUALITY CONTROL

- A. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, are secure.

3.08 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
- B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

END OF SECTION

SECTION 03200
STEEL REINFORCEMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Reinforcing steel bars, wire fabric and accessories for cast-in-place concrete.

1.02 RELATED SECTIONS

- A. Section 03100 - Concrete Formwork.
- B. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCES

- (1) Applicable standards referred to in this section.

- A. ACI 301 - Structural Concrete for Buildings.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.
- C. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.
- D. ANSI/ASTM A497 - Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
- E. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
- F. AWS D12.1 - Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction.
- G. CRSI - Concrete Reinforcing Steel Institute - Manual of Practice.
- H. CRSI - Placing Reinforcing Bars.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300 submittals.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with CRSI - Manual of Standard Practice ACI 301, ACI 318-89.
- B. Maintain one copy of each document on site for the use of Engineer.

1.06 COORDINATION

- A. Coordinate work under provisions of Section 01039.
- B. Coordinate with placement of formwork, formed openings and other Work.

PART 2 PRODUCTS

2.01 REINFORCEMENT

- A. Reinforcing Steel: Minimum Compressive strength of 460N/mm² yield grade deformed billet steel bars, unfinished.

2.02 ACCESSORY MATERIALS

- A. Tie Wire: Minimum 16 gauge annealed type or 18 gauge stainless wires.
- B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapour barrier puncture.
- C. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic coated steel or Stainless steel type; size and shape as required.

2.03 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI Manual of Practice ACI 318 ANSI/ASTM A184.
- B. Locate reinforcing splices not indicated on drawings, at point of minimum stress. Review location of splices with Engineer.

PART 3 WORKMANSHIP

3.01 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position.
- B. Do not displace or damage vapour barrier.
- C. Accommodate placement of formed openings.
- D. Maintain 40mm concrete cover around reinforcing
- E. Conform to applicable code for concrete cover over reinforcement.

3.02 FIELD QUALITY CONTROL

- A. Field inspection will be performed under provisions of Section 01400 quality control.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cast-in-place concrete.

1.02 RELATED SECTIONS

- A. Section 03100 - Concrete Formwork: Formwork and accessories.
- B. Section 03200 - Steel Reinforcement.

1.03 REFERENCES

- (1) Comply with the following codes, specifications and standards, except where more stringent standards are required by this specification, or as shown on the Drawings.
 - A. ACI 301 - Structural Concrete for Buildings.
 - B. ACI 302 - Guide for Concrete Floor and Slab Construction.
 - C. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
 - D. ACI 308 - Standard Practice for Curing Concrete.
 - E. ACI 318 - Building Code Requirements for Reinforced Concrete.
 - F. ASTM C33 - Concrete Aggregates.
 - G. ASTM C150 - Portland Cement.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300 submittals.

1.05 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700 Project closeout.
- B. Accurately record actual locations of embedded utilities and components which are concealed from view.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301, ACI 318 building code requirements or for reinforcement concrete.

1.07 COORDINATION

- A. Coordinate work under provisions of Section 01039 co-ordination and meeting.
- B. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement Generally:-

- (1) Portland cement to ASTM C 150, type I for Superstructure Works
- (2) Sulphate resisting cement to ASTM C 150, type V for Substructure Works

B. Aggregates Generally:-

- Use aggregates from natural sources to ASTM C 33 for all concrete. Do not use aggregate that contain more than 1% of free mica by volume of fine or coarse aggregates, or other deleterious materials in such form or in sufficient quantity to adversely affect the strength, at any age, or the durability of the concrete. Such materials include clay, particularly as an adherent coating, flaky or elongated particles, and shale or other laminated material, coal or other organic impurities, iron pyrites and soluble sulphate salts such as those of calcium, magnesium and sodium.
- Maximum size of aggregates shall be 20 mm.

C. Coarse aggregate:-

- Shall be crushed natural gravel or crushed rock of suitable shape and grading having hard, strong, durable pieces free from an adherent coating. Coarse aggregates shall be washed thoroughly to remove clay, silt, bark, sticks, alkali, organic matter or other deleterious matter. Coarse Aggregate Particle Gradation is as follows.

<u>Sieve Size</u>	<u>Percent Passing</u>
# 4	100%
3/8 inch square	80% - 100%
1/2 inch square	10% - 40%
3/4 inch square	0% - 4%

D. Fine aggregate:-

- Shall be natural sand or crushed gravel sand complying with ASTM C 33 having hard, strong, durable particles free from an adherent coating. Fine aggregates shall be washed thoroughly to remove clay, loam, alkali, organic matter or other deleterious matter. Fine Aggregate Particle Gradation is as follows.

<u>Sieve Size</u>	<u>Percent Passing</u>
# 4	95% - 100%
# 8	85% - 95%
# 16	45% - 85%
# 30	40% - 60%
# 50	10% - 30%
# 100	2% - 10%
# 200(wet)	0% - 2.5%

ALL AGGREGATES; shall be screened and washed and shall have less than the following maximum salt contents as acid soluble chlorides and sulphates. The table also shows the maximum salt contents allowed in the mixed concrete.

	Chlorides	Sulphate
Percent by weight of fine aggregate	0.06	0.4

Percent by weight of coarse aggregate	0.03	0.4
Total in concrete as percent by weight of cement.	0.05	2.4*

* Exclusive of Sulphate Content of cement

E. Water:-

- (1) Water for mixing:
Obtain water for mixing concrete and other cement products from potable supply system.
- (2) Water for curing:-
Water from the potable supply system, do not use sea water.

2.02 ADMIXTURES

1. Super plasticisers to ASTM C 494, type "A".
2. Concrete retarding to ASTM C 494 type "B" or "D" select the suitable admixtures which may used in concrete mixtures for "Special Structural Concrete" with prior acceptance of the Engineer.
3. The Engineer shall be advised in advance of the following data:-
 - a) The typical dosage and detrimental effects of under-dosage and over-dosage.
 - b) Chemical name(s) of the main active ingredient(s) in the admixture.
 - c) Whether or not the admixture contains chlorides, and if so, the chloride of the admixture expressed as a percentage of equivalent anhydrous calcium chloride by weight of admixture.
 - d) Whether or not the admixture leads to the entertainment of air when used at manufacturer's recommended dosage.

Admixtures required in the works shall be obtained from reliable manufacturers whose products he proposes to use for the acceptance of the Engineer and these must be used strictly in accordance with the manufacturer's instructions.

2.03 ACCESSORIES

- A. Vapour Barrier: Polyethylene sheeting minimum 0.15 mm thick of approved manufacturer, test in accordance with ASTM E 96 and E 154, and shall be laid below grade application.

2.05 CONCRETE MIX

A. Design Mix

All concrete used shall have a minimum of following compressive strength at 28 days. The cement shall be Sulphate resistant for all concrete below grade and ordinary Portland for above grade works. A cover of 50mm shall be provided for below grade concreting, 40mm cover for columns and beams and 30mm for slab concreting.

1 Concrete Compressive Strength in Water Retaining Structures	30 N/mm ²
------------------------------------------------------------------	----------------------

2 Concrete Compressive Strength in Building Structures	25 N/mm ²
3 Blinding concrete	10 N/mm ²

- B. Concrete used for Water retaining structures, pump stations and Structural members, which has 30 N/mm² of compressive strength at 28 days shall have following qualities.

Minimum Cement Content: - 380 kg/m³
Water Content: - 200liters/m³
Water cement ratio: - 0.5
Nominal maximum size of aggregate: - 3/4 inch
Coarse Aggregates Content: - 1100 kg/m³
Fine Aggregates Content: - 700 kg/m³
Air Content: - 5 to 8%
Slump at time and point of discharge: - 100 to 140mm
Chemical admixtures: - According to ASTM C 494

- C. The Contractor shall furnish to the Engineer for approval before commencing any concrete work on Site the design of the mix he proposes to use.

2.06 BONDING AGENTS AND ADHESIVES

- A. Bonding Agents as required
- B. Primer and Sealers: As recommended by the adhesive and bonding agent manufacturers.

2.07 CONTROL AND EXPANSION JOINTS

- A. Joint Filler: Pre-formed, non-extruding asphalt impregnated resilient material; ASTM D 1752, Type 1, 3/8 inch wide by depth required to bring top surface within 1/2 inch of slab surface.
- B. Joint Sealer: Self-levelling Polyurethane, ASTM C920, Type M, Grade SL, Class 25. Colour: gray.
- C. Expansion Joint Cap: Removable, high impact extruded polystyrene, placed on joint filler during concrete placement.

2.08 WATER STOPS

- A. PVC water stop materials shall be an elastomeric plastic compound, the basic resin of which shall be polyvinyl chloride, and containing any additional resins, plasticizers or other materials needed for the material to comply with the requirements specified.
- B. PVC water stop materials shall meet the following physical requirements:

Physical Property Value	ASTM Std.
Tensile Strength – min. MPa14.0	D412, Die C
Ultimate Elongation – min. (%)300	D412, Die C
Low Temp. BrittlenessPass	D746
Stiffness in Flexure – min. MPa8.3	D747
Specific Gravity - max104	D792
Accelerated ExtractionPass	CRD C572*
Effect of AlkaliesPass	CRD C572*
Water Adsorption – max. (%)0.5	D570

- C. Water stops shall be 210mm x 9mm thick multi – rib type with Canter bulb for construction, Control and expansion joints.
- D. Water stops for all joints shall be continuous around the corners and intersection, either in horizontal or vertical direction, as indicated on the Drawings. Field splices and joints shall be made in accordance with the water stop manufacturer's instruction, using a thermostatically controlled heating iron.

PART 3 WORKMANSHIP

3.01 EXAMINATION

- A. Verify site conditions under provisions of Section 01039 coordination and meetings.
- B. Verify requirements for concrete cover over reinforcement.

3.02 PREPARATION

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

3.03 PLACING CONCRETE

- A. Place concrete in accordance with ACI 318.
- B. Notify Engineer minimum 24 hours prior to commencement of operations.
- C. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints, and/or construction joint device are not disturbed during concrete placement.
- D. Install vapour barrier under concrete on grade. Lap joints minimum 150 mm and seal watertight by sealant applied between overlapping edges and ends taping edges and ends.
- E. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- F. Place concrete continuously between predetermined expansion, control, and construction joints.
- G. Do not interrupt successive placement; do not permit cold joints to occur.

3.04 CONSTRUCTION JOINTS

- A. Form all joints perpendicular to main reinforcement. Continue reinforcing across joints, unless otherwise indicated; provide longitudinal keys at least 1-1/2 inch deep at all joints in walls between walls and slabs or footings. Remove key forming wood inserts and thoroughly clean surface of concrete at all joints before placing next lift.
- B. Roughen surface of concrete at joints and remove laitance to obtain bond before placing next lift; if use of keys is impractical due to congestion or inaccessibility or if it is inadvisable to disturb surface before it has hardened, use only wet sandblast method for preparing surface.
- C. Dampen hardened concrete of joints between footings and walls, joints in unexposed walls, and all others not specifically mentioned here in after and roughen by air water cutting.
- D. Dampen hardened concrete joints in exposed work and roughens by air/water cutting. Thoroughly cover joint surfaces with neat cement mortar of similar proportions to mortar in concrete; apply mortar as thick as practicable on vertical surfaces and a minimum of 1/2 inch thick on horizontal surfaces; places next lift before mortar has reached its initial set.
- E. For bonding new concrete to existing concrete use bonding agent. For grouting dowels and reinforcing bars use specified adhesives in accordance with manufacturer's instructions.
- F. Provide key forming wood inserts strips in walls; pour concrete to 1/2 inch above lower edge or strip.

3.04 CONTROL AND EXPANSION JOINTS

- A. Provide control joints at maximum of 5m each way, unless otherwise noted, in interior slabs on grade. Where saw cut joints are permitted, start cutting as soon as concrete has hardened sufficiently to prevent dislodgement of aggregates. Saw a continuous slot to a depth of one – forth the thickness of the slab but not less than 1 1/4 inch. Complete saw cutting within 12 hours after placement.

3.05 CURING AND PROTECTION

- A. Careful attention shall be given to the proper curing and protection of all new concrete. This work shall be protected from the elements, fast flowing water and from defacement. Concrete shall be cured for a period not less than that given in the following table by methods that shall ensure that cracking, distortion and efflorescence are minimized:

<u>Type of Structure</u>	<u>Curing Time (Days)</u>
Vertical Walls and Roof Slabs	14
Thrust Blocks	7
Bedding Concrete	3
Supporting for Existing Concrete	14
Other Minor Structure	7

Note: Thrust Blocks and Bedding Concrete may be backfilled after concrete has hardened sufficiently to permit removal of forms, but pipes cannot be filled with water until 7 days have passed.

- B. Components which are intended to have a similar exposed surface finish shall receive the same treatment.

- C. Care shall be taken not to disturb the concrete by direct or indirect loading, striking of forms or otherwise, until it has hardened sufficiently.
- D. Construction loads shall not be allowed on beams, decks or slabs until the concrete has attained its designed strength, nor shall the Contractor impose loading exceeding the design loading.

Water Curing

- E. Concrete shall be moist cured by maintaining all surfaces wet continuously (not periodically) for the duration of the entire curing period or until covered with fresh concrete. Wooden forms shall be wetted immediately after concrete has been poured and shall be kept wet with water until removed. Water for curing shall be free from any elements which will cause staining or discoloration of the concrete.

Curing With Moist Earth

- F. Encasement concrete and thrust blocks may be cured by this method, in lieu of the burlap method. The surface shall be covered with moist earth minimum 0.15 meter thick, for not less than four (4) hours and not more than twenty four (24) hours after the concrete are placed.

3.06 CONCRETE FINISHING

- A. FAIRFACE CONCRETE: White cement exposed aggregate finish to match precast concrete unless otherwise described in the Contract, all formwork joints for exposed surface of concrete finish shall form a regular pattern with horizontal or vertical lines continuous through each structure and all construction joints where permitted shall coincide with these horizontal or vertical lines.

B. INTERIOR EXPOSED CONCRETE SURFACES OF WALLS

1. Unless otherwise shown, leave with a smooth finish, even textured and free of blemishes. Repair or replace defective areas, as directed. As soon as the face forms are removed, remove all fins and other projections carefully, level offsets and grind where necessary. Repairing, replacing and pointing and filling voids shall be done to the Engineers satisfaction. Patch as specified under paragraph "Patching".
2. Do not sprinkler dry cement or mixture of dry cement and sand on the surface to absorb moisture. Remove excess moisture by either a patented absorption process or vacuum processes.
3. Thoroughly compact the topping by using motor-driven floats of metal discs or by roller weighing not less than 10 lbs per linear inch. Finish by troweling, and broom to produce a non skid surface.
4. Start curing as soon as practicable and maintain for at least 7 days.

5. DUSTPROOFER

Apply two coats of dust proofer in accordance with the approved manufacturer's printed instructions.

C. EPOXY PAINTS FOR CONCRETE TANKS

1. Primer Epoxy Coating for Concrete Tanks: Material must have a high viscosity self-priming paint that is highly resistant to rust, corrosion, fumes, chemical attacks and excellent resistance to oils, solvents, alkalis and most dilute acids. It must be water impermeable that penetrates on concrete substrates when applied while leaving a tough film on the surface.

Concrete must be cured 28 days 24C and 50% relative humidity or equivalent. Prepare surfaces in accordance with ASTM D4258 Surface Cleaning of Concrete and ASTM. Dry film thickness shall be 4-5 mils per coat. Material shall have a pot life of 1-2 hours @ 25C.

2. Top Coat Epoxy Coating for Concrete Tanks; Paint material must be highly resistant to rust, corrosion, UV exposure, fumes and chemical attacks.

Epoxy coating material shall be fixable, with minimum impact resistance of 16 kgs. It shall have a minimum dry to coat of 3 hours at 29°C at a spreading rate of 24 sq.m. per gallon at dry film thickness of 3 mils.

3.07 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed in accordance with ACI 301 and under provisions of Section quality control.
- B. Tests of cement and aggregates may be performed to ensure conformance with specified requirements.
- C. Two concrete test cylinders will be taken for every 25 cu m of each class of concrete placed.
- D. One slump test will be taken for each concreting.

3.08 PATCHING

- A. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
- B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.
- C. Patch imperfections in accordance with ACI 301.

3.09 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by the Engineer.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

END OF SECTION

SECTION 04050
MORTAR AND MASONRY GROUT

PART 1 - GENERAL

1.01 SECTION INCLUDES; the following minimum works

- A. The Contractor shall become familiar with other sections of the Specifications affecting work of this trade.
- B. Furnish all labours, materials, plant, equipment and appliances and perform all necessary operations required to execute the work of this section.
- C. Mortar and grout for concrete block masonry, concrete pavings, edgings to concrete pavings, ceramic tiles etc.

1.02 RELATED SECTIONS; elsewhere in this document, are not necessarily comprehensive or complete and it is the Contractor's responsibility to ascertain all applicable sections required to understand the full Scope of Works intended.

- A. Section 02784 Concrete Pavers
- B. Section 04200 Unit Masonry System
- C. Section 08110 Standard Steel Doors and Frames

1.03 REFERENCES; the minimum standards for products specified in this section shall be relevant BSI standards including but not limited to the following. Except as otherwise specified herein, perform work in accordance with specification codes and standards cited therein and to latest applicable addenda and supplements.

BS 12	:	Part 2 - Portland Cement.
BS 146	:	Part 2 - Portland Blast Furnace Cement.
BS 882	:	Aggregates for Concrete
BS 890	:	Building Limes.
BS 1014	:	Pigments for Portland cement.
BS 1199&1200;	Sands	
BS 3148	;	Water.
BS 4721	:	Sand - Lime for Mortars.
BS 4887	:	Plasticizers.
BS 5628	;	Structural Use of Masonry.
BS 6073	;	Precast Concrete Blocks.

ACI Manual of Concrete Practice.

1.04 SUBMITTALS

- ❖ REPORTS; submit reports on mortar indicating conformance of component mortar materials to requirements of the Specification.
- ❖ MANUFACTURER'S CERTIFICATE; certify that products meet or exceed specified requirements,

1.03 DELIVERY, STORAGE AND HANDLING;

- ❖ DELIVER, STORE, PROTECT, AND HANDLE PRODUCTS; to site in accordance with the recommendation of the manufacturers,
- ❖ PACKAGED MATERIALS; to be maintained clean, dry, and protected against dampness, freezing, and foreign matter.

1.04 ENVIRONMENTAL REQUIREMENTS;

- ❖ MAINTAIN MATERIALS AND SURROUNDING AIR TEMPERATURE; to minimum 5oC prior to, during, and 48 hours after completion of masonry work.
- ❖ MAINTAIN MATERIALS AND SURROUNDING AIR TEMPERATURE; to maximum 32oC prior to, during, and 48 hours after completion of masonry work.

PART 2 - PRODUCTS

2.01

- ❖ SAND; to be used for mortar shall be clean and sharp. It shall be chemically and structurally stable and comply with the following Table of Grading. It should conform to BS 1199 and 1200.

BS Sieve	Inches	mm (Approximate)	Percentage passing
-	1/8	3.0	95-100
7	.095	2.4	80-100
14	.047	1.2	60-100
25	.024	0.6	30-100
52	.012	0.3	5-65
100	.006	0.15	0-15

- ❖ HYDRATED LIME POWER; to BS 890
- ❖ LIME PUTTY; ready prepared to BS 890, prepared hydrated lime powder to Water until a mixture with a consistency of thick cream is obtained. Do not disturb minimum 16 hours before use.
- ❖ LIME – SAND MIX; to BS 4721.
- ❖ COLOURED LIME SAND WET MIX; to BS 4721
- ❖ ORDINARY PORTLAND CEMENT; to BS 12 – part 2.
- ❖ BLAST FURNACE CEMENT; to BS 146 – part 2.

- ❖ WATER; for mortars shall be clean, fresh, tested, certified as requested by the Engineer to BS 3148.

- ❖ MORTAR TYPES; shall be defined as follows:

Type M: 17.2 Mpa compressive strength at 28 days;
 75% water retention minimum;
 12% air content maximum

Type S: 12.4 Mpa compressive strength at 28 days;
 75% water retention minimum;
 12% air content maximum

Type N: 5.2 Mpa compressive strength at 28 days;
 75% water retention;
 14% air content maximum

Type N: 2.4 Mpa compressive strength at 28 days;
 75% water retention;
 14% air content maximum

- ❖ ADMIXTURES; Plasticizers conforming to BS 4487.

2.02 MORTAR MIXES

- ❖ MIX CONSTITUENTS; to proportions specified. Contractor to confirm which mix type is proposed for the works. Measure by volume, using clean young boxes made to size to suit volumes required. Overfill gauge and strike off excess materials with straight edge.
- ❖ MORTAR MIXES; shall comply with BS 5628: part 3. The mortar mix for concrete masonry shall be 1:3 Masonry Cement: sand or 1:4 Cement Sand with plasticizer and for glass unit masonry 1:2:9 Cement: lime: Sand.
- ❖ SAND PROPORTION; of mixes given for dry sand. Allow for bulking if sand is damp. Where a range sand proportion is given (eg 5- 6) use higher value for well graded sand, lower for coarse or uniformly fine sand.
- ❖ PLASTICIZER; shall be added as recommended by the manufacturer.
- ❖ DRY ADMIXTURES; to be disclosed in mixing water for each batch of mortar.
- ❖ APPROVED SAMPLES; of mortar should not change type or proportion of constituent materials.

2.03 MORTAR MIXING

- ❖ MIX MORTAR INGREDIENTS; in quantities needed for immediate use in accordance with BS 5628

- ❖ MIX MORTAR; by mechanical mixer, thoroughly so that all individual constituents are incorporated evenly but do not over mix mortars containing Plasticisers.
- ❖ KEEP MIXER CLEAN; at all times and discharge mortar onto a clean level banker Board.
- ❖ USE MORTAR WITHIN ONE HOUR; of discharge from mixer at normal temperatures. In no case must mortar be used after the initial set has taken place. Reconstitution of mortar will not be permitted.
- ❖ MORTAR GENERALLY; mix constituents with the minimum amount of water to provide the consistency required.
- ❖ MASONRY CEMENT SAND MORTAR; mix to masonry cement manufacturer's recommendation
- ❖ MASONRY CEMENT SAND MORTAR; mix to masonry cement manufacturer's recommendation

2.04 GROUT MIXES

- ❖ BOND BEAMS, LINTEL ETC; 30 N/mm² strength at 28 days mixed in accordance with the ACI Manual of concrete practice.
- ❖ HOLLOW BLOCK VOIDS; to be filled with cement sand mortar 1:3 at Jambes and sills. Voids in hollow concrete blocks to be filled with grout every two meters and reinforced with 2Y8 to give rigidity to the high external walls. The grout mix should be Cement: Sand of 1:2.5 (proportion by volume).

2.05 GROUT MIXING

- ❖ MIX GROUT INGREDIENTS; quantities needed for immediate use.
- ❖ ADMIXTURES; to be added in accordance with manufacturer's instructions Mix uniformly.

PART 3 - WORKMANSHIP

3.01

- ❖ MORTAR AND GROUT; to be installed to requirements of the specific masonry section.
- ❖ GROUT; to be put into masonry cores and cavities to eliminate voids.
- ❖ GROUT SHOULD NOT BE INSTALLED; in lifts greater than 400 mm without consolidating grout by rodding.
- ❖ REINFORCEMENT; should not be displaced while placing grout.
- ❖ EXCESS MORTAR; to be removed from grout spaces.
- ❖ MORTAR TYPE; for various locations shall be as follows:

- Load bearing partitions: Type S or M
- Non-load-bearing partitions and
Exterior stonework: Type N.
- Grouting mortar: Type M.
- Parging mortar: Type S.
- Reinforced masonry: Type S.
- Pointing mortar: Type O.
- Mortar for bearing courses: Type M.

3.02 FIELD QUALITY CONTROL

- ❖ FILED INSPECTION AND TESTING; shall be performed.
- ❖ TEST MORTAR AND MASONRY UNITS; to CP 112 PT; 1 test in conjunction with masonry unit sections specified

END OF SECTION

SECTION 04200
UNIT MASONRY SYSTEM

PART 1 - GENERAL

1.01

- ❖ SECTION INCLUDES; the following minimum works
 1. The contractor shall be familiar with the sections of the specifications affecting work of this trade.
 2. Furnish all labours, materials, plant, equipment and the appliances and perform all necessary operations required to execute the work of this section.
 3. Concrete block work for use in external and internal walls together with reinforcement anchorage and precast concrete lintels.
- ❖ RELATED SECTIONS; elsewhere in this document, are not necessarily comprehensive or complete and it is the Contractors responsibility to ascertain all applicable sections required to understand the full Scope of Works intended.
 - A. Section 04050 -Mortar and Masonry Grout.
 - B. Section 07900 -Joints Sealers.
- ❖ REFERENCES; The minimum standards for products specification in this section shall be relevant BSI standards including but not limited to the following. Except as otherwise specified herein, perform work in accordance with the specification codes and standards cited therein and addenda and supplements.
 - BS12 ; Part 2 -Portland cement
 - BS 729 ; Hot Dip Galvanizing
 - BS 882 ; Aggregate of Concrete
 - BS1369; Metal Lathing
 - BS 2989; Hot Dipped Zinc Coating
 - BS 4423; Steel Fabric Reinforcement
 - BS 5628; Structural use of Masonry
 - BS6073; Precast Concrete Blocks
 - BS8000; Part 3- Masonry Works

1.02 SUBMITTALS

- ❖ PRODUCT DATA; provide manufacturers data for masonry unit and manufacturers literature for fabricated wire reinforcement.
- ❖ SAMPLES; submit two samples of masonry units to illustrate colour, texture and extremes of color range, and two 600mm length of fabricated wire reinforcement, together with two samples of all other items of anchorage and accessories.

- ❖ MANUFACTURERS CERTIFICATE; certify that products meet or exceed specified requirements.
- ❖ SHOP DRAWINGS; for each level which shows control and expansion joints, wall layout and wall opening shall be submitted. Openings and sleeves for all mechanical, plumbing and electrical works shall be coordinated with respective trades and shown on these drawings.

1.03 QUALIFICATIONS

- ❖ MANUFACTURER; local Company specializing in manufacturing the products specified in this section with minimum 5 (five) years documented experience.

1.04 REGULATORY REQUIREMENTS

- ❖ CONFORM; to General Specifications Requirements for all masonry construction.

1.05 MOCK -UP

- ❖ PROVIDE MOCK-UP; of composite masonry under provisions of section 01450
- ❖ WHEN ACCEPTED; mock-up will demonstrate minimum standard for the work. Mock-up may not remain as part of the work.

1.06 DELIVERY, STORAGE, AND HANDLING

- ❖ DELIVER, STORE, PROTECT AND HANDLE; Products as recommended by the manufacturer.

1.07 ENVIRONMENTAL REQUIREMENTS

- ❖ MINIMUM TEMPERATURE; of the material and the surrounding air temperature should be maintained to 25degrees C prior to, during, and 48 hours after completion of masonry work.
- ❖ MAXIMUM TEMPERATURE; Maintain materials and surrounding air temperatures to maximum of 33 degrees C prior to, during, and 48 hours after completion of masonry work.

PART 2 - PRODUCTS

2.01 CONCRETE MASONRY UNITS

- ❖ PRECAST CONCRETE MASONRY UNITS; Shall be non-load bearing type and shall comply with the requirements of KSS10, except that units for the use in foundation below slab on grade shall be manufactured in sulphate resisting cement. Units shall be either of hollow or solid construction as or required. Units shall be hard, sound, and free from cracks and shall have sharp well-defined edges.
- ❖ SPECIAL SHAPES; provide where shown and where required for corners, jambs, sash, control joints, headers, bonding and other special conditions. Provide radius bullnose shapes at all external corners of block partitions.
- ❖ INSULATED LIGHTWEIGHT BLOCKS; Sizes as required in Drawings.

2.02 PRECAST CONCRETE INTERLOCKING PAVING BLOCKS

- ❖ PAVING BLOCKS; Should comply with the specified requirements of the General Specification of Motorway / Expressway System. Colour and configuration of the blocks shall be subject to the approval of the Engineer.

2.03 MORTAR AND GROUT

- ❖ MORTAR AND GROUT; shall be as specified in section 04100

2.04 MASONRY ACCESSORIES

- ❖ WALL TIES; Wall ties shall be perforated type one piece formed in solid stainless steel complying with BS. 1449 part 2 and shall be obtained from a reputable manufacturer. The length of the ties shall be approximately 80mm less than the total thickness of the wall and shall be used in conjunction with insulation retainer discs.

- ❖ ANCHORING DEVICES FOR MASONRY;

1. Provide straps, clip anchors, dovetail anchors, bars, bolts and rods of the type and size indicated but fabricated from not less than 1.52mm thick sheet metal or 9.5mm diameter rod stock, unless otherwise indicated.
2. Flexible Anchors: Where masonry is indicated or Specified to be anchored to structural framework with flexible anchors, provide two-piece anchors which will permit horizontal and vertical movement of masonry but will provide lateral restraint.

- ❖ INSERTS FOR MASONRY;

1. Unit Type: Furnish cast iron or malleable iron inserts of the type and size indicated or fabricated from not less than 2.65mm thick steel, hot-dip galvanized after fabrication with 458 grams per square meter zinc coating.
2. Dovetail Slots: Furnish dovetail slots with filler strips for every other course of block walls abutting concrete columns. Fabricate from 1.52mm thick galvanized steel, unless otherwise indicated.
3. Reinforcement for all suspended brick faced slab or lintel: Provide galvanized steel rods not less than 6mm diameter with a tightening system, held in position (through holes in bricks) by galvanized steel hooks every five bricks and to the configuration shown.

- ❖ EXPANSION AND CONTROL JOINTS; provide compressible filler of selected softwood resin and oak fibers impregnated with a bitumen emulsion.

- ❖ CLEANING SOLUTION; non-acidic, not harmful to masonry work or adjacent materials.

2.05 LINTELS CONCRETE SUPPORT SLABS, SILLS AND COPING

- ❖ PRECAST CONCRETE LINTELS COPING AND SILLS; sized to suit block wall thickness and coursing.
- ❖ PRECAST CONCRETE SUPPORT SLABS; Contractor to design and coordinate concrete thickness and reinforcement to support imposed loads as required, unless otherwise mentioned in the drawings.
- ❖ SUBMIT CALCULATIONS; to show that lintel sizes are adequate for the location.

- ❖ INSITU CONCRETE LINTELS COPING AND SILLS; as shown on drawings and described in section 03100.

PART 3 - WORKMANSHIP

3.01

- ❖ FIELD CONDITIONS; to be verified and checked whether acceptable and are ready to receive work.
- ❖ VERIFY ITEMS PROVIDED BY OTHER SECTIONS OF WORK; are properly sized and located.
- ❖ VERIFY THAT BUILT-IN ITEMS; are in proper location and ready for roughing into masonry work.

3.02 PREPARATION

- ❖ DIRECT AND COORDINATE; placement of metal anchors supplied to other sections.
- ❖ TEMPORARY BRACING; to be provided during installation of masonry works. Maintain in place until building structure provides permanent bracing.

3.03 COURSING

- ❖ ESTABLISH; lines, levels, and coursing as indicated. Protect from displacement.
- ❖ MAINTAIN; masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- ❖ CONCRETE MASONRY UNITS;
 1. Bond; running.
 2. Coursing; one unit and one mortar joints to equal 210mm.
 3. Mortar Joints; Concave.

3.04 PLACING BONDING

- ❖ BLOCKWORK; shall be set out and built to the dimensions indicated the courses shall be properly leveled, perpend kept and quoins, jambs and other angles plumb as the work proceeds. All block walls shall be carried up regularly, not leaving part more than 5 courses lower than another. Any wall left at different levels shall be raked back.
- ❖ CONTROL; to be provided in concrete masonry walls at maximum 6000 mm intervals, and apply control joint filler. For control joints in exposed work apply exposed expansion joint sealant as specified in Section 07900. Stop reinforcement at either side of control joints.
- ❖ MASONRY SHALL BE BUILT-IN; running bond laid plumb, true to line with level accurately spaced courses, corners and reveals plumb and true, each course breaking joint with course below. All joints shall be 10mm.
- ❖ WET BLOCKS; as recommended by manufacturer prior to laying but do not lay with excess water on them.
- ❖ MORTAR; solidly bed each course of mortar. Butter vertical joints their entire depth and length. Sloughing of the mortar into joints is not permitted. Bond each course at corners and intersections.

- ❖ UNFINISHED WORKS; to be step back for jointing with new work; toothing will not be permitted.
- ❖ TOP AND END RESISTENTS; to be provided for all block walls in accordance with relevant codes of practice. For wall heads, provide 50x50x3mmthick metal angles 200mm long on both sides at intervals of not more than 2.0m.
- ❖ REINFORCEED TIE BEAMS; to be provided for block work in excess of 3m height as per standard practice.
- ❖ STOP JOINTS OR FIRE STOPPING; to be provided for block work on the underside of structural slabs or beams or projections. Saw cut block at top of wall to suit coursing.
- ❖ BLOCKWORK WALLS; to be carried in pots of all the waffle slabs and soffits of slabs or beams, see structural drawings for details.
- ❖ ANCHOR, TIE, DOWEL, RESTRAIN, REINFORCE OR BOND; masonry including ends, corners and intersections. Grout voids around all anchors, dowels etc.
- ❖ WHERE BLOCK WALLS ABUT CONCRETE COLUMNS, WALLS ETC; they shall be tied to the column, wall, by means of galvanized straps anchored into the concrete and built into the block work at every second course.
- ❖ BROKEN OR CRACKED BLOCKS; shall not be used.
- ❖ DAMAGED OR DEFECTIVE UNITS; will not be permitted in masonry. Work containing damaged or defective units shall be taken down and rebuilt to the Architects satisfaction at no cost to the contract.
- ❖ BLOCK CUTTING; to be with proper tools to provide straight, cleans unchipped edges.

3.05 REINFORCEMENT AND ANCHORAGE

- ❖ HORIZONTAL JOINT REINFORCEMENT; to be installed in each alternate course 400mm c/c approximately.
- ❖ MASONRY JOINT REINFORCEMENT; to be placed in first and second horizontal joints above and below openings. Extend minimum 400 mm each side of opening.
- ❖ JOINT REINFORCEMENT; to be placed continuous in first and second joint below top of walls.
- ❖ OVERLAP; joint reinforcement ends minimum 150 mm.

3.06 MASONRY FLASHINGS

- ❖ EXTEND FLASHINGS; horizontally under parapet caps and at bottom of walls and elsewhere as necessary.
- ❖ OVERLAP; end joints minimum 150mm and seal watertight.
- ❖ FLASHING; to be turned fold, and sealed at corners, bends, and interruptions.

3.07 LINTELS & STILLS

- ❖ PRECAST CONCRETE LINTELS AND SILLS; to be installed over openings as required.

- ❖ REINFORCED UNIT MASONRY LINTELS AND SILLS; to be installed over openings where steel or precast concrete lintels are not scheduled, to the Engineer's approval.
- ❖ REINFORCING BARS; should not be spliced. Support and secure reinforcing bars from displacement. Maintain position within 13 mm of dimensioned position.
- ❖ GROUP FILL; to be placed and consolidated without displacing reinforcing.
- ❖ MASONRY LINTELS AND SILL; should be allowed to attain specified strength before removing temporary supports.
- ❖ MINIMUM BEARING; to be 200 mm on each side of opening for spans up to 2.0m. Increase by 100mm for each 1.0m in excess of 2.0m span.

3.08 CONTROL AND EXPANSION JOINTS

- ❖ HORIZONTAL JOINT REINFORCEMENT; should not be continued through control and expansion joints.
- ❖ FORM CONTROL JOINT; with a sheet building paper bond breaker fitted to one side of the hollow contour end of the block unit. Fill the resultant core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.

3.09 BUILT-IN WORK

- ❖ INSTALL; built in items plumb and level.
- ❖ DOOR FRAMES; shall be bedded and exposed edges pointed in mortar and fixing cramps shall be built in.
- ❖ WINDOW FRAMES; shall be bedded in mortar and exposed edges pointed in mastic. Fixing lugs shall be built in and channels in frames grouted with mortar.
- ❖ WHERE BUILT-IN ITEMS SHALL BE EMBEDDED IN CORES OF HOLLOW BLOCK UNITS; place a layer of metal lath in the joint below and rod mortar or grout into core. Grout shall be a fluid mix of cement and sand.

3.10 MAXIMUM TOLORANCES

- ❖ VARIATION FROM ALIGNMENT OF COLUMNS; 6mm.
- ❖ VARIATION FROM UNIT TO ADJACEDT UNIT; 1.5mm.
- ❖ VARIATION FROM PLANE OF WALL; 13mm in 6 meters
- ❖ VARIATION FROM PLUMB; 5mm in 3 meters.
- ❖ VARIATION FROM LEVEL COURSING; 5mm in 3metres

3.11 CUTTING AND FITTING

- ❖ CONTRACTOR TO EXECUTE; all rough and fair cutting, leaves all chases, holes mortises, built in heads of sills, lintels and the like, all as required, and perform all necessary attendance upon other trades and make good on completion.

- ❖ CHASES, SLOTS, REGLETS, OR OPENINGS; to be formed necessary for the proper installation of work of trades as required .Keep chases and reglets free from mortar or other debris.
- ❖ ACCURATE CUTTING, PATCHING AND REPAIRING; to be provided in connection with masonry work as required to accommodate the work of other trades. Grout voids around holes and built-in-items solid.
- ❖ CORBORUNDUM SAW; designed to cut masonry units to be used with clean sharp corners. Cut units to fit adjoining work neatly. Use full units without cutting where possible.
- ❖ COORDINATE; with all other trades prior to cutting holes, chases or the like to establish exact requirements and locations.
- ❖ APPROVAL; to be obtained prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry works may be impaired.

3.12 CLEANING

- ❖ CLEANWORK; under provisions of section 01770.
- ❖ REMOVE; excess mortar and mortar smears.
- ❖ REPLACE; defective mortar. Match adjacent work.
- ❖ CLEAN SOILED SURFACES; with cleaning solution.
- ❖ NON-METALLIC TOOLS; to be used in cleaning operation.

3.13 PROTECTION OF FINISHED WORK

- ❖ PROTECT FINISHED INSTALLATION; as per section 01500.
- ❖ PROTECTION BOARDS; to be provided with out damaging the completed work, at exposed external corners, which may be damaged by construction activities.

END OF SECTION

SECTION 05500
METAL FABRICATIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES; the following minimum works

- A. The contractor shall become familiar with other sections of the specifications affecting work of this trade.
- B. Furnish all labour, material, plant, equipment and appliances and perform all necessary operations required to execute the work of this section.
- C. This section establishes requirements for metal fabrications, including cat ladders, non – ornamental handrails and balustrades, and chequer plate flooring and gratings, manhole covers, etc.
- D. The contractor shall provide all light metal or miscellaneous metal, which are shown or implied by the drawings and required for the work, weather description in this section or not.

1.02 REFERENCES; The minimum standards for products specification in this section shall be relevant BSI standards including but not limited to the following. Except as otherwise specified herein, perform work in accordance with the specification codes and standards cited therein and addenda and supplements.

BS 6339	-	Code of practice for dead and imposed loads.
BS 5750	-	Part 2 Specification for production and installation.
BS 1470	-	1457- Specification for aluminium.
BS 4190	-	Specification for bolts, nuts and screws
BS 693	-	General requirement for oxy – acetylene welding of mild steel.
BS 729	-	Hot dip galvanized coatings on iron and steel articles.
BS 1449	-	Parts 1 and 2 steel plate, sheet and strip
BS 1723	-	Brazing
BS 2994	-	Cold rolled steel sections
BS 3571	-	Part 1 – Metal Welding
BS 3692	-	Bolts, nuts, screws
BS 4174	-	Self – tapping screws.
BS 4183	-	Machine Screws
BS 4190	-	Bolts, nuts, screws
BS 4320	-	Washers.
BS 4345	-	Slotted Angles.
BS 4360	-	Structural Steel
BS 4848	-	Hot rolled steel sections
BS 5135	-	Metal arc welding

BS 6323	-	Steel Tubes
BS 6399	-	Part 1 – Design and Imposed Loads
BS DD 24	-	Corrosion protection of steel
CP 3012	-	Preparation for bonding, brazing and welding
BS 7079	-	Steel finish for painting
ASTM 123	-	Zinc (Hot Dip Galvanized) coatings on iron and steel products
ASTM 153	-	Zinc (Hot Dip) coatings on iron and steel products
SSPC-PA 1	-	Shop, Field and Maintenance Painting

1.03 SUBMITTALS

- ❖ SHOP DRAWINGS; under provisions of Section 013300
- ❖ PRODUCT DATA; under provisions of Section 01330
- ❖ SHOP DRAWINGS; indicate profiles, sizes, connections attachments, reinforcement's anchorage, size and type of fasteners and accessories. Include erection drawings and details where applicable. Indicate welded connections.
- ❖ WELDING PROCEDURES; to be submitted for shop and filed work
- ❖ MANUFACTURER'S MILL CERTIFICATE; to be submitted certifying that products comply with specified requirement for strength and elongation.
- ❖ SAMPLES; to be submitted of materials and products for metal fabrications as requested by the Engineer.

1.04 PERFORMANCE REQUIREMENTS

- ❖ DESIGN, FABRICATE AND INSTALL; metal fabrications including all fixings and accessories in accordance with the specifications and the design intent indicated on the drawings.
- ❖ DESIGN METAL FABRICATIONS; to carry all dead loads including self weight indicated and live loads in accordance with BS: 6399 part 1. Design calculations shall include all necessary factors of safety.
- ❖ MAXIMUM DEFLECTION; under design loads shall be 1 / 360 th of span.
- ❖ CO – ORDINATE; all necessary holes in chequer plate flooring for services.

PART 2 - PRODUCTS

2.01

- ❖ STRUCTURAL STEEL; to BS 4360 Grade 43
- ❖ WELDABLE STRUCTURAL STEEL; to BS 4360 Grade 43
- ❖ STEEL PLATE, SHEET AND STRIP; to BS 1449
- ❖ STAINLESS STEEL PLATE, SHEET AND STRIP; to BS 1449 part 2. Stainless Bar to BS 970 part 4.

- ❖ COLD ROLLED SECTIONS; to BS 2994
- ❖ BOLTS, NUTS AND WASHERS; to BS 4190 & BS 4320
- ❖ STEEL TUBES; to BS 1775 & BS 1387
- ❖ MALLEABLE IRON CASTING; to BS 309, BS 310 & BS 3333
- ❖ HOT DIP GALVANIZING; to BS 729
- ❖ GROUT; premixed non – shrink grout.
- ❖ FASTENERS; stations sted fasteners for exterior use or where built into exterior walls, Bolts and nuts hexagon type to BS 4190.
- ❖ PRIMER; red oxide.
- ❖ METAL FABRICATIONS WHICH WILL BE EXPOSED TO VIEW IN THE FINISHED WORK; use only materials which are smooth and free of surface blemishes including pitting, seam marks , roller marks , trade marks or roughness.
- ❖ PRODUCTS ARE TO COMPLY; with the standards described in this section.
- ❖ FIXINGS TO CONCRETE OR MASONRY; are to be of expanding anchor or cast – in / built – in devices of approved type.
- ❖ MANUFACTURES DETAILS AND REFERENCES; for expanding bolts shall be submitted by the Contractor to the Engineer for review.
- ❖ SCREW AND OTHER FASTENINGS; shall be selected to prevent galvanic action with the components fastened. Where possible, fixings shall be concealed. However, where exposed in finished surfaces, they shall be flush shown.
- ❖ SEPARATE DISSIMILAR METALS; with bituminous paint or performed dielectric separators which prevent galvanic action.

2.02 FABRICATION

- ❖ INCLUDE SUPPLEMENTARY PARTS; necessary to complete metal fabrication not specifically shown or specified.
- ❖ VERIFY MEASUREMENTS AND DIMENSIONS; at site and co–operate in the co-ordination and programming of the work of this section with the work of other related trades so as not to delay the progress.
- ❖ METALS; shall be free from warps, buckles, creases, holes and other defects that would impair strength, durability or appearance and shall be of best commercial quality for the purpose required. All items shall be true to details, clean, straight, with sharply defined profiles and smooth finish surfaces.
- ❖ FABRICATE METALWORK UNITS; to sizes, shapes and profiles required .Cut, drill and tap as required for fixing to supports or structure.

- ❖ METAL WORK; shall be formed plumb, true and level for anchorage, and be provided with suitable anchors, expansion bolts, or other anchoring devices shown or required to provide support for intended use. Furnish such metal work in ample time for setting and securing in place.
- ❖ FABRICATE THE WORK; as necessary for performance requirements, and for support to the structure. Separate dissimilar metals with bituminous paint or preformed dielectric separators which will prevent corrosion.
- ❖ THREADED CONNECTIONS; to be made up tight.
- ❖ FIT AND MATCH ALL WORK; with continuity of line and design, using rigidly secured tight and even joints unless otherwise shown.
- ❖ WELD WITH ELECTRODES; and by methods recommended by manufacturer of material being welded, and in accordance with appropriate British standards. Use only methods which will avoid distortion of exposed welds flush and smooth to match and blend with adjoining surfaces. Grind using clean wheels and compounds which are free of iron and iron compounds.

2.03 FABRICATION TOLERANCES

- ❖ SQUARENESS; 3mm maximum difference in diagonal measurements
- ❖ MAXIMUM OFFSET BETWEEN FACES; 1.5 mm.
- ❖ MAXIMUM MISALIGNMENT OF ADJACENT MEMBERS; 1.5 mm
- ❖ MAXIMUM BOW; 3 mm in 1.2 m.
- ❖ MAXIMUM DEVIATION FROM PLANE; 1.5 mm in 1.2 m.

2.04 FINISHES – STEEL

- ❖ General: Comply with NAAMM AMP 500 "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to application and designations of finishes.
- ❖ Finish metal fabrications after assembly.
- ❖ CLEAN SURFACES; of rust scale grease and foreign matter prior to finishing.
- ❖ DO NOT PRIME SURFACE; in direct contact with concrete.
- ❖ General: Shop-paint uncoated surfaces of metal fabrications, except those to be embedded in concrete or masonry or to receive sprayed-on fireproofing, surfaces and edges to be welded, and galvanized surfaces, unless otherwise indicated. Comply with requirements of SSPC-PA 1 for shop painting.
- ❖ Galvanizing: For those items indicated for galvanizing, apply zinc-coating by the hot-dip process in compliance with the following requirements:
 - ASTM A123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forced shapes, plates, bars, and strip 0.0299 inch (0.7595 mm) thick and heavier.
 - ASTM A153 for galvanizing iron and steel hardware.

- ❖ Surface Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below.
 - Remove oil, grease and similar contaminants in accordance with SP-1, "Solvent Cleaning".
 - Remove loose rust, scale, spatter, slag and other deleterious materials in accordance with SSPC, utilizing the following methods as required:
 - SP-2 "Hand-Tool Cleaning"
 - SP-3 "Power-Tool Cleaning"
 - SP-7 "Brush-Off Blast Cleaning"
- ❖ Painting: Immediately after surface preparation, apply structural steel primer paint in accordance with manufacturer's instructions and at a rate to provide dry film thickness of not less than 3.0 mils (0.076 mm). Use painting methods that result in full coverage of joints, corners, edges, and exposed surfaces.

Apply 2 coats of paint to surfaces that are inaccessible after assembly or erection.

PART 3 - WORKMANSHIP

3.01 INSPECTION

- ❖ FIELED CONDITIONS; to be verified whether acceptable and are ready to receive work.
- ❖ SHOP MATERIALS AND WORKMANSHIP; shall be subject to inspection by the Engineer.
- ❖ SHOP PAINTING; prior to acceptance, surface preparation and dry film thickness of shop primer shall be subject to inspection by the Engineer.

3.02 PREPARATION

- ❖ CLEAN AND STRIP PRIMED STEEL ITEMS; to bare metal where site welding is required.
- ❖ SUPPLY ITEMS; to be cast in to concrete or embedded in masonry with setting templates, to appropriate sections.

3.03 INSTALLATION

- ❖ INSTALL ITEMS; plumb and level, accurately fitted, free from distortion or defects.
- ❖ PROVIDE FOR ERECTION LOADS, DEAD LOAD AND ANY IMPOSED LOAD; based on worst condition likely to occur, in addition to any localised pressure or the effects of suction .
- ❖ OBTAIN APPROVAL; prior to site cutting or making adjustments not scheduled.
- ❖ FASTENINGS SHOULD BE TIGHTENED; to ensure that even pressure is applied to the sealing washers and that the washers are not damaged. Sealing washers should neither distort nor spread and should be soft enough to seal with out application of high pressure and thick enough to accommodate misalignment. Sealing washers to fit tight to the shaft of the fastener to prevent water penetration.

- ❖ DELIVER ITEMS; which are to be built in to the work of other sections in time so as not to delay the progress of the work.
- ❖ TAKE ALL MEASUREMENTS REQUIRED ON SITE; check measurements, compare dimensions and other data with various trades installing adjoining work to ensure proper co – ordination
- ❖ FIX ALL METAL FABRICATIONS; in accordance with the manufacturer's instructions and recommendations, except as otherwise shown or specified in reviewed shop drawings.
- ❖ PROVIDE; all fastenings, welds and fixings as required.
- ❖ FASTEN METAL WORK; to concrete or solid masonry with expansion bolts. Fastening to wood plugs will no be permitted.

3.04 HANDLING AND STORAGE

- ❖ DELIVER FABRICATED UNITS AND COMPONENT PARTS; to site, completely identified in accordance with assembly diagrams prepared for this work. Store in accordance with manufacturer's instructions, above ground, properly protected from the weather and construction activities.

3.05 CLEANING AND PROTECTION

- ❖ LEVEL ALL WORK CLEAN; following installation. The contractor shall be responsible for protecting the completed work from excessive dirt, misuse and damage during other construction activity. Final cleaning of the metal fabrications shall be by the Contractor.
- ❖ ANY DAMAGE SHALL BE REPAIRED; and parts replaced, including repairs to adjacent work damaged in connection with work of this section.

END OF SECTION

**SECTION 09200
LATH AND PLASTER**

PART 1 - GENERAL

1.01 SECTION INCLUDES; the following minimum works

- A. Plasterwork to walls and ceiling, with stops, corner beads, fixing, and accessories.
- B. Plaster two coat applications over masonry or concrete, and one coat finishing plaster.
- C. Internal and external render.
- D. Metal lathing.
- E. Provide all labor, material, plant, equipment and appliances and perform all necessary operations required to execute the work of this section.

1.02 RELATED SECTION; elsewhere in this document, are not necessarily comprehensive or complete and it is the Contractor's responsibility to ascertain all applicable sections required to understand the full Scope of Works intended.

- A. Section 03300 : Cast – In – Place Concrete
- B. Section 04300 : Unit Masonry System
- C. Section 09260 : Gypsum Board System

1.03 REFERENCES; The minimum standards for products specification in this section shall be relevant BSI standards including but not limited to the following. Except as otherwise specified herein, perform work in accordance with the specification codes and standards cited therein and addenda and supplements.

- BS 882: 1201 : part 2 - Aggregates
- BS 890 : Limes
- BS 120: part 2 : Nails
- BS 1369: part 1 : Metal Lath
- BS 1494: part 2 : Fixings
- BS 3148 : Water for Plastering
- BS 4721 : Ready – Mixed Lime / Sand for Mortar
- BS 4887 : Mortar Plasticizer
- BS 5262 : External Rendering Finishes
- BS 5492 : Internal Plastering

1.04 SUBMITTALS

- ❖ SUBMITTAL FOR REVIEW; Submit details of the work to be carried out along with required shop drawings , giving details of dimensions, relation and connections with adjoining work , with corner stops and other accessories.
- ❖ QUALIFICATION OF APPLICATOR; Company specializing in performing the work of this Section with minimum ten years , documented and proven experience approved by the manufacturer.

1.05 MOCK-UP

- ❖ MOCK – UP; provide mock up for an area of at least 15 M2 with specified accessories installed. Approved mock ups shall remain as sample of the standard to be achieved in all related area and may, with the approval of the Engineer as part of the work.

1.06 RELATED ITEMS

- ❖ RELATED ITEMS SEQUENCING; do not commence plastering work until;
 - A. Openings, chases or other apertures required for services are formed.
 - B. Fixing for pipes, fixing pads and plugs have been fixed.
 - C. Metal lath, beads and other plaster accessories have been fixed
 - D. Making good has been completed.

1.07 COORDINATION;

- A. The work of this section shall be coordinated with that of associated trades. In no case shall work requiring inspection be concealed by plaster until it has been approved by the Engineer.
- B. Make all changes and adjustment of the materials of this section necessary to accommodate the prescribed work of other section, including cutting and patching.

1.08 DELIVERY, STORAGE AND HANDLING;

- A. Deliver, store and handle material under provision of section 01600.
- B. Manufactured materials shall be delivered in original packages containers or bundles, bearing manufacturers name and brand, and shall be stored under cover in a dry and well ventilated enclosure.
- C. Store plaster, cement and lime off ground, under water tight cover, away from sweating walls and other damp surfaces, until ready for use. Remove damaged or deteriorated materials from site at first reasonable opportunity.

1.09 ENVIRONMENTAL CONDITIONS;

- ❖ TEMPERATURE AND VENTILATION; generally comply with ASTM C 926 and BS 5492 as appropriate.
- ❖ VENTILATION; Ventilate building spaces as required to remove water in excess of that required for hydration of plaster . Begin ventilation immediately after plaster is applied and continue until it sets.

1.10 PROTECTION;

- ❖ PROTECT; all fixtures, frames, inserts and other contiguous or from rusting, soiling or clogging due to plastering.
- ❖ INDEPENDENT SCAFFOLDING; to be used to avoid pit log holes and other breaks in surfaces

PART 2 - PRODUCTS

2.01

- ❖ PORTLAND CEMENT; conforming to BS1191.
- ❖ LIME; Hydrated lime conforming to BS 890 class B.
- ❖ PORTLAND CEMENT PLASTER BASE COATS; ASTM C144 natural sand. Sieve size between No 4 and No. 100
- ❖ PORTLAND CEMENT PLASTER FINISH; Graded Silica Sand passing a 30mesh screen.
- ❖ BONDING AGENT; waterproofing compound shall be used, as approved by Engineer.
- ❖ WATER; Clean and potable tested to BS 3148.
- ❖ CORNER BEADS; not less than 26 gauge (0.45mm) galvanized steel, formed with a dead not exceeding 5mm, with expanded flanges at least 63 mm wide.
- ❖ CASING AND STOP BEADS; not less than 24 gauge (0.60mm) galvanized steel, formed with expanded wire unless otherwise shown.
- ❖ METAL CORNER REINFORCEMENT; Expanded large mesh diamond lath fabricated from zinc alloy or welded wire mesh fabricated from 1.2 mm diameter corner of Portland cement plaster on exterior exposures while allowing full plaster encasement.
- ❖ CONTROL JOINT – TWO PIECE TYPE; pair of galvanized steel lined, square reveal beads with surface width of 20 mm and minimum depth of 15 mm.
- ❖ CONTROL JOINTS – ONE PIECE TYPE; Folded pair of galvanized steel line square reveal beads with surfaces width of 20 mm and minimum depth 15 mm .

- ❖ STRIP LATH; expanded copper bearing steel not less 1.35 kg / m².
- ❖ LATHING NAILS; Hardened, Zinc coated masonry nails, offset head or hook – head lath nails lengths as required proper anchorage.
- ❖ REINFORCEMENT FOR WIRE MESH; to be 50 mm x 50 mm galvanized steel, 0.6 mm thick woven mesh, self – furring type.
- ❖ ANCHORAGE METHODS; to be by means of nails to BS 1202 part 1 table 3) staples tying wire (1.2mm diameter annealed iron wire galvanized to BS 443, Section3) or other manner acceptable to the Engineer.
- ❖ POLYETHENE SHEETING; to be 4 mils thick.
- ❖ ACOUSTICAL SEALANT; to be non – hardening, non – skinning, recommended by the installer and approved by Engineer.
- ❖ BUILDING PAPER; to BS 1521, type A1

2.02 PORTLAND PLASTER CEMENT MIXES

- ❖ PROPORTIONS; All mixes are by volume unless otherwise specified. Mix proportions are suggestive only; variations to meet local conditions and achieve the desired finish are permitted within the limits specified in ASTM C926 or BS 5492/5262 as appropriate.
- ❖ BASE COAT; ASTM C926 or BS 5492/5262 as appropriate as follows.

1 part Portland cement
3 to 5 parts natural sand
¼ part lime putty.
- ❖ BROWN COAT; ASTM C926 or BS 5492/5262 as appropriate as follows.

1 part Portland cement
3 to 5 parts silica sand
¼ part lime putty.
- ❖ FINISH COAT; same as brown coat. The finish surface shall be granular in appearance and texture similar to that of the sand blasted precast concrete panels. Surfaces are to be uniform in appearance, without defects and variations from section to section. The colour of the finish coat shall be to the approval of the Engineer.
- ❖ MIX ONLY AS MUCH PLASTER; as can be used prior to initial set. Do not re - temper mixes after initial set has occurred.
- ❖ PIGMENTS; to be added to finish coat in accordance with manufactures instructions Ensure uniformity of mix and coloration.

- ❖ FUNGICIDE; as recommended by plaster manufacturer

PART 3 - WORKMANSHIP

3.01 GENERAL

- ❖ BRITISH STANDARD; comply with BS 8000: part 10 unless specified otherwise, in respect of the following:
 - A. material handing and storage (section 2);
 - B. applying plaster and rendering mixes internally (section3);
 - A. checking, handling and site storage of materials and components (section 2.1)
 - C. expanded metal and mesh lathing backgrounds (subsection2.2.3);
 - D. plain expanded metal lathing backgrounds (section 2.2.4);
 - B. ribbed lathing backgrounds (section 2.2.5).and with BS 5262 in respect of external sanding as follows;
 - 1. Background preparation (section 4)
 - 2. Work in (section 5).
- ❖ ADDITIONSL REQUIRMENT; the following clauses in this Work section are alternative, supplementary or additional requirement to those contained in BS 8000: part 10. Where the same item of work is specified in both the BS and this specification, the clauses in this Work section take precedence.

3.02 EXAMINATION

- ❖ VERIFY SITE CONDITIONS; are ready to receive work.
- ❖ SUBSTANCES DETRIMENTAL TO PLASTER; should not exist on surfaces to receive work.
- ❖ MANSONRY; Verify joints are cut flush.
- ❖ CONCRETE; verify surfaces are flat, and honeycomb is filled flush.
- ❖ GROUND AND BLOCKING; Verify item within walls for other sections of work have installed.
- ❖ BUILDING SERVICES; Verify services within walls have been tested and approved.
- ❖ ACCEPTANCE OF BACKGROUND; Ensure the following back ground conditions are satisfied before applying coatings.

- A. Adequately true and level to achieve specified tolerance.
- B. Adequately fixed.
- C. Free from contamination and loose layers.
- D. Adequately prepared to give a good bond.
- E. Free of any coatings of bituminous compound or any other detrimental waterproofing or damp-proofing agent.

❖ PREPARATION OF SURFACES;-

- A. Comply with ASTM C926 or BS5262 Para 20 for all plaster.
- B. Do not apply materials to damp or wet surfaces or to concrete that is less than 6 weeks old.
- C. Do not begin plastering until:
 - 1. Openings, chases or other apertures required for services are formed.
 - 2. Fixing for pipes, fixing pads, and plugs have been fixed.
 - 3. Making good has been completed.
- D. Cut ends of metal mesh beads, etc., and damaged areas of conduit, switch and outlet-boxes etc., have been coated with black tar-based paint.
- E. Apply bonding agent where required in accordance with manufacturer's instructions

3.03 INSTALLATION

- ❖ GENERAL; Apply 3-coat (spatter + scratch coat +final coat). Work on all bases. Apply finish coat with a reasonably uniform thickness over entire surface with vertical surfaces flat, straight and plumb. Make interior angles square, and make arises square but slightly rounded. Solidly grout hollow metal frames occurring in plaster walls with plaster specified for base or brown coat. Where casing beads do not occur at the Junction of plaster and hollow metal frames cut a groove in the base coat and later in the finish coat to minimize the appearance of cracks at these joints.
- ❖ MIXING; Use mechanical mixers for mixing plaster. Hand mixing is not permitted. Do not use frozen, caked, or lumped material. Clean mechanical mixers, mixing boxes and tools after mixing each batch; keep free of plaster from previous mixes. Thoroughly mix plaster with proper amount of water until uniform in colour and consistency. Retempering not permitted; discard plaster which has begun to stiffen. Provide waterproof protection under mixer.
- ❖ FOR INSULATED LIGHT BLOCK WALL; chicken wire mesh to be applied before laying the finishes in full compliance with manufacturer's instructions and Engineer's approval.

- ❖ THICKNESS OF PLASTER ;Comply with ASTM C 926 or BS5492 as appropriate for all applications otherwise shown or specified for Portland Cement Plaster) thickness shall be 20mm unless otherwise indicated.

3.04 APPLICATION OF PLASTER

- ❖ GENERAL; To avoid abrupt changes in the uniform appearance of the succeeding coat, each plaster coat shall be applied to an entire wall without interruption .Joining of wet plaster to set plaster should be made at naturally occurring interruptions in the plane of the plaster, such as arises or openings. Where this is not possible, such joining shall be cut square and straight and at least 150mm, away from a joining in the preceding coat.
- ❖ APPLY PLASTER; in accordance with ASTM 926 or BS 5492 as applicable.
- ❖ WHERE PLASTER THICKNESS IS REQUIRED TO BE MORE THAN 20 MM ; plaster base coat and brown coat as specified above and as per ANSI A 42.4. After Brown Coat has gained sufficient strength apply metal lath over whole area and fasten securely with hardened galvanized nails or lath nails spaced not more than 200mm staggered. Apply base coat, brown coat and finish coat on metal lath to achieve plaster thickness as required.
- ❖ ACCURACY; finish surface in accordance with BS 8000: Part 10: paragraph 3.2.2. and finish all angles and corners to a right angle unless otherwise specified, and with walls and reveals plumb and square.
- ❖ DUBBINGOUT;
 - A. correct inaccuracies by dubbing out in thick nesses of not more than 10mm in same mix as first coat;
 - B. allows to set but not dry out before the next coat is applied;
 - C. cross scratch surface of each dub-bout coat immediately after set.
- ❖ COATING APPLICATION; apply each coat:
 - A. firmly to achieve good adhesion, and rule to even surface. Work undercoat well into interstices to obtain maximum key;
 - B. to each wall and ceiling surface in one continuous operation;
 - C. at full thickness down to floor level or skirting grounds;
- ❖ UNDERCOATS; Minimum 8mm thick with thickness greater than 16mm applied in two even coats. Rule to an even surface and cross scratch each coat to provide a key.
- ❖ FINISH COAT; Trowel or float to produce a tight, malt, smooth surface with no hollows, abrupt changes of level or trowel marks. Do not use water brush and avoid excessive trowelling and over polish. Minimum thickness should be 3mm.

3.05 APPLICATION OF MISCELLANEOUS ACCESSORIES

- ❖ CORNER BEADS; Provide on all external corners and arises and in single lengths where the length of a corner or arises does not exceed the standard stock lengths. Meter the beads at corners and fasten securely with tie wires, hardened galvanized nails, staples or offset head or hook head lath nails spaced not more than 200mm, staggered.
- ❖ CASING OR STOP BEADS; Provide where shown and where plastering terminates and is not covered by other finish. Provide sheet metal closures at reveals. Set the beads level, plumb and true to line. Install in lengths as long as is practicable and align joints with concealed splice or tie plates. Secure beads with tie wire, hardened galvanized nails or other accepted methods. Space fastenings not more than 200mm apart.
- ❖ STRIP LATH; Where plaster is to be applied across differing background and varying chases provide strip lath 300mm wide located centrally over joint; except that where small widths of one material are involved completely bridge the one material with mesh wide enough to extend 75mm each side. Insert an isolating membrane of building paper under lath to separate plaster from base material, and bed lath in undercoat.
- ❖ INSTALL CONTROL JOINTS; where distance between natural interruption or expansion joints in the work exceeds 9m. in either direction.
- ❖ APPLY; in accordance with manufacture's printed instructions.

3.06 FIELD QUALITY CONTROL

- ❖ PLASTER SAMPLING; Samples may be taken from work in place at any time. Areas represented by samples which show over sanding or wrong aggregate proportion will be rejected. All surfaces which do not conform to the specified uniformity of finish including surface texture and colour, shall be subject to rejection by the Engineer and shall be replaced by the Contractor.

3.07 PATCHING

- ❖ WORK UNACCEPTABLE; will be those containing cracks, blisters, pits, checks, or discoloration. Remove such work, including rejected work, and replace with new. Patching of defective work would be permitted only with the Engineer's approval.
- ❖ REPAIRS; Perform cutting, patching, repairing and pointing-up operations neatly and thoroughly. Repair the cracks and indented surfaces by moistening the plaster and filling with new material, trowelled or tamped flush with adjoining surfaces. Point-up and finish surfaces around fixtures, outlet boxes piping, fittings, tile and other work flush with adjacent plaster. Where new plaster adjoins plaster which has been installed more than 48 hours cut existing plaster at an angle of approximately 45 Deg. with the surface before installing new plaster.

3.08 DRYING CONDITIONS

- ❖ CEMENT BASED UNDERCOATS; allow to dry out thoroughly to ensure that drying shrinkage is substantially complete before applying next coat.
- ❖ CEMENT RENDERING ; after initial set keep cement rendering damp by spraying or other suitable method for at least 7 days to delay evaporation .

309 CLEANING AND PROTECTION

- ❖ SPATTERING OF PLASTER; to be minimized or other work. Promptly clean windows and other surfaces which have been soiled.
- ❖ PROTECT PLASTER; from the weather, premature drying, marking, dirt, dust, marring or other damage throughout the construction period so that it will be without any indication of damage at the time of substantial completion of the works.

END OF SECTION

SECTION 09310

CERAMIC TILES

PART 1 - GENERAL

- 1.01 SECTION INCLUDES; the following minimum works
- A. Ceramic tiles for walls, floor and skirting finish for floors and walls
 - B. Work includes tiles to swimming pools, fountains, toilets and kitchen.
 - C. Provide all labour, material, plant, equipment and appliances and perform all necessary operations required to execute the work of this section.
- 1.02 RELATED SECTION; elsewhere in this document, are not necessarily comprehensive or complete and it is the Contractor's responsibility to ascertain all applicable sections required to understand the full Scope of Works intended.
- A. Section 04050 Mortar and Masonry Grout
 - B. Section 07900 Joint Sealant
 - C. Section 09200 Lath and Plaster
- 1.03 REFERENCES; the minimum standards for product specification in this section shall be relevant BSI standards including but not limited to the following. Except as otherwise specified herein, perform work in accordance with specification codes and standards cited therein and addenda and supplements.
- BS 5385 : Code of practice for Design & Installation of Tiles
 - BS 6431 : Ceramic Tiles
 - BS 8000 : Part 11, Code of practice for floors and wall Tiling
 - CP 202 : Tile Flooring
- 1.04 SUBMITTALS
- A. SHOP DRAWINGS; Provide shop drawings for installation and erection of all parts of the work. Provide plans, elevations and details where tiles terminate and at meeting of floor and walls.
 - B. MEASUREMENTS; to be taken in the field and verify all dimensions before submitting Shop Drawings.
 - C. SAMPLES; for each tile type, submit samples of four tiles, each mounted on rigid panel board. Board shall include grouted joints. Engineer's acceptance shall be for colour pattern and texture only. Compliance with other requirements is the responsibility of the Contractor.

- D. PRODUCT DATA; for each product or material used, submit manufacturer's product data, including installation instructions, use limitations and recommendations. Provide certifications stating that materials comply with requirements.
- E. MAINTENANCE DATA; Including recommended cleaning methods, cleaning materials, stain removal methods and polishes and waxes

1.05 QUALIFICATION

- A. MANUFACTURER; Specialist in manufacturing products specified with minimum 5 years experience.
- B. INSTALLER; specialist in this work with minimum 10 years experience, approved by manufacturer.

1.06 MOCK-UP

- A. PROVIDE MOK-UP; for an area of at least 10 m2, or room, whichever is smaller, for each kind of the tile. Approved mock-ups shall remain as sample of the standard to be achieved in all related areas and may, with the approval of the Engineer, remain as part of the work.

1.07 DELIVERY STORAGE AND HANDLING

- A. DELIVER, STORE AND HANDLE; materials and products in a manner to prevent damage. Replace damaged items with no change in Contract Price.
- B. DELIVER MATERIALS AND PRODUCTS; in unopened factory labeled packages indicating the name, brand, type, class, size and colour.
- C. STORE AND HANDLE; in strict compliance with manufacture's instructions and recommendation
- D. PROTECT ADHESIVES; from overheating in accordance with manufacture's instruction.
- E. DO NOT INSTALL; in an unventilated environment.
- F. ILLUMINATE INTERNAL SURFACES; during the work and inspection to closely resemble illumination provided by permanent installation.
- G. MAINTAIN TEMPERATURE AND HUMIDITY; at levels similar to those which will prevail after building is occupied, during installation.

PART 2 - PRODUCTS

2.01 GENERAL;

All tiles to conform to BS 6421.

Bending strength:35-40N/mm²

Scratch resistance:5-7 Mohs

Color/ Finish: As directed by Engineer

2.02 TILES; color to be decided by the Engineer:

- Non-slip ceramic floor tiles, size 150mm x 150mm x 8mm, to pantries / washroom / toilets
- Glazed ceramic wall tiles, size 150mm x 150mm x 6mm, to pantries / washroom / toilets up to 2.4 m height

Toilet & Pantry Floor tiles – 150 x 150 x 8

Toilet wall tiles- 150 x 150 x 6

2.03 ADHESIVE MATERIALS; use adhesives conforming to BS 5980 suitable for tile background and the environment to be used. Use “CEMENT” chemicals by CMCI - Dammam , KSA , and Fax : 03-8574951.

2.04 GROUT MATERIALS; Use grout to be two component pigmented epoxy composition having the following characteristics:

- A. Initial setting time: 2 hours
- B. Shrinkage of mixed Components during cure: 0.25% after seven days
- C. Compressive strength: 4500 psi minimum after seven days
- D. Colour: To be agreed later.

2.05 SEALANT; as specified in Section 07900.

2.06 ACCESSORIES

- A. FLOOR DIVIDER STRIPS; Use 6 mm wide stainless steel strips of required depth.
- B. CONTROL STRIPS; Double or split units, 3 mm , of same materials and colour as divider strips with 3 mm wide full depth , using silicone rubber laminated between strips
- C. TILE SPACERS; Provide tile spacers for typical conditions to make a complete installation. Match type, colour, class and co-ordinate size with filed units, or as directed by the Engineer.

2.07 MORTAR

- A. PORTLAND CEMENT; Use ordinary Portland cement conforming to BS 1191, white colour wherever required.
- B. WATER; Clean and potable tested to BS 3148 .
- C. SAND; Use sand conforming to BS 1199 and 1200 .

- D. LIME; hydrated lime class B, conforming to BS 890.

PART 3 – WORKMANSHIP

3.01 GENERAL

- ❖ BRITISH STANDARD; comply with BS 8000: Part II Section 1.1 in respects of the following:
 - A. materials handling and preparation (subsection 2);
 - B. fixing floor tiles (subsection 3);
 - C. protection and cleaning (subsection 4); and BS 5385: Part 3 in respect of the following:
 - 1. bedding tiles in cement and sand mortar bonded to a base (subsection 4.1);
 - 2. bedding tiles in cement and sand mortar over a separating layer (subsection 24.3);
 - 3. grouting (subsection 25); unless specified otherwise.
- ❖ ADDITIONAL REQUIREMENTS; the following clauses in this Work section are alternative supplementary or additional requirements to those contained in BS 8000. Section 11.1. Where the same item of work is specified in both the BS and this specification, the clauses in this Work section take precedence

3.02 PREPARATION AND INSPECTION

- ❖ EXAMINE; all surfaces to receive work of this Section, and notify Engineer In writing of all conditions which would adversely affect this work. Do not commence work in any area where such notice of adverse conditions has been sent to the Engineer, until corrective work has been completed or waived.
- ❖ SLABS TO DRY ADEQUATELY; before applying materials. At the direction of Engineer, perform simple calcium-chloride test to ensure concrete surfaces are free of contained moisture.
- ❖ FILL ALL CRACKS; sub-surfaces using approved crack filler in accordance with manufacturers printed instructions. Clean sub floors of all remaining dirt and loose particles before application of flooring materials.
- ❖ UNDERLAYMENT; shall be provided as part of the work in concrete Division to correct floor slabs with surfaces not constructed to specified tolerances. However, small dips and minor imperfections on the floor surface shall be corrected using specified latex leveling mortar as part of the work under this Section.

3.03 INSTALLATION FOR FLOOR TILES

- ❖ ADHESIVE, MORTAR BED, TILE AND GROUT; to be installed in accordance with manufactures instruction

- ❖ SPREAD, LEVEL AND COMPACT; Cement –Sand mortar in (1:4) ratio, of stiff, plastic consistency.
- ❖ MORTAR BED; to be applied over surfaces shown to a thickness of maximum 50 mm
- ❖ THRESHOLDS; to be placed at locations shown.
- ❖ EDGE STRIPS; to be placed at exposed tile edges.
- ❖ CUT AND FIT; tile tight to penetrations through tile. Form corners and bases neatly
- ❖ TILE JOINTS; uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar, or excess grout.
- ❖ SOUND TILE; after setting . Replace hollow sounding units.
- ❖ EXPANSION AND CONTROL JOINTS; to be kept free of adhesive, mortar or grout .Apply sealant to joints.
- ❖ SLOPE FLOORS; to drain where they occur.
- ❖ TILE TO BE ALLOWED TO SET; for a minimum 24 hours prior to grouting tile joint , Grout to match tile colour or otherwise directed by Engineer .
- ❖ SEALANT; to be applied to junction of tile and dissimilar materials and junction

3.04 INSTALLATION FOR WALL TILES

- ❖ ADHESIVE, ADMIXTURE AND GROUT; to be installed in accordance with manufactures instructions
- ❖ APPLY THE PASTE; as backing on tiles.
- ❖ CUT AND FIT; tile tight to penetrations through tile. Form corners and bases neatly. Align floor, skirting and wall joints.
- ❖ TILE JOINTS; to be placed uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar or excess grout.
- ❖ INTERNAL ANGLES; to be placed square or coved and external angles square or bull – nosed.
- ❖ CERAMIC ACCESSRIES; to be installed rigid in prepared openings.
- ❖ SOUND TILE; after setting. Replace hollow sounding units.
- ❖ EXPANSION AND CONTROL JOINTS; to be kept free of adhesive, mortar, or grout. Apply sealant to joints.
- ❖ TILE TO BE ALLOWED TO SET; for a minimum 48 hours prior to grouting. Grout tile joints to match tile colour or otherwise directed by Engineer .

- ❖ SEALANT; to be applied to junction of tile and dissimilar materials and junction of dissimilar planes.

3.05 CONTROL AND EXPANSION JOINTS

- ❖ CONTROL JOINT OR EXPANSION JOINT; to be provided where required by ANSI standard for proper workmanship, install divider strips of widths as specified and depths as required for the setting beds. Expansion joints shall be provided where tile works abuts restraining surfaces such as perimeter walls, curbs, columns and pipes etc. directly over joints in structural floor including construction joints. For large areas space joints at 6m to 8m intervals in both directions. At expansion joint provide divider strips at both sides and fill with joint fillers and sealants

3.06 CLEANING AND PROTECTION

- ❖ SPONGE AND WASH TILE; thoroughly and diagonally across joints after tile has thoroughly set. Remove all surface cement and take care not to damage tile or adjacent materials. Do not use acid cleaners. Finally, clean all tile using dry cloths.
- ❖ REMOVE AND DISPOSE; of at the end of each day, all cartons, rubbish and debris resulting from the work of this Section.
- ❖ PROTECT TILE; after cleaning with non - staining heavy Kraft paper or other approved coverage until acceptance of the building. The General Contractor shall replace torn or worn papers on tile after the tile setter has completed his work.

END OF SECTION

SECTION 09420

PRECAST TERRAZZO

PART 1 - GENERAL

1.01 SECTION INCLUDES; the following minimum works

- A. Precast terrazzo for flooring, skirting risers and treads using cement mortar bedding as detailed in application methods.
- B. The work includes but is not limited to the labor, materials and equipment and services requirement for the layout, supply and fix flooring for skirting, treads and risers as described herein.

1.02 RELATED SECTIONS; elsewhere in this documents are not necessary comprehensive or complete and it is the Contractor's responsibility to ascertain all applicable sections required to understand the full Scope of works intended.

- A. Section 04100 Mortar and Masonry grout
- B. Section 07900 Joint sealants

1.03 REFERENCES; the minimum standards for products specification in this section shall be relevant BSI standards including but not limited to the following. Except as otherwise specified herein, perform work in accordance with the specification codes and standards cited there in and addenda and supplements. The minimum standards for products specified in this Section shall be relevant to British Standards including but not limited to the following:

BS12	:	Portland cement
BS 146	:	Blast Furnace Portland cement
BS 1199& 1200	:	Sands
BS 3148	:	Portable Water
BS 4131	:	Terrazzo Tiles
BS4357	:	Precuts Terrazzo
BS 5385	:	Code of Practice for Design & Installation of Tiles
CP 202	:	Flooring

1.04 SUBMITTALS

- A. SHOP DRAWINGS; Show detailed layout for divider strips control joint strips and base and other strips. Show large scale details of precuts terrazzo jointing and edge conditions, and show elevation and plan layout Include anchorage and other special features.
- B. SAMPLES; Submit samples of terrazzo, for each size and shape, four no each for approval. Samples shall include specials, trim, grout, adhesive and bedding. Samples shall show the surface texture and the maximum range or variation in colour and shade these samples will be used to evaluate construction of units proposed. Sample submissions review shall be for colour, texture and finish.
- C. MANUFACTURE'S CERTIFICATE; certify that products meet or exceed specified requirement.
- D. G070 PRODUCT DATA; submit product data for each type of terrazzo, accessory item and competent material specified.

- E. MANUFACTURERS DATA; to be submitted, clean as recommended using by machine, when building is ready for occupancy.

1.05 QUALIFICATIONS

- A. MANUFACTUER; Specialist in manufacturing product specified with minimum 5 years experience.
- B. INSTALLER; Specialist in this Work with minimum 10 years experience, approved by manufactures.

1.06 MOCK – UP

- A. PROVIDE MOCK UP; for an area of at least 10 M2 for each kind of terrazzo. Mock up shall include treads and risers. Approved mock up, shall remain as sample of the standard to be achieved in all related area and may, with the approval of the Engineer, remain as part of the work.

1.07 DELIVERY STORAGE AND HANDLING

- A. COMPLY; with manufacture's instructions and recommendations for delivery, storage and handling requirements.
- B. DELIVER MATERIALS; to project site in an undamaged condition.
- C. PINCH OR WRECKING BARS; to be provided to remove terrazzo materials.
- D. SOTRE TERRAZZO MATERIALS; off ground, under cover, and in a dry location
- E. TERRAZZO MATRIALS; covered and in a dry location.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. ILLUMINATE INTERNAL SURFACES; during the work and inspection to closely resemble illumination provided by permanent installation.
- B. MAINTAIN TEMPERATURE AND HUMIDITY; before, during and after installation, at levels similar to those which will prevail after building is occupied.

PART 2 - PRODUCTS

- A. SIZE AND SHAPES; shall be 300mm x 300 x 30mm as shown on the drawings or as required for proper execution, terrazzo tile shall be formed on hydraulic presses.
- B. TILE TIRM SHAPES; like dull nose, coves, internal and external corners, etc. to be provided as shown and when needed to produce an acceptable overall appearance in accordance with the actual “setting out at site.
- C. FACE SECTION; of terrazzo tiles shall consist of Portland cement confining ASTM C – 150, type I. non staining white, marble chips maximum size 12 mm , selected natural sand (ASTM 33) (clean and free of all impurities) . Greater apportion shall be no less than 70 % selected

aggregated and 30% matrix. No aggregates with a value below Ha 10 and more than 20 as tested for abrasion resistance (ASTM C- 241) shall be used

- D. BACK OR UNDERLAYING SECTION; of terrazzo tiles shall consist of Portland cement and coarse sand. Back section shall have a cement / sand ratio of 1: 3.
- E. TERRAZZO TILE SHALL BE COMPRESSED; to produce the exact size as per drawings with square, flushes edges. Compressive strength shall be minimum of 280 kg / cm² when tested in accordance with ASTM C-150. When cured for one day in moist air and 6 days in water.
- F. MARBLE CHIPS; shall be natural sound marble chips with out x cassava laser lakes size and colours necessary to match sample.
- G. DIVIDER STRIPS; 6mm wide with required deep, stainless steel strips.
- H. CONTROL STRIPS; Double or split units , 3mm of same material and colour as divider strips with 3mm wide full depth silicone filler material laminated between .
- I. NON- SLIP INSERTS; Three carborundum non-slip strips on stairs treads for 25 mm wide and at positions as directed by Engineer.
- J. SEALERS; Colorless, penetrating liquid type to completely seal cementitious matrix surface, not detrimental to terrazzo components.
- K. PORTLAND CEMENT; use ordinary Portland cement confirming to British standards and to use white colour wherever required.
- L. WATER; Use clean and potable tested to BS 3148.
- M. SAND; Use sand confirming to BS 1199 and 1200.
- N. ADMIXTURE; Water proofing admixture confirming to BS 5385

PART 3 - WORKMANSHIP

3.01

- A. BRITISH STANDARD; comply with BS 8000: Section 11.1, unless specified otherwise, in respect of the following:
 - a. materials handling and preparation (subsection2);
 - b. fixing floor tiles (subsection3);
 - c. protection and cleaning (subsection 4);
- B. ADDITIONAL REQUIRMENTS; the following clause in this part of the Work section are alternative, supplementary or additional requirement to those contained in BS 8000: Section 11.1. Where the same item of works is specified in both the BS and this specification, the clause in this Work section take precedence

3.02 PREPARATION

- A. PROTECT; surrounding work from damage or disfiguration.

- B. SEAL; substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances with self –levelling screed if necessary.
- C. SEALER AND/OR CONDITION TO BE APPLIED; to substrate surfaces in accordance with adhesive manufacturer's instructions.
- D. COMMENCEMENT OF WORK; shall imply acceptance of surfaces and conditions under which the work is conducted and installed. All defects in tile work resulting from such acceptance shall be corrected at the contractor's cost.
- E. WORK SHALL COMMENCE; only after ground, anchors, plugs, hangers, bucks , electrical and mechanical work to be in or behind tile have been installed . All surfaces shall be dry and clean before setting bed is applied.
- F. CLEAN BACKGROUND AND SUBSTRATE; immediately before installation of terrazzo. Remove dirt, insecure coatings, moisture and other substances which would interfere with bond of tile bedding or adhesive.
- G. DELIVER; fabricated units and component parts to site, and store accordance with manufacturer's instructions, above ground, properly protected from the weather and construction activities in a locked store.

3.03 INSTALLATION

- A. FOR FLOORS; provide 50mm cement sand mortar setting bed 1:3 of cement sand with sufficient water to provide a workable mortar when fully mixed mixing by machine only.
- B. LAY TERRAZZO; in grid pattern. Align joints when adjoining on the floor, base and trim are the same size. Set out from the centre and work outwards in both directions in each space. Adjust to minimize cutting. Provide uniform joint widths.
- C. PRESS INTO CEMENT BED; using care to maintain accurate joint alignment and spacing.
- D. BEAT IN; with a rubber faced bearing block to obtain maximum contact between the backs and adhesive or bedding.
- E. FIT CLOSELY; around pipes passing through walls and floors.
- F. CONTROL JOINTS; to be provided for the floor installed in internal spaces where floors meet restraining surfaces such as perimeter walls, cove, bases, curbs, columns, pipes, etc. and directly over control joints in floor slabs.
- G. FILL CONTROL JOINTS; to full depth of setting beds from subsurface to rear face of terrazzo. Keep remaining void clear of grout and debris. After completion of grouting operations, control joints sealant of colour to match adjoining grout will be applied as specified in Division 07900.
- H. ADHESIVE TILE AND GROUT; to be installed in accordance with manufacturer's instructions .
- I. EDGE STRIPS; to be placed at exposed edges.
- J. CUT AND FIT; terrazzo tight to penetrations through. Form corners and bases neatly. Align floor, and wall joints.
- K. JOINTS; to be placed uniform in width, subject to variance in tolerance allowed in size. Make joints watertight, without voids, cracks, excess mortar or excess grout.

- L. SOUND; after setting. Replace hollow sounding units.
- M. EXPANSION JOINTS; to be kept free of adhesive or grout. Apply sealant to joints.
- N. SETTING TIME; to be minimum of 24 hours prior to grouting. Clean all loose setting bed materials from joint spaces.
- O. GROUT FLOOR; with prepared waterproof epoxy grout mixed to a creamy consistency in accordance with manufacturer's directions. Where coloured grout is required, each area to be grouted shall be grouted from a single grout batch.
- P. FORCE MAXIMUM GROUT; into joints with trowel or squeeze or as recommended by grout manufacturer. Before grout sets, strike or tool joints to base a cushion (curve between face and edge) and fill all skips and gaps. Do not permit setting bed materials to show through grouted joints.
- Q. CURE GROUT JOINTS; by maintaining damp condition for three (3) days. Use waterproof paper joints lapped 10 cm and held in place with tape or weight, or use other methods approved by the Engineer. Allow floors to set an additional 48 hours before permitting light foot traffic.
- R. SEALANT; to be applied to junction of tile and dissimilar materials and junction of dissimilar planes.
- S. AREAS TO BE CLOSED TO TRAFFIC; where work is being performed until the installation has set.
- T. PATTERNED AND SHADED UNITS; shall be mixed from various bundles to achieve a homogenous appearance free of odd looking units.
- U. LOCATIONS OF ACCESSORIES; to be verified before installing. Co-ordinate with plumbing and other trades. Fully tile surfaces behind all surface mounted items including trim and plumbing fixtures, etc.

3.04 SURFACE FINISHING

- A. GRIND TERRAZZO SURFACE; with power disc machine, successively sequence using coarse to fine grit abrasive, using a wet method.
- B. GROUT MIX; to be applied to match matrix over ground surfaces to fill honeycomb exposed during grinding. After grout has sufficiently cured, grind, using a fine grit abrasive.
- C. WAX POLISH; the complete surface.

3.05 CLEANING

- A. CLEAN AND GROUT; surfaces.
- B. CURE GROUTING; in compliance with manufacturer's instructions and recommendations, and as specified to obtain high early bond strength, internal cohesive strength and surface durability.
- C. FINISHED INSTALLATION; to be left clean and free of cracks, chipped, broken, unbounded, or otherwise defective. Remove and replace all defective work.

- D. CLEANING OF TERRAZZO; shall be done after the bed and grout has thoroughly set. Sponge and wash thoroughly and diagonally across joints. Remove all surface cement and take care not to damage the adjacent materials. Do not use acid cleaners. Finally polish with clean, dry cloth.
- E. PROTECT TERRAZZO; after cleaning with non-staining heavy kraft paper or other approved cover until handover of the building. Torn or worn papers on tile after the tile-setter has completed his work shall be replaced .Do not permit traffic over finished floor surface for 4 days after installation.
- F. REMOVE PROTECTION; and clean all work before hand over of building at direction of Engineer.
- G. ANY DAMAGE SHALL BE REPAIRED; and parts replaced, including repairs to adjacent work damaged in connection with work of this section.

END OF SECTION

SECTION 09900 PAINTING

PART 1 - GENERAL

1.01 SECTION INCLUDES; the following works:

- A. Provide all labour, material, plant, equipment and appliances and perform all necessary operations required to execute the work of this section.
- B. Surface preparation.
- C. Surface finishes as per schedule forming part of this Section and finish schedule included in drawings.
- D. Colour selection schedule as indicated on Schedule of Finishes included in drawings or provided at a later date.
- E. Finish coats to work supplied primed under other sections.

1.02 RELATED SECTION;

- ❖ Related Sections; elsewhere in this document, are not necessarily comprehensive or complete and it is the Contractor's responsibility to ascertain all applicable sections required to understand the full Scope of Works intended.

- A. Section 08210 : Wood doors
- B. Section 09200 : Lath and Plaster
- C. Section 09260 : Gypsum Board system

1.03 SUBMITTALS

- ❖ **PRODUCT DATA;** submit product data for all kinds of paints and on special coatings. For all paint materials submit:
 - A. Names of manufacturers and specific brands.
 - B. Manufacturer's catalogue data
 - C. Recommended mixing and application instructions.

1.04 SAMPLES;

- A. Submit samples for all kinds of paints.
- B. Before delivery of paint materials, submit three properly identified samples of each paint system and each colour applied to 150 x 450mm tempered pressed wood panels.

C. Each sample submitted shall indicate:

1. Paint system
2. Type of paint for each coat.
3. Colour and sheen of finish coat.
4. Location where paint system will be used.

- ❖ CERTIFICATES; with each delivery of material submit in duplicate the supplier's affidavit, signed by the Contractor, certifying that each type of material delivered complies with the specification.

1.05 QUALITY ASSURANCE

- ❖ PERFORM WORK; in accordance with relevant British Standard, including but not limited to the following:

BS245	:	Solvents for Paints
BS2521	:	Lead Based Primers
BS3900	:	Test for Paints
BS4764	:	Cement Paints
BS5493	:	Protective Coatings for Iron & Steel
BS6150	:	Painting of Buildings
BS8000:		Part 12 Code of Practice for Decorative Wall coverings & Painting
BS3262	:	Hot Applied Road Marking Material

1.06 QUALIFICATIONS

- ❖ MANUFACTURER; Specialist in manufacturing Products having a minimum four years satisfactory field service in hot, sunny climates. Laboratory tests simulating field conditions will not be accepted in lieu of actual, documented field results.
- ❖ APPLICATION; Specialist in this Work with minimum three years documented experience.
- ❖ FIELD SAMPLES: 3 No., up to 20m2 panels illustrating colour, texture and finish.

1.07 DELIVERY, STORAGE AND HANDLING

- ❖ DELIVERY; Deliver all material to the Project site in the original labeled sealed cans and containers, with labels intact and seals unbroken. Seals shall remain unbroken until after inspection and acceptance of materials by the Engineer. Deliver materials in ample quantities sufficiently in advance of the need, to avoid any delays or interruptions in work.
- ❖ STORAGE; Provide temporary buildings for the exclusive use of paint storage and paint mixing. No space will be allowed in new structures for these purposes. Observe all regulations required for storage of paint and post all necessary safety signs required by governing codes. Location of temporary buildings will be determined by Engineer. Damage to any building or its contents caused by failing to exercise proper precaution to prevent such as shall be directed rectified by

the Contractor within 24 hours notice as by the Engineer. Contractor shall arrange with Engineer to have necessary keys and access to all temporary buildings where paints are stored.

- ❖ PROTECTION; Place paint or solvent soaked rags, waste, or other materials which might constitute a fire hazard in metal containers and remove from premises at the close of each day's work. Take every precaution to avoid damage by fire. Protect the work of all other trades against damage, making injury by suitable covering during the progress of the painting and finishing work. Repair any damage done.

1.08 ENVIRONMENTAL CONDITIONS

- ❖ CONDITIONS OF APPLICATION; Paint shall not be applied in rain, fog or moist, or when the air is dust laden, or when the relative humidity exceeds 65%. Paints, other than water-thinned coatings, shall be applied only to surfaces that are completely free of surface moisture as determined by sight, touch and moisture meter, as specified.
- ❖ TEMPERATURE OF APPLICATION; Paint shall not be applied when temperature of the surfaces to be painted and the surrounding atmosphere is below 10°C for water thinned coatings and below 7°C for other coatings. Maintain temperatures within the building at a minimum of 16°C during painting and drying periods.
- ❖ LIGHTING; 860 lux measured mid-height at substrate surface, shall be provided during application.

PART 2 - PRODUCTS

2.01 SEALERS

- ❖ ALKALI RESISTING PRIMER; an approved proprietary type suited to the surface to which it will be applied.
- ❖ HARDBOARD SEALER; an approved proprietary type.

2.02 WOOD PRIMING PAINTS

- ❖ LOW LEAD PRIMER; to BS 5358: Type A.
- ❖ WATER THINNED PRIMER; to BS 5082
- ❖ ALUMINIUM PRIMER: to BS 4756.

2.03 METAL PRIMING PAINTS

- ❖ RED LEAD PRIMER FOR IRON AND STEEL; to BS 2523: Type B.

- ❖ ZINC PHOSPHATE PRIMER (LOW LEAD); an approved proprietary type with lead content within the limits given in BS 4310.
- ❖ RED OXIDE OF IRON/ZINC CHROME PRIMER FOR STEEL; an approved proprietary type.
- ❖ ZINC CHROME PRIMER: an approved proprietary type.
- ❖ ONE – PACK PRIMER FOR GALVANIZED STEEL (LOW LEAD): an approved proprietary type with lead content within the limits given in BS 4310.
- ❖ METALLIC ZINC RICH PRIMER: to BS 4652.
- ❖ ETCHING PRE – TREATMENT PRIMER: an approved proprietary type.

2.04 UNDERCOAT AND FINISH PAINTS

- ❖ GENERAL PURPOSE PAINT: undercoat and finish to BS 7644.
- ❖ INTERIOR QUALITY EMULSION PAINT: to BS 7719.
- ❖ THERMOPLASTIC , REFLECTIVE PAINT : white or yellow on bituminous or cement concrete pavement to be applied by mechanical means , or as directed by Engineer and as detailed in BS 3262 part 1 & 3 .

2.05 PREPARATION MATERIALS

- ❖ PREPARATION MATERIALS : subject to the requirement of this specification, ensure paint removes , abrasive papers and blocks , cleaning agents , mould inhibitors , rust inhibitors, size , stopping knotting , fillers and other materials are of types recommended by the coating manufacture for the surfaces being prepared . Consult the Engineer if any conflict exists between this specification and any such recommendations made.
- ❖ WHITE SPIRIT; to BS 245, Type A.
- ❖ KONTTING; to BS 1336.
- ❖ STOPPING FOR INTERNAL WOOD WORK; ready mixed emulsion polymer or oil based type.
- ❖ STOPPING FOR EXTERNAL WOOD WORK; ready mixed emulsion polymer or oil based type and suitable for exterior use.
- ❖ STOPPING AND FILLER FOR WOOD WORK TO RECEIVE CLEAR FINISHES; ready mixed and tinted to match timber species.
- ❖ FILLER FOR PLASTER WORK; water mixed powder type.
- ❖ FILLER FOR INTERNAL WOOD WORK; a leadless proprietary type.

- ❖ FILLER FOR EXTERNAL WOOD WORK; a leadless proprietary oil based exterior type
- ❖ RUST REMOVER; phosphoric acid type.
- ❖ PAINT REMOVER; to BS 3761.

PART 3 - WORKMANSHIP

3.01 GENERAL

- ❖ BRITISH STANDARD; comply with BS 8000: part 12, unless specified otherwise, in respect of the following:
 - A. materials handling and preparation (section 2)
 - B. applying paint (subsection 3.2)
- ❖ ADDITIONAL REQUIRMENTS; the following clause in this Work section are alternative, supplementary or additional requirements to those contained in BS 8000 : part 12. Where the same item of work specified in both the BS and this specification, the clauses in this Work section take precedence .

3.02 EXAMINATION

- ❖ SURFACES AND SUBSTRETE CONDITIONS; to be verified and ensured ready to receive work as instructed by product manufacturer.
- ❖ EXAMINE SURFACES; to be finished prior to commencement of work. Report any condition that may affect proper application.
- ❖ SHOP APPLIED PRIMER; to be tested for compatibility with subsequent cover materials. Report any incompatibility.
- ❖ MEASURE CONTENT; to be tested of surfaces using an electrical moisture meter. Do not apply finishes unless moisture content of surfaces are below the following:
 - A. Plaster and Gypsum Wallboard: 12 %
 - B. Concrete and masonry: 12 %.
 - C. Interior Wood: 15%.
 - D. Exterior Wood: 15 %.
 - E. Concrete Floors: 8%

3.03 PREPARATION

- ❖ REMOVER; electrical plates, hardware, light fixture trim, escutcheons, and fittings to be removed prior to preparing surfaces or finishing.

- ❖ CORRECT DEFECTS AND CLEAN SURFACES; which affect work.
- ❖ TIMBER MARKS; to be sealed which may bleed through surface finishes, with shellac.
- ❖ IMPERVIOUS SURFACES; Scrub with solution of tri – sodium phosphate and bleach to remove mildew. Rinse with clean water and allow surfaces to dry.
- ❖ ALUMINUM SURFACES: remove contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately after cleaning.
- ❖ ASPHALT CREOSOTE, OR BITUMINOUS SURFACES; remove foreign particles to allow adhesion of finishing materials. Apply compatible primer or sealer.
- ❖ INSULATED COVERINGS; Remove dirt, grease and oil from canvas and cotton.
- ❖ CONCRETE FLOORS: Remove contamination, acid etch, and rinse with clean water. Verify required acid – alkali balance is achieved. Allow to dry.
- ❖ COPPER SURFACES, PAINT FINISH; remove contamination by steam, high pressure water, or solvent washing. Apply vinyl etch primer immediately after cleaning.
- ❖ COPPER SURFACES NATURAL OXIDISED FINISH: Remove contamination by applying oxidizing solution of copper acetate and ammonium chloride in acetic acid. Rub on repeatedly for required effect. Once attained, rinse with clean water and allow to dry.
- ❖ GYPSUM BOARD; fill minor defects with filler compound. Spot prime defects after repair.
- ❖ GALVANIZED SURFACES; Remove contamination and oils and wash with solvent. Apply coat of etching primer.
- ❖ CONCRETE AND MASONRY SURFACES; remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.
- ❖ PLASTER SURFACES; Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- ❖ UNCOATED STEEL AND IRON SURFACES; Remove grease, mill scale, weld splatter, dirt and rust. Remove heavy coatings of scale by wire brushing or sandblasting; wash with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Spot prime paint after repairs. Spray paint all metal works where all indicated.
- ❖ SHOP – PRIMED STEEL; Sand and scrape to remove loose primer and rust feather edges to make touch – up patches inconspicuous. Clean with solvent. Prime bare steel.

- ❖ INTERIOR WOOD: Wipe off dust and grit prior to priming / sealing. Seal knots, pitch streaks and sappy sections. Fill nail holes and cracks after primer/sealer has dried; sand light between coats.
- ❖ EXTERIOR WOOD; Remove dirt, grit and foreign matter. Seal knots, pitch streaks and sappy sections. Fill nail holes with tinted exterior crackling compound after primer / sealer has been applied.
- ❖ WOOD AND METAL DOORS; Seal top and bottom edges with primer.

3.04 COATINGS

- ❖ STIR LIQUID PAINTS; thoroughly so that all solids are fully and evenly incorporated.
- ❖ SHAKE CLEAR VARNISH CONTAINERS; properly do not stir contents.
- ❖ THIN PAINTS OR VARNISHES; should not be done unless so directed by the manufacturer
- ❖ OBSERVE MANUFACTURES DETAILS; of life timing and curing directions when preparing multi coat finishes. Do not use coatings beyond pot life.

3.05 PAINT APPLICATION

- ❖ SELANING; consult the Engineer where the adequacy of specified sealer to suit porosity of surfaces is doubted, or if one full coat of sealer or emulsion paints is insufficient to satisfy the porosity of the surfaces , or surfaces may be harmful to subsequently applied paint systems.
- ❖ PRIMING IRON AND STEEL; allow minimum drying times for priming paint to BS 2523 of:
 - A. seven days before applying undercoating;
 - B. two days between successive coats of priming paint.
- ❖ BRUSH APPLICATION; apply in wet, even film over all surfaces, avoiding brush marks, sags, runs , orange – peel and other defects .Ensure adequate edge protection.
- ❖ METALLICATION PAINT COVERING RATE; avoid excessive brushing out. Coverage must not exceed 18 m2 per liter.
- ❖ ROLLER APPLICATION; do not apply the following with rollers:
 - A. priming coats;
 - B. paint for work not of a plain character.
- ❖ SPRAY PAINTING GENERALLY; do not apply by spray:
 - A. priming paints for wood;

B. lead paints within the meaning of the control of Lead at work Regulations 1980.

3.06 APPLICATION OF CLEAR WOOD FINISHES

- ❖ OIL STAINING; apply stain to give an even colour and penetration over entire surface.
- ❖ VARINISHING;
 - A. apply first coat by brush avoiding an even thickness at edges and angles;
 - B. brush well into the surfaces;
 - C. applies subsequent coats by brushing full even coats free of sags and other defects;
 - D. ensures good even protection of edges etc.
- ❖ WAX POLISHING; apply pre-polishing oil with a circular rubbing motion at a rate of 22 2 per liter, and wipe dry. Allow at least 48 hours to elapse, then wax polish to approved finish, by preach polishing.
- ❖ PROPRIETARY FINISHES; apply first coats in joinery shop where practicable. Do not allow deterioration of first coats before application of subsequent coats.
- ❖ FIRE PREVENTION; carefully dispose of rags, swabs etc. soaked in flammable solvents or varnishes, to avoid fire risk.
- ❖ CLEANING; Upon completion of the work , clean up and remove from the premises , as may be necessary or directed by the Engineer , all surplus materials , tools , appliances , empty cans cartons and rubbish resulting from painting work . Clean off all paint and oil spattering and drippings and any resulting stains.
- ❖ ADJUSTMENT; Repaint all paint work which has become damaged or defected during the course of construction, and level all paint work in clean, neat and damaged material directly attributable to paint work. Repaints coatings falling below specified and / or scheduled finish and shade as required.

3.07 SCHEDULE

- ❖ FINISHES – EXTERIOR;
 - A. plaster
 - 1 coat block filler
 - 1 coat acid and alkali resistant primer
 - 3 coats acrylic - latex
 - B. Concrete
 - 1 coat block filler
 - 1 coat acid and alkali resistant primer
 - 3 coats acrylic - latex

- | | | |
|----------------------|---|--------------------------------------------------------------------|
| C. Galvanized Steel | - | 1 coat galvanized metal primer |
| | - | 3 coats exterior alkyd enamel |
| D. Steel | - | 3 coats exterior alkyd enamel |
| E. Gypsum Board | - | 1 coat exterior latex primer |
| | - | 3 coats acrylic-latex |
| F. Wood - Painted | - | 1 coat wood filler. |
| | - | 1 coat wood primer |
| | - | 1 coat undercoat (thinned 5%) |
| | - | 2 coats alkyd paint, semi-gloss |
| G. Pavement Markings | - | 2 coats chlorinated rubber paint, white parking lines, 100 mm wide |
| | - | Direction arrows as indicated |

W450 FINISHES - INTERIOR

- | | | |
|-------------------------------------|---|---------------------------------------------------|
| A. Plaster | - | 1 coat block filler |
| | - | 1 coat acid and alkali resistant primer |
| | - | 3 coats alkyd enamel |
| B. Concrete | - | 1 coat block filler |
| | - | 1 coat acid and alkali resistant primer |
| | - | 3 coats alkyd enamel |
| C. Concrete Parking Lines | - | 1 coat zone marking and highway stripping paint |
| D. Concrete Block | - | 1 coat block filler |
| | - | 3 coats alkyd enamel |
| E. Galvanized Steel | - | 1 coat galvanized metal primer |
| | - | 3 coats alkyd enamel |
| F. Gypsum Board | - | 1 coat latex primer/sealer |
| | - | 3 coats alkyd enamel |
| G. Insulation Pipes | - | 1 coat fire resistant latex sealer |
| | - | 2 coats latex alkyd paint |
| H. Mechanical Equipment | - | 2 coats gloss enamel |
| I. Metal Convectors & Heating Units | - | 2 coats gloss enamel |
| J. Piping, Conduit & Ductwork | - | 1 coat metal primer |
| | - | 2 coats fire retardant and mildew resistant Paint |

- K. Miscellaneous Steel - 2 coats alkyd enamel

- L. Millwork for Paint Finish - 1 coat wood filler
 - coat wood primer
 - 2 coats alkyd enamel

- M. M. Traffic Marking & Sign - 1 coat base primer
 - 2 coats reflective paint

- N. Steel Doors, handrails, metal staircase and miscellaneous metal works
 - 1 coat base primer
 - 2 coat glossy enamel paint

- O. Wood - Painted - 1 coat latex primer sealer
 - 1 coat under coat (For alkyd coats only).
 - 2 coats alkyd enamel, eggshell.

END OF SECTION

SECTION 11170
PACKAGED SUBMERSIBLE LIFT STATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Packaged Submersible Lift Stations

1.02 RELATED SECTIONS

- A General Requirements
- B Sections – 02200, 02240, 02260, 02315, 02316, 02530, 02631

1.03 QUALITY ASSURANCE

- A Regulations: Comply with local codes and ordinances of governing authorities having jurisdiction.
- B All items of equipment supplied shall be of Equipment produced by companies regularly engaged in Manufacturers manufacturing this type of equipment and who maintain service and parts departments from which service, repairs and replacements may be obtained quickly at all times. Mechanical details of the equipment offered shall have been tried and tested by the actual construction and operation of mechanisms of the exact type and of comparable size and operating in similar service.
- C The pump manufacturer shall have several units of similar type pumps installed and operating for no less than five years.

1.04 SUBMITTAL

- A Submit under provision of Section 01300.
- B Provide Operations and Maintenance manuals and Maintenance for all equipment specified in this section.
- C Include in the Manuals the following data:
 - i. System description
 - ii. Design parameters, system hydraulics, design calculations, and system curves.
 - iii. Performance curves for the pumps, layout, and wiring diagrams, control system schematic, level control system schematic.
 - iv. Related civil, mechanical, and electrical drawings.
 - v. Manufacturer's operating instructions.
 - vi. Name, address, and telephone number of equipment suppliers and service agents.
 - vii. Information on guarantees and warranties.

The Contractor shall be responsible to furnish the Shop Drawing and supporting calculations regarding Structural Stability of the Packaged Submersible Lift Station.

1.05 REFERENCES:

A DIN/EN 12056

B DIN/EN 124

A All works should conform to applicable requirements and referenced standards of the International Organization for Standardization (ISO), American Society for Testing and Materials (ASTM), National Electrical Manufacturer's Association (NEMA), Institute of Electrical and Electronic Engineers (IEEE), CE Conformité Européne.

1.06 IDENTIFICATION:

A All equipment shall be fitted with the of Equipment manufacturer's identification nameplates indicating size, equipment model, manufacturer's name, operating points, serial number, voltage, cycle, phase and power of motors, all factory supplied.

B Suitable nameplates to be permanently affixed onto the pumps, control enclosure components, and other operating components to indicate the purpose of the component or operating routine and parameters applying to the component. The lift station pumps and control equipment are CE approved and the CE logo appears on the nameplates of these components.

PART 2 PRODUCTS

2.01 Packaged Lift Station:

A The packaged pump station shall be fully assembled with all the necessary equipment to ensure a fully functioning pump station. The following shall be the minimum included, but not limited to; two submersible pumps, pump discharge connections, lifting chain or cable, plug valves, check valves, vacuum breaker/air release, float valves, required pipe work, external connections suitable for incoming and discharge force main, guide rails, vent assembly with filter, duplex control panel, control panel support and a fiberglass reinforced plastic basin assembly.

B With a pedestrian rated or traffic/vehicle rated where indicated on drawings, access cover suitable for pump removal. A prefabricated anti-flotation base complete with lifting lugs, stainless steel hold-down devices shall be provided. The package shall be manufactured by a firm with a minimum of 5 years experience in producing prepackaged basin assemblies for submersible pumps. No infiltration allowed.

C The wet-well GRP laminate must be constructed to withstand or exceed two times the assumed loading on any depth of the wet well. The inner surface shall be smooth and resin rich, free of cracks, exposed fibers, porosity and crazing. The exterior surface shall be relatively smooth with no exposed fibers or sharp projections. Color should be relatively equal throughout. Foreign inclusions, dry spots, pinholes or pits, delaminations, large dimples not meeting thickness

requirements, and air bubbles are not acceptable.

- D The tank bottom shall be of sufficient thickness to withstand the applicable hydrostatic uplift pressure with a safety factor of two (2). In saturated conditions the deflection of the empty basin shall be less than 9.5mm (elastic deflection) and shall not interfere with bottom pump mounting requirements. Any mounting studs, plates, cap screws into the bottom of the tank should be stainless steel and resin covered except for the threads. Any inserts should be stainless steel or brass and resin covered except for threads.
- E An anchoring device or tank collar (Anti-floatation) to counteract buoyancy forces shall be provided on the bottom of the tank in the form of a ring, and shall extend a minimum of 75mm beyond the O.D. of the basin wall. The thickness shall be uniform, but increased as needed to prevent cracking or failure, assuming two (2) times applied load as tank dimensions increase. Wall and collar should be blended with a radius not exceed 38mm beyond wall O.D. Tank manufacturer to provide approval calculations showing acceptable stress/thickness verification upon request.
- F Assembled inside the basin will be the guide rail system, discharge piping and valves for each pump. The basin sidewall will have a factory mounted discharge fitting. Each rail system shall have stainless steel guide rails for ease of installation and removal of pump. The rail system shall be fully supported at the top and bottom.
- G Conduit fittings shall be mounted on the outside of the basin wall. Float switches will be suspended from SS float brackets.
- H The Access frame and cover to be fabricated to withstand shear and deflect not more than 1/79 of the maximum span for minimum specified loads of 7.2 kPa uniform load or 1100 kg point load. The cover to rest on a full rubber gasket and to be hinged along one side with a continuous hinge. Top of the access frame and cover to be flush, the handle recessed. Install padlock within the recess to lock the cover in the closed position. Provide cover stay to allow the cover to be locked in the open position. Each access frame to be capable of supporting the full weight of any submersible pump which can be installed through its opening. The access cover will include 150 mm grade rings to allow for setting the top elevation to match the ground elevation.
- I The basin will be properly installed by utilizing sufficient material to prevent floatation from high groundwater conditions. Additionally, 300 mm of backfill material, or clear stone, shall be provided to support the sides and bottom of the basin.
- J Furnish two submersible non-clogs, grinding type wastewater pumps per station. Pump characteristics, flow, head, and material selection: as indicated in Project Document and drawing. Each pump shall be equipped with a submersible electric motor connected for operation with 16 meters of submersible, SOW or SUBCAB cable. The neoprene or CPE jacketed cable shall be sized according to CE standards and carry a CE approval. The pump performance and power requirements will be as per the Pump schedule in the drawings. Each pump shall be fitted with 5 meters of galvanized steel lifting chain or cable. The safe working load of the lifting chain or cable shall be at least 40% greater than the pump weight.
- K Supply each unit complete with a mating, cast iron discharge connection and galvanized lifting chain or cable, approved for overhead lifting and of adequate strength to permit raising and

lowering of the pump. Discharge connection elbow to be permanently installed in wet well, together with the discharge piping. Pump to be automatically connected to discharge connection elbow when lowered into place, and easily removed for inspection and service.

- L The pump/motor unit shall also be approved for service in Class I, Division 2, Groups A, B, C or D hazardous locations.
- M Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be of AISI type 304 stainless steel. All metal surfaces coming into contact with the sewage, other than stainless steel or brass, shall be protected by an approved, sewage resistant coating. Machine all mating surfaces where watertight sealing is required and fitted with nitrile or neoprene rubber o-rings. Accomplish sealing by metal-to-metal contact between machined surfaces. Control compression of nitrile rubber or neoprene o-rings without the requirement of a specific torque limit. Do not use secondary sealing components, rectangular gaskets, elliptical o-rings, grease or other devices or materials.
- N Provide two vertical guide bars or cables or Cables with each pump to ensure correct alignment of pump with automatic discharge connection. For each pump, guide bars or cables to be as specified in the Project Documents, securely fixed at lower end to the discharge connection by means of corrosion proof bosses, provided. Extend guide bars or cables from discharge connection toward ground level to be securely fixed by a corrosion proof bracket (upper guide bar holder), anchored to the station roof. Provide bracket with special inserts to position the guide bars rigidly, where applicable.
- O Hydraulic Sealing Flange: The pump shall be supplied with a universal coupling, which bolts to the pump discharge flange and shall accept the discharge elbow provided by the pump manufacturer. Seal of the pump at the discharge flange shall be accomplished by a simple downward linear motion of the pump with the entire weight of the pump guided to and pressing against the discharge connection; no part of the pump shall bear directly on the sump floor and no rotary motion of the pump shall be required for sealing. Sealing at the discharge shall be affected by a rubber lip to insure a positive leak proof system and for ease of removal. Metal to metal discharge connections will not be considered equal. The pump shall be guaranteed not to leak at the discharge flange.
- P Install check valves as specified and resilient seat gate valves in each pump discharge line. Each valve to have a throughway size equal to the pump discharge pipe size to ensure full, free-flow operation.
- Q Install a single combination vacuum/air release valve in the discharge piping.
- R The pump motor: squirrel-cage induction type design, housed in a watertight chamber of maximum efficiency and durability. Design motor for continuous duty capable of sustaining a maximum of fifteen (15) starts per hour. Motor speed and electrical characteristics as indicated in Project Documents. Motor stator shall be directly shrink fitted into the stator housing. Insulate stator winding and leads with moisture-resistant varnish capable of withstanding a temperature of 155°C or the motors maximum temperature rise, whichever is greater. Dip and bake stator three (3) times in Class F varnish. Rotor bars and short-circuit rings to be made of aluminum. Use thermal sensors to monitor stator temperatures on all pumps. Equip stator with not less than two

(2) thermal switches embedded in the end coils of the stator windings (one switch per phase to protect the motor against surcharges and high temperature). Use these in conjunction with, and supplemental to, external motor overload protection, and wired to the control panel. The motor shall have a voltage tolerance of +/- 10%. The motor shall be designed for continuous operation in up to a 40°C (104°F) ambient and shall have a maximum operating temperature rise of 80°C (176°F). A motor performance chart shall be provided upon request exhibiting curves for motor torque, current, power factor, input/output kW and efficiency. The chart shall also include data on motor starting and no-load characteristics.

- S Seal junction box chamber containing the Seal terminal board from the motor by an elastomer compression grommet for pumps of 3 kW (4 hp) or more. Alternatively, use of triple-sealed cable entry system does not require a seal junction box chamber. Equip motor housing with a moisture detector to detect any leakage of water or sewage, into the stator housing. The signals from the thermal switches and the moisture detector to be wired to the control panel. Accomplish control of the moisture detector and the winding thermal switches by using a control/indicator relay(s) which will be installed and wired inside the control panel to stop the pump unit upon a fault signal.
- T Pump shaft shall be AISI 400 or 431 series stainless steel. The pump shaft is and extension of the motor shaft. Couplings shall not be acceptable. The use of stainless steel sleeves to protect a lesser grade of shaft material will not be considered equal. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impellers. The wear ring shall be stationary and made of brass, which is drive fitted to the volute inlet.
- U Pumps shall be complete with valve sets. Valve models and manufacturer's to be approved before installation.
- V Provide each pump with a tandem mechanical shaft seal system. The upper of the tandem set of seals operates in an oil chamber. This set contains one stationary tungsten-carbide ring and one positively driven rotating carbon ring. The seals function as an independent secondary barrier between the pumped liquid and the stator housing. The lower of the tandem set of seals shall function as the primary barrier between the pumpage and the stator housing. This set shall consist of a stationary ring and a positively driven rotating ring, both to be solid tungsten carbide, silicon carbide or carbon ceramic. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load. The seal lubricant shall be non-toxic and FDA approved for potable water applications.
- W Bearings: The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Single row, or sleeve lower bearings are not acceptable.
- X Controls: Pump manufacturer to supply a completely assembled control panel. The control panel shall be housed in a double door EEMAC 4X enclosure with locking outer door. The panel shall have a manual transfer switch with a pinned receptacle, fused main disconnect, motor starter complete with overload elements for each pump. Overload protection shall be provided in the panel. The panel shall include a pump starting circuit for capacitor start/capacitor run motors. Pump run lights, HOA selector switches and seal leak and high motor temperature indication shall be provided for each pump. The panel will have an audible and visible high water alarm. Intrinsically safe relays required for the level regulators. Dry contact for remote monitoring of high

water and pump monitoring relay alarm conditions. Elapsed time meter for each pump and a 15 Amp convenience receptacle. Provision shall be provided in the control panel to run the pump using portable generator in case of power failure.

Y Contractor shall be responsible for installing the panel in a manner that maintains the EEMAC 4X (IP43) rating. Locate all switches and junction boxes outside of the wet well to avoid corrosion or flood damage. The wet well shall be considered a Class I, Division II environment and the installation shall meet all applicable codes.

Z Provide pump power and level regulator cables in sufficient length to the control panel via an external conduit. Provide conduit fittings and strain relief connectors in sufficient number and size to permit installation of the conduit to the pumping station. All external conduits to enter the control panel enclosure only through the bottom. Seal conduits with a permanently flexible sealant, preventing entry of liquid, vapor or gas from the wet well. Locate seal to enable motor removal complete with electrical disconnect without disturbing the seal. Code all wiring in the pump station either by colour or by a numbering system.

AA Provide four liquid level regulators to control the operation of the pumps in accordance with variations of sewage levels in the pump chamber:

High Level Alarm

2nd Pump Start

1st Pump Start

Both Pumps off

PART 3 WORKMANSHIP

3.01 Handle and install equipment in strict accordance with manufacturer's written instructions. Ensure such instructions are submitted along with shop drawings and are available on site when required.

3.02 Take all necessary field dimensions to ensure accurate and proper fitting of the work and equipment supplied.

3.03 Provide openings as required to accommodate shafts, stems, beams, conduit and the like passing through the structure, at no additional cost to the Contract.

3.04 Provide temporary supports, hoists, and bracing to prevent overloading of the structure while equipment is being installed. Confirm weights of equipment with the manufacturer.

3.05 Provide correct type and full number, size and length of anchor bolts and other connecting bolts as required by equipment manufacturer. Preset anchor bolts in concrete where convenient; otherwise leave suitable openings in concrete and set anchor bolts later using Red-Head Epoxy anchors or other approved fastening methods.

3.06 Coordinate location and provide items for embedding into cast-in-place concrete.

3.07 Provide small connecting pipe work, fittings and valves whether shown on the Drawings or not but required for proper functioning and servicing of the equipment. All such work shall be done in

accordance with the manufacturer's instructions at no additional cost to the Contract. Where pipe is to be connected to equipment, the fitting of the piping shall be done in a manner such that neither pipe equipment is strained during the joining procedure.

- 3.08 Prior to starting the pumps, remove the plug or cap from the force main in the manhole. After pumps and piping have been installed, test pumps with the material they are to pump, or with water. Operate and pump for a duration of time sufficient to satisfy that the complete installation has been properly done and aligned and that the pumps run free from heating, rubbing or vibration and meet the requirements of these Specifications, and that the pumps and piping are free and clear of debris and obstructions.
- 3.09 Demonstrate that each pump can be easily removed from the lift station without obstruction or removal of any station equipment. Make any adjustments necessary to carry out pump removal in this manner.
- 3.010 Demonstrate the operation of all valves and make any adjustments necessary to permit the valves to be operated smoothly without obstruction and allow the pumps to be removed with the valves in an open or closed position. Check level regulators for correct operation.
- 3.011 The guarantee period shall not be affected by temporary trial use of the equipment.
- 3.012 Clean and renew equipment and systems used before acceptance. Restore to original or new working condition. Protect equipment and systems openings from dirt, dust and other foreign materials during temporary usage.
- 3.013 Provide the services of competent servicemen, Testing and mechanics or other trained personnel of the Start-up equipment supplier's or manufacturer's to check the complete installation and be present for start-up of the equipment. A written report signed and approved by the equipment manufacturer's representative shall be submitted to the Engineer.
- 3.014 Test pumps proper operation at rated power supply values and for electrical and mechanical integrity prior to shipment. Pump Start-up supplier to have adequate test facilities to at least provide a single-point performance test or a complete performance curve at an accuracy of $\pm 1\%$. Submit certified test curve prior to shipment.
- 3.015 Pump/motor assembly to be CE approved as one, integral unit, as per standard for LIQUID PUMPS. Proof of this approval to be submitted by the pump manufacturer together with the approval drawings. An approval of the motor unit only shall not be acceptable. Cable to be CE approved, SOW type, neoprene-jacketed, with a 90°C rating. The supplier shall grant the right of inspection of the pumping station to any authorized representative of the purchaser before shipment from factory. If inspection is requested give 48 hours notice in advance of the time when the equipment will be ready for inspection at the factory.
- 3.016 The lift station and control panel shall be located inside a fenced area with a minimum size of 5m x 5m. The control panel shall be installed below a shade as shown in drawings.

END OF SECTION

SECTION 11200

WATER SUPPLY AND TREATMENT EQUIPMENTS

PART1 GENERAL

1.01 WORK INCLUDED

A. Supply and installation of Reverse Osmosis Plant including all civil, electrical and mechanical works with associated piping as manufactured by from sources approved to Engineer.

1.02 RELATED WORK(S)

- A. Section 02510 - Water Distribution
- B. Section 02520 - Wells
- C. Section 16000 - Electrical Works
- D. Section 15400 - Plumbing Systems

1.03 REFERENCE STANDARDS

- A. NEMA 250.....Enclosures for Electrical Equipment (1000 volts maximum)
- B. SS-C-744a.....US Federal Specifications - Sampling, Inspection and Testing of Pressure Sand Filters and Filter Media (Also ASME Manual of Engineering Practice No. 13)

1.04 QUALITY ASSURANCE

- A. Equipment supplied shall have local agents certified by the manufacturer to check, test, adjust and commission the equipment.
- B. Reverse Osmosis plant shall be assembled and tested at the manufacturers' or licensee's own premises. Furnish copy of manufacturing license along with material submittal, where appropriate.
- C. Requirements and recommendations of the following organisations shall be conformed to as appropriate:
 - 1. National Sanitation Federation (NSF)
 - 2. American Society of Mechanical Engineers (ASME)
 - 3. International Electrotechnical Commission (IEC)
- D. Equipment shall have labels attached permanently, indicating:
 - 1. Name of Manufacturer
 - 2. Model / Serial numbers
 - 3. Certified Ratings
 - 4. Maximum Operating Parameters

1.05 SUBMITTALS

- A. Product datamust include, pre treatment, micro filtration, feed pump stations, dosing stations, R.O station, all necessary controls, P & ID diagrams, disinfection equipment, selection and sizing criterion, and details of all required spares, data on equipment dimensions, service connections, operating weight and installation drawings and instructions to be submitted under provisions of the General Conditions of Contract.

- B. Manufacturer's / independent laboratory's test certificates confirming that the equipment construction and performance meet or exceed the specified requirements shall be submitted, as required.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Products shall be delivered to site, stored and protected under provisions of the General Conditions of Contract.
- B. Weatherproof covering shall be retained on equipment until commissioning.

PART 2 PRODUCTS

2.01 REVERSE OSMOSIS DESALINATION PLANT

The RO PLANT consisting of 2 units with the capacity of 60m³/day in each shall be fully assembled with all the necessary equipment and all the civil and mechanical works related to the same to ensure a fully functioning Plant. The following shall be the minimum included in each plant, but not limited to;

A. Ultra-Filtration (UF) System Skid Mounted

- ❖ 1 no of Bag Type Pre-Filter, 100 micron washable type, Filter Housing Stainless Steel 316.
- ❖ 1 no of Ultra-Filtration (UF) Feed Pump with 7.0 cu.m/hr and necessary fitting and instruments.
- ❖ 1 lot of Ultra-Filtration membrane complete with pressure vessel c/w necessary air scouring and back flushing devices.
- ❖ 1 no of back Flushing Pump with 14.0 cu.m/hr and necessary fitting and instruments.
- ❖ 1 no of Ultra-Filtration (UF) Permeate Tank, Polypropylene Material, 2.0 cu.m capacity.

B. Reverse Osmosis (RO) System Skid Mounted.

- ❖ 2 units of RO Feed Pump with 7.0 cu.m/hr and necessary fitting and control instruments
- ❖ 1 lot of 5 micron guard filter (cartridge) with HDPE housing and necessary fitting and instruments
- ❖ 1 lot of Reverse Osmosis Membrane c/w Fiber Glass Reinforcement Plastic Pressure Vessel
- ❖ 1 unit of High Pressure Pump with 7.0 cu.m/hr c/w Turbine Energy Recovery System and necessary fitting and instruments

C. RO Cleaning-In-Place (CIP)

- ❖ Provide 1 set of CIF c/w Chemical Tank, pump, filter and necessary fitting and instruments

D. Anti-Scalant Dosing System

- ❖ Provide 1 set of Anti-Scalant System c/w Chemical Tank, Dosing Pump, Fitting and control instruments

E. Chlorination System

- ❖ Provide 1 unit of Electrolytic Chlorine System with capacity 250 g/day Salt required 3 – 3.5kg to produce per kg of Chlorine

F. Piping Work

- ❖ 1 lot and pressure tested suitable for sea water

G. Steel Structure

- ❖ Provide Stainless Steel 316 of Steel Structure to host the above Equipments and facilities.

H. Control Panel

- ❖ Provide PLC with 14 inches of touch panel
- ❖ Provide free standing Stainless Steel control panel casing suitable for out door type

I. Testing & Commissioning

- ❖ Provide Testing and Commissioning at site for 1 week duration.

2.02 SYSTEM DESCRIPTION

ULTRA-FILTRATION AS REVERSE OSMOSIS PRE-FILTER SYSTEM

- 1 The UF Feed Pump will draw the sea water from Row water Storage Tank and feed to Skid Mounted Ultra-Filtration Unit (UF).
- 2 Sea water of Total Dissolve Solid < 38,000ppm is passed through the bag filter (100 micron) as the first line of protection to remove all large and abrasive debris.
- 3 The permeate is then passed through the Ultra-Filtration (UF) unit operating in a dead-end mode and stored in the *UF Back Flush Tank* and *UF Permeate Tank*. The unit comprises of a number of Ultra-Filtration membrane with preset timer for automatic back flushing. The water for the back flushing is drawn from the UF Back Flush Tank. The UF membrane has pore size of less than **0.1 micron** and is capable of producing permeate with high degree of cleanliness – suitable as Reverse Osmosis (RO) feed water. Thus, the RO unit will be able to maintain high flux and quality of permeate water with minimum maintenance and worries on the clogging or fouling.

REVERSE OSMOSIS (RO) SYSTEM FOR SEA WATER DESALINATION PROCESS is performed according to the following steps

- 1 The RO process operates in a cross flow mode with 40% recovery where high pressures

pump drawn the water from UF Permeate Tank and feeding toward RO unit. The UF permeate is first passed through a guard filter follow by treating with anti-scalant and neutralization with Sodium Meta-Bisulphate. The guard filter is just another precaution to protect the RO unit in the event of any contamination from the UF Permeate Tank.

- 2 The RO Permeate with Total Dissolve Solid < 500ppm is then channelled to the RO Permeate Tank. The Reject water with Total Dissolve Solid > 60,000ppm is diverted to the EnergyRecovery / Pressure Exchange Unit to recover most of the waste energy prior to discharge back to sea.

1. Foot Print and Weight.

UF / RO Skid
 Dimension : 5 m X 1.6 m X 2 m Ht
 Weight : ~ 1250 kg.

2. UF Permeate Tank

Material : GRP
 Volume : ~ 10 m3.

3. Power Consumption

Power Consumption : ~ 5.5 kWh/m3 of RO Permeate

2.03 DESIGN DATA

REVERSE OSMOSIS DESALINATION PLANT DESIGN SPECS - WATER ANALYSIS

	Feed Water to RO Plant (Seawater)	Product from RO Plant (Freshwater)
Ca	448	0.6
Mg	1330	1.78
Na	11400	89.15
K	383	3.88
NH	4 0.00	0
Sr	0.1	0
Ba	5.8	0.01
Fe	0	0
Mn	0	0
CO3	0.5	0
HCO3	132	1.88
SO4	2940	3.5
Cl	20600	143.6
NO3	0	0
Fe	0	0
SiO2	1	1.01
CO2	2.66	2.63
Sum of Ions	37240.4	244.41
TDS (180 C)	37173.23	243.45
pH	7.5	6.5
Hardness (as CaCO3)	6595.82	8.83

Control system:

Control panel with plant protection system , PLC (programmable logiccontroller), Touch screen ,motor soft-starters etc.

Spare parts, laboratory equipment and consumables for one year operation:

Spare parts for two years operation and laboratory equipments

Consumables for two years operation

PART 3 WORKMANSHIP

3.01 COORDINATION

- A. The selection, installation and operation of the RO unit shall be in close coordination with the construction of wells, deep well pumps and the piping network.
- B. Hooks, rails or other provisions shall be provided to allow for hoisting or movement of equipment in technical areas.
- C. Data on the required power supplies shall be furnished to the electrical trade.

3.02 SELECTION

- A. Pumps shall be selected with the operating points within 20 % on either side of the maximum efficiency point.
- B. Maximum and minimum impeller sizes shall not be selected for unit pumps, as far as possible.

3.03 INSTALLATION

- A. Clearances shall be provided around equipment for operation, maintenance and ventilation.
- B. Manufacturer's installation instructions shall be complied with in all respects.
- C. Lifting devices shall be attached to equipment only at designated points. The equipment shall not be dropped or subjected to any kind of shock.
- D. Services of manufacturer's specialist representative shall be provided for commissioning of equipment.

3.04 GUARANTEES AND WARRANTIES

- A. The Contractor/ Supplier shall be responsible to furnish guarantee and warranty certificates of a period of 5 years, dully registered with the manufacturer for proper functioning of the SRO plant at no additional cost to the Employer or Client.

END OF SECTION

SECTION 16010

ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 General

- A This Section covers items common to Sections of Division 16. This section supplements requirements of Division 1.

1.02 Codes and Standards

- A Do complete installation in accordance with British Standard IEE BS7671 Latest Edition and in accordance with all local standards, except where specified otherwise.

1.03 Scope of Work

- A The work to be done under this contract consists of furnishing all materials, tools, equipment and labour, and performing the electrical services as indicated and as specified.
- B The work generally includes, but is not necessarily limited to the following:
 - 1) Supply and installation of new three-phase (as indicated on the drawings) power services to each of the new pumping stations, treatment facility and RO plant.
 - 2) Contractor shall determine the appropriate points to connect new power services to the existing Island power grids for each pumping station, treatment facility and the RO plant. Contractor shall supply and install all cables, conduit and trenching necessary to make the connection to the Island power grids, including one spare conduit. Contractor shall verify that there is adequate capacity for each of the new loads before any connections are made. Contractor shall provide and install any over-current or overload protection required to complete connections to existing power grid. Contractor shall size protection and conductors based on existing conditions of the power grid and take into consideration all voltage drops.
 - 3) Supply new diesel stand-by generators, including trailers for portable generators and sound-proof enclosures.
 - 4) Supply and installation of completely assembled duplex pump controllers, complete with the following:
 - a) IP68 rated enclosure, double door arrangement with locking outer door.
 - b) Auto transfer switch/Manual transfer switch.
 - c) Service entrance rated main circuit breaker.
 - d) Four-pin weather-proof generator socket with screw cap and provision for pad locking for connection to a portable generator.
 - e) Microprocessor controls.
 - f) Pump motor starters, complete with overload, over temperature and seal fail protection.
 - g) 15 Amp, residual current device protected, type G, convenience socket.
 - h) Elapsed time meter for each pump.
 - i) Electric heater.
 - j) Pump run lights, HAND-OFF-AUTO selector switches and speed potentiometers for each pump.
 - k) Dry contact for remote monitoring of high water and pump monitoring relay alarm conditions.
 - l) Silence able, audible and visible high water alarm.
 - m) All power and instrument wiring.
 - 5) Supply and install mounting structure for the control panel.
 - 6) Supply and installation of four (4) float switches for each pumping station.

- 7) Conduct all tests required to place each pumping station into proper working order.
 - 8) Provide training for two (2) people for a minimum of two (2) days (not including start-up/commissioning time) for each Island.
- 1.04 Care, Operation and Star up
 - A. Instruct Engineer and operating personnel in the operation, care and maintenance of systems, system equipment and components.
 - B. Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, and Start-up adjust, balance and calibrate components and instruct operating personnel.
 - C. Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.
 - 1.05 Voltage Ratings
 - A. Operating voltages:
 - 1) 380-415 volts, 3-phase, 4-wire, 50 cycles.
 - 2) 230 volts, single-phase, 3-wire, 50 cycles.
 - B. Motors, control and distribution devices and equipment to operate satisfactorily at 50 Hz within normal operating limits.
 - 1.06 Permits, Fees
 - A. Submit to Electrical Inspection Department and Inspection and Supply Authority, where appropriate, necessary number of drawings and specifications for examination and approval prior to commencement of work.
 - B. Pay associated fees.
 - C. Contractor to provide drawings and specifications required by Electrical Inspection Department and Supply Authority, where appropriate, at no cost.
 - D. Notify Engineer of changes required by Electrical Inspection Department prior to making changes.
 - E. Furnish Certificates of Acceptance from authorities having jurisdiction on completion of work to Engineer.
 - 1.07 Materials and Equipments
 - A. Provide materials and equipment in accordance with the General Conditions of the Contract.
 - B. Equipment and material to be certified.
 - C. Factory assembles control panels and component assemblies.
 - 1.08 Electric Motors, Equipment
 - A. Supplier and installer responsibility is indicated in the General Conditions of the Contract and General Requirement.
 - 1.09 Finishes
 - A. Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - B. Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
 - C. Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
 - 1.10 Equipment Identification
 - A. Identify electrical equipment with nameplates and labels, as approved by Engineer in English and Dhivehi language:

- 1.11 Wiring
- A. Identify wiring with permanent indelible Identification identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
 - B. Maintain phase sequence and colour coding throughout.
 - C. Colour code: to British Standard.
 - D. Use colour coded wires in communication cables, matched throughout system.
- 1.12 Conduit and Cables Identification
- A. Colour code conduits, boxes and metallic sheathed cables.
 - B. Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- 1.13 Wiring Termination
- A. Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminium conductors.
- 1.14 Warning Signs
- A. As specified and to meet requirements of Electrical Inspection Department and Engineer.
- 1.15 Load Balance
- A. Measure phase current to control panels with normal loads (lighting and power) operating at time of acceptance.
 - B. Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - C. Submit, at completion of work, report listing phase and neutral currents on control panels, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.
- 1.16 Conduit and Cable Installation
- A. If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
 - B. Installed cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- 1.17 Field Quality
- A. All electrical work to be carried out by Control qualified, licensed electricians.
 - B. The work of this division to be carried out by a contractor who holds a valid Electrical Contractor license.
 - C. Conduct and pay for following tests:
 - 1) Power generation and distribution system including phasing, voltage, grounding and load balancing.
 - 2) Circuits originating from branch distribution panels.
 - D. Furnish manufacturer's certificate or letter Control confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
 - E. Insulation resistance testing.
 - 1) Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - 2) Megger 350-600 V circuits, feeders and equipment with a 750 V instrument.
 - 3) Check resistance to ground before energizing.
 - F. Carry out tests in presence of Engineer/Employer's representative.
 - G. Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
 - H. Submit test results for Engineer's review.
- 1.18 Co-ordination
- A. Ensure circuit protective devices such as of Protective over current trips, relays and fuses are Devices installed to required values and settings.

PART 2 - PRODUCTS

(Not applicable.)

PART 3 - WORKMANSHIP

3.1 Connection to each local Island Power Grid

- A. There are above-ground junction boxes on each Island to connect to the power grid. Contractor is to select appropriate connection point on site, based on the local conditions. Each pump station requires either a single-phase, 230 V power feed or a three-phase, 380-415V power feed. See drawings for each pumping station's requirements.
- B. Contractor is to verify that the power grid has adequate capacity for the additional loads.
- C. Contractor is to supply and install all trenching, conductors and conduit to connect the pump control panel to the power grid.
- D. Contractor is to supply and install fuses and/or fused switches as necessary to make the power connections.
- E. Contractor to verify the size of all fuses and cables. Sizes are to be based on British and local codes for protection sizing, taking into consideration voltage drops that will occur over the length of the cable and short circuit current. The minimum protection sizes shall be:
 - 1) For three-phase, 380-415V power feeds to pre-packaged, below grade pumping stations:
 - a) Minimum fuse size = 15A
 - b) Minimum cable size = 4 mm²
 - 2) For three-phase, 380-415V power feeds above ground treatment facility:
 - a) Minimum fuse size = 30A
 - b) Minimum cable size = 6 mm²

END OF SECTION

Section 16051

INSTALLATION OF CABLES IN TRENCH AND IN DUCTS

PART 1 - GENERAL

- 1.01 Related Sections
 - A. Excavating, Trenching and Backfilling: Section 02200
 - B. Electrical General Requirements: Section 16010

PART 2 - PRODUCTS

- 2.01 Trench
 - A. Trench is to be as shown on shop drawings. Two (2) 50 mm diameter rigid PVC conduits are to be installed in the trench, along with pressure treated or hardwood planks.
- 2.02 Markers
 - A. Concrete type cable markers: 600 x 600 x 100 mm with words: cable, joint or conduit impressed in top surface, with arrows to indicate change in direction of cable and duct runs.
 - B. Ribbon tape markers at 200 mm below finished grade for trenches. Markers to be red in colour.

PART 3 - WORKMANSHIP

- 3.01 Cable Installation in Ducts
 - A. Install cables as indicated in ducts.
 - B. Do not pull spliced cables inside ducts.
 - C. Install multiple cables in duct simultaneously.
 - D. Use British Standard approved lubricants of type compatible with cable jacket to reduce pulling tension.
 - E. To facilitate matching of colour coded Installation in multiconductor control cables reel off in same Ducts direction during installation.
 - F. Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.
 - G. After installation of cables, seal duct ends with duct sealing compound.
- 3.02 Markers
 - A. Mark cable every 150 m along cable duct runs and changes in direction.
 - B. Where markers are removed to permit installation of additional cables, reinstall existing markers.
- 3.03 Field Quality
 - A. Perform tests in accordance with Section 16010.
 - B. Perform tests using qualified personnel. Provide necessary instruments and equipment.
 - C. Check phase rotation and identify each phase conductor of each feeder.
 - D. Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 mega ohms.
 - E. Pre-acceptance tests.
 - 1) After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
 - 2) Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
 - F. Acceptance Tests Control

- 1) Ensure that terminations and accessory equipment are disconnected.
 - 2) Ground shields, ground wires, metallic armour and conductors not under test.
 - 3) High Potential (Hipot) Testing - Conduct hipot testing in accordance with manufacturer's recommendations.
- G. Provide Engineer with list of test results showing location at which each test was made, circuit tested and result of each test.
- H. Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF THE SECTION

Section 16060

GROUNDING

PART 1 - GENERAL

- 1.01 Related Sections
 - A. Electrical general Sections requirements: Section 16010

PART 2 - PRODUCTS

- 2.01 Equipment
 - A. Clamps for grounding of conductor: size as required.
 - B. Rod electrodes: copper clad steel 16 mm dia by 3 m long.
 - C. Grounding conductors: bare stranded copper, tinned, soft annealed size as indicated.
 - D. Insulated grounding conductors: green, PVC, 6 mm² minimum size to equipment if not indicated.
 - E. Ground bus: copper, size as required, complete with insulated supports, fastenings, connectors.
 - F. Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - 1) Grounding and bonding bushings.
 - 2) Protective type clamps.
 - 3) Bolted type conductor connectors.
 - 4) Thermit welded type conductor connectors.
 - 5) Bonding jumpers, straps.
 - 6) Pressure wire connectors.

PART 3 - WORKMANSHIP

- 3.01 Grounding
 - A. Install continuous grounding system Installation including, electrodes, conductors, connectors and accessories in accordance with requirements of local authority having jurisdiction.
 - B. Install connectors in accordance with manufacturer's instructions.
 - C. Protect exposed grounding conductors from mechanical injury.
 - D. Make buried connections, and connections to electrodes, structural steel work, using copper welding by Thermit process or permanent mechanical connectors.
 - E. Use mechanical connectors for grounding connections to equipment provided with lugs.
 - F. Use tinned copper conductors for aluminium structures.
 - G. Soldered joints are not permitted.
 - H. Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
 - I. Install flexible ground straps for bus joints, where such bonding is not inherently provided with equipment.
- 3.02 Electrode
 - A. Install ground rod plate electrodes. Make Installation grounding connections to station equipment.
 - B. Make special provision for installing electrodes that will give acceptable resistance to ground value, where rock or sand terrain prevails.
 - C. Use minimum 6 mm² copper conductors for Installation connections to electrodes.
- 3.03 Equipment Grounding

- A. Install grounding connections to equipment including non-current carrying parts of: generators, motors, distribution panels, raceways, pipe work, screen guards, switchboards. Any exposed building metal, within or forming part of building, starters, and terminal boxes.
- 3.04 System and Circuit Grounding
 - A. Install system and circuit grounding connections to neutral of 230V and 380-415V systems and low voltage systems.
- 3.05 Grounding Bus
 - A. Install copper grounding bus, sized as required, mounted on insulated supports.
 - B. Ground items of electrical equipment to ground bus with individual bare stranded copper connections.
- 3.06 Field Quality
 - A. Perform tests in accordance with Section 16010.
 - B. Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Engineer.
 - C. Perform tests before energizing electrical system.

END OF SECTION

Section 16071

FITTINGS AND SUPPORTS

PART 1 - GENERAL

- 1.01 Related Work
 - A. Fastenings and supports: Basic Product Requirements.

PART 2 - PRODUCTS

- 2.01 Support Channels
 - A. Use channels and supports provided wherever possible
 - B. U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted, suspended, or set in poured concrete walls and ceilings.

PART 3 - WORKMANSHIP

- 3.01 Installation
 - A. Use the support equipment provided with the pumping station wherever possible.
 - B. Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
 - C. Fasten exposed conduit or cables to building construction or support system using straps.
 - 1) One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - 2) Two-hole steel straps for conduits and cables larger than 50 mm.
 - 3) Beam clamps to secure conduit to exposed steel work.
 - D. Suspended support systems.
 - 1) Support individual cable or conduit runs with 6 mm dia. threaded rods and spring clips.
 - 2) Support 2 or more cables or conduits on channels supported by 6 mm dia. threaded rod hangers where direct fastening to building construction is impractical.
 - E. For surface mounting of two or more conduits use channels at spacing as required by conduit diameter.
 - F. Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
 - G. Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
 - H. Do not use wire lashing or perforated strap to support or secure raceways or cables.
 - I. Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Engineer.
 - J. Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Section 16122

WIRES AND CABLES (0 - 1000 V)

PART 1 – GENERAL

- 1.01 Related Work
 - A. Wire and Box Connectors - 0 - 1000 V.
- 1.02 References
 - A. BS7671: 1992, Requirements for Electrical Installations. IEE Wiring Regulations. Sixteenth edition or Latest Edition.
 - B. BS6500: 1994, Electric Cables. Flexible Cords Rated up to 300/500 V, for Use with Appliances and Equipment Intended for Domestic, Office and Similar Environments.
- 1.03 Product Data
 - A. Submit product data in accordance with the General Conditions of the Contract.

PART 2 - PRODUCTS

- 2.01 Power Wires
 - A. Conductors: stranded for Class 2 copper to BS6360.
 - B. The minimum size of the conductors feeding:
 - 1) Three-phase, pre-packaged, below grade pumping stations: 4 mm²
 - 2) Single-phase, pre-packaged, below grade pumping stations: 6 mm²
 - 3) Three-phase, above ground, treatment facility, 6mm²:
 - C. Copper conductors:
 - 1) Conductors in conduit: size as required, with 1000 V insulation of chemically cross-linked thermosetting polyethylene (XLPE) material type GPB to BS7655 with type 9 PVC sheath; flame retardant to BS4066 part 1 and of 90°C maximum operating temperature.
 - 2) Direct buried armoured cables:
 - i) 1000 V insulation.
 - ii) Multi-conductor cabling with individual conductors insulated with chemically cross-linked thermosetting polyethylene (XLPE).
 - iii) Interlocked aluminium armour.
 - iv) Polyvinyl Chloride (PVC) jacket between conductors and armour.
 - v) Outer polyvinyl Chloride (PVC) jacket.
 - vi) Flame retardant to BS4066 part 1 and of 90°C maximum operating temperature.
 - 3) Voltage rating 600/1000 volts in accordance with BS7889.
- 2.02 Control and Instrumentation Cables
 - A. Multipair PE insulated with the following characteristics and ratings:
 - 1) In accordance with BS5308 Part 1, Type 1.
 - 2) Conductors: Solid (Class 1), stranded (Class 2) or flexible (Class 5) copper conductors to BS6360 to fit specific application.
 - 3) Insulation: Polyethylene insulation Type 03 to BS6234.
 - 4) Pair Identification: See colour coded.
 - 5) 100 m max pair lay length (min. 10 twists per metre).
 - 6) Binder tape: p.e.t.p. tape 50% overlap.
 - 7) Outer Sheath: PVC outer sheath Type TM.1 to BS7655. In addition, outer sheath displays following characteristics: Min. oxygen index: 30% Max. HCL Emission @ 800°C: 15%
 - 8) Flame retardant to BS4066/IEC60332 Part 3 Category C (NMV1.5).

- 9) Voltage Rating: 300/500V.
- 10) Temp Rating: 65°C max conductor operating temperature.

PART 3 - WORKMANSHIP

3.01 Installation of Power Cables

- A. Contractor shall verify all power cable diameters on site. Cable diameters are to comply with all local and British codes. Contractor shall take into account the existing overload protection used in the Island's power grid, as well as any voltage drops in the conductor runs and size the cables appropriately.

3.02 Installation of Control Cables

- A. Install control cables in conduit.
- B. Ground control cable shield.

END OF SECTION

Section 16131

SPLITTERS, JUNCTION, PULL BOXES AND CABINETS

PART 1 – GENERAL

- 1.01 Shop Drawings
 - A. Submit shop drawings and product data for and Product Data cabinets in accordance with Section 01015.

PART 2 - PRODUCTS

- 2.01 Junction and Pull Boxes
 - A. Welded steel construction with hinged covers for surface mounting on interior of pumping stations and treatment facility
 - B. Welded stainless steel weather-proof construction with hinged covers for surface mounting outdoor installations.
 - C. Explosion-proof junction boxes for all areas classified as a hazardous location.

PART 3 - WORKMANSHIP

- 3.01 Junction and Pull Box Installation
 - A. Install junction and pull boxes in inconspicuous but accessible locations.
- 3.02 Identification
 - A. Provide equipment identification in accordance with Section 16010.
 - B. Install size 2 identification labels indicating voltage and phase.

END OF SECTION

Section 16132

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

PART 1 - GENERAL

1.01 Waste Material Disposal

- A. Collect and remove all plastic, paper packaging and corrugated cardboard from packages, etc., from the site after the completion of the project and disposal of in appropriate manner.

PART 2 - PRODUCTS

2.01 Outlet and Conduit Boxes –General

- A. Size boxes in accordance with BS4662 and BS7671 1992 Standards.
- B. Gang boxes where wiring devices are grouped.
- C. Blank cover plates for boxes without wiring devices.

2.02 Fittings - General

- A. Bushing and connectors with nylon insulated throats.
- B. Knock-out fillers to prevent entry of debris.
- C. Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
- D. Double locknuts and insulated bushings on sheet metal boxes.

PART 3 - WORKMANSHIP

3.1 Installation

- A. Support boxes independently of connecting conduits.
- B. Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- C. For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- D. Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

END OF SECTION

Section 16133

CONDUITS, CONDUIT FASTENING AND CONDUIT FITTINGS

PART 1 – GENERAL

1.01 References

- A. Conduit and conduit fittings shall comply with the appropriate British Standard referred to below:
 - 1) Steel conduit and fittings - BS31, BS6053, BS6099 Part 1.
 - 2) Liquid tight PVC covered flexible steel conduit - BS731 Part 1, BS6053, BS6099 Part 1.
 - 3) Steel conduit fittings with metric threads - BS4568, BS6053, BS6099 Part 1.
 - 4) High impact (PVC) non-metallic (rigid and flexible) conduits and fittings - BS4607, BS6053, BS6099 Part 2, Section 2.2.

PART 2 - PRODUCTS

2.01 Conduits

- A. Rigid aluminium threaded conduit.
- B. Rigid Polyvinyl Chloride (PVC) conduit for underground services and conduits in cast-in-place concrete.
- C. Flexible metal conduit: liquid-tight flexible metal.

2.02 Conduit Fastenings

- A. One hole malleable galvanized iron steel straps to secure surface conduits 50 mm diameter and smaller. Two hole steel straps for conduits larger than 50 mm diameter.
- B. Beam clamps to secure conduits to exposed steel work.
- C. Channel type supports for two or more conduits at 1.40 m oc.
- D. Threaded rods, 6 mm dia., to support suspended channels.

2.03 Conduit Fittings

- A. Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- B. Factory "ells" where 90° bends are required for 25 mm diameter and larger conduits.
- C. Watertight connectors for liquid tight flexible conduit.

2.04 Expansion fitting for Rigid Conduit

- A. Weather-proof expansion fittings with internal bonding assembly suitable for 100 to 200 mm Conduit linear expansion.
- B. Weather-proof expansion fittings for linear expansion at entry to panel.

2.05 Fish Cord

- A. Polypropylene.

PART 3 – WORKMANSHIP

3.01 Installation

- A. Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- B. Use rigid aluminium threaded conduit where required by local codes.
- C. Use rigid PVC conduit underground and in poured concrete slabs.
- D. Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.

- E. Minimum conduit size for lighting and power circuits: 20 mm diameter.
- F. Bend metallic conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- G. Mechanically bend steel conduit over 20 mm dia.
- H. Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- I. Install fish cord in empty conduits.
- J. Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- K. Dry conduits out before installing wire.

3.02 Surface Conduits

- A. Run parallel or perpendicular to building lines.
- B. Run conduits in flanged portion of structural steel.
- C. Group conduits wherever possible on suspended or surface channels.
- D. Do not pass conduits through structural members except as indicated.
- E. Do not locate conduits less than 63 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.03 Concealed Conduits

- A. Run parallel or perpendicular to structure lines.

3.04 Conduits Underground

- A. Slope conduits to provide drainage.

3.05 Conduits in Cast-in-place. Concrete

- A. Run conduits 25 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.
- B. Locate to suit reinforcing steel. Install in centre one third of slab.
- C. Protect conduits from damage where they stub out of concrete.
- D. Install sleeves where conduits pass through slab or wall.
- E. Where conduits pass through waterproof membrane provide oversized sleeve before membrane is installed. Use cold mastic between sleeve and conduit.
- F. Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.
- G. Encase conduits completely in concrete with minimum 25 mm concrete cover.
- H. Organize conduits in slab to minimize cross-overs.

END OF SECTION

Section 16141

WIRING DEVICES

PART 1 - GENERAL

- 1.01 Shop Drawings and Product Data
 - A. Submit shop drawings and product data in accordance with Section 01015.
- 1.02 References IEC 60669.

PART 2 - PRODUCTS

- 2.01 Switches
 - A. 20 A, 230 V, specification grade single pole, two way, or three-way switches as indicated.
 - B. Manually-operate general purpose ac switches with following features:
 - 1) Terminal holes approved for 6 mm² wire.
 - 2) Silver alloy contacts.
 - 3) Urea or melamine molding for parts subject to carbon tracking.
 - 4) Suitable for back and side wiring.
 - 5) Ivory nylon, heavy duty toggle.
 - 6) Integral ground terminal.
 - C. Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
 - D. Switches of one manufacturer throughout project.
- 2.02 Receptacles.
 - A. Duplex socket, type G, 230 V, 15 A, U ground, with following features:
 - 1) Ivory urea molded housing.
 - 2) Suitable for 6 mm² for back and side wiring.
 - 3) Break-off links for use as split receptacles.
 - 4) Eight back wired entrances, four side wiring screws.
 - 5) Residual current device protected.
 - 6) Triple wipe contacts and riveted grounding contacts.
 - 7) Ivory nylon face.
 - B. Other receptacles with ampacity and voltage as indicated.
 - C. Receptacles of one manufacturer throughout project.
- 2.03 Cover Plates.
 - A. Cover plates for wiring devices.
 - B. Cover plates from one manufacturer throughout project.
 - C. Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
 - D. Ivory, nylon coverplates for all floor areas, for wiring devices mounted in flush-mounted outlet box.
 - E. Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
 - F. Single and multigang plates to match devices.

PART 3 – WORKMANSHIP

- 3.01 Installation
 - A. Switches:
 - 1) Install devices as indicated.
 - 2) Ensure equipment is secure, plumb and true.
 - 3) Make all connections including grounding and bonding.

- 4) Install single throw switches with handle in "UP" position when switch closed.
 - 5) Install switches in gang type outlet box when more than one switch is required in one location.
 - 6) Mount toggle switches at height specified in Section 16010 – Electrical General Requirements or as indicated.
- B. Receptacles:
- 1) Install devices as indicated.
 - 2) Ensure equipment is secure, plumb and true.
 - 3) Make all connections including grounding and bonding.
 - 4) Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - 5) Where split receptacle has one portion switched, mount vertically and switch upper portion.
 - 6) Mount receptacles with "U" ground up for vertically mounted and neutral slot at top for horizontally mounted receptacle.
 - 7) Install surface mounted receptacles in unfinished areas.
- C. Cover plates:
- 1) Protect cover plate finish with paper or plastic film until painting and other work is finished.
 - 2) Install suitable common cover plates where wiring devices are grouped.
 - 3) Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

END OF SECTION

Section 16151

WIRE AND BOX COLLECTION 0 - 1000V

PART 1 - GENERAL

Not applicable.

PART 2 - PRODUCTS

2.01 Materials.

- A. Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as required.
- B. Fixture type splicing connectors: with current carrying parts of copper sized to fit copper conductors 6 mm² or less.

PART 3 - WORKMANSHIP

3.01 Installation

- A. Remove insulation carefully from ends of conductors and:
 - 1) Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer.
 - 2) Install fixture type connectors and tighten. Replace insulating cap.

END OF SECTION

Section 16238

POWER GENERATION DIESEL SYSTEMS

PART 1 - GENERAL

1.01 Related Work

- A. Electrical General Requirements: Section 16010:

1.02 References.

- A. This specification includes applicable considerations of:
- 1) American Society of Mechanical Engineers (ASME)
 - 2) Association of British Generating Set Manufacturers (ABGSM)
 - 3) British Standards Institution (BS)
 - 4) EEC 89/392 Safety and Health
 - 5) Electrical Generating Systems Association (EGSA)
 - 6) Deutsches Institut fuer Normung (DIN)
 - 7) Institute of Electrical and Electronics Engineers (IEEE)
 - 8) International Electrotechnical Commission (IEC)
 - 9) Ingress Protection (IP)
 - 10) International Standards Organization (ISO) 9000
 - 11) National Electric Manufacturers Association (NEMA)
 - 12) National Fire Protection Association (NFPA)
 - 13) Occupational Safety and Health Act (OSHA)
 - 14) Diesel Engine Manufacturers' Association (DEMA).
 - 15) ISO 3046/1-1981, Specification for Reciprocating Internal Combustion Engines: Performance.

1.03 Description of System

- A. The work to be done under this Section consists of furnishing all materials, labor, tools, and equipment and performing all operations necessary to provide a generator set, complete with weather protective, super sound attenuated enclosure for each pumping station. Generator sets for single-phase, 230V, and three-phase, 280-425V, pre-packaged, System below grade pumping stations shall be complete with trailer and cable to connect to 4-pin socket on control panel. Generator sets for three-phase, 380-415V above ground treatment facility shall be stationary and permanently connected to the control panel it feeds. The work includes: manufacture, testing, guarantee, delivery and supervision of commissioning for packaged diesel generator sets complete with all accessories as specified herein. The sets shall be of proven standard design with a record of satisfactory performance; prototypes will not be accepted. Where any provision of this specification causes a deviation from the Manufacturer's normal practice such as to materially impair performance, price or delivery of the equipment, the Manufacturer shall call attention to this in his quotation and shall offer his normal standard equipment as an alternative.
- B. Each generating system to consist of:
- 1) Diesel engine.
 - 2) Alternator.
 - 3) Alternator control panel.
 - 4) Battery charger and battery.
 - 5) Fuel supply system.
 - 6) Exhaust system.
 - 7) Steel mounting base.
 - 8) Enclosure.

- C. Systems to be designed to operate as emergency standby, unattended in remote location.

1.04 Shop Drawings.

- A. Submit shop drawings in accordance with Section 01015.
- B. Include for each system:
 - 1) Engine: make and model, with performance curves.
 - 2) Alternator: make and model.
 - 3) Voltage regulator: make, model and type.
 - 4) Battery: make, type and capacity.
 - 5) Battery charger: Make type and model.
 - 6) Alternator control panel: make and type of meters and controls.
 - 7) Governor type and model.
 - 8) Cooling air requirements in m³/s.
 - 9) British standard or DIN rating of engine.
 - 10) Flow diagrams for:
 - i) Diesel fuel.
 - ii) Cooling air.
 - 11) Dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators; exhaust system, drip trays, and total weight.
 - 12) Continuous full load output of set at 0.8 PF lagging.
 - 13) Description of set operation including:
 - i) Manual starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency.
 - ii) Manual starting.
 - iii) Automatic shut down and alarm on:
 - a) Overcranking.
 - b) Overspeed.
 - c) High engine temp.
 - d) Low lube oil pressure.
 - e) Short circuit.
 - f) Alternator overvoltage.
 - g) Lube oil high temperature.
 - h) Over temperature on alternator.
 - i) Low coolant flow.
 - iv) Manual remote emergency stop.
 - 14) Enclosure type.

1.05 Operation and Maintenance Data

- A. Provide operation and maintenance data for diesel generators in accordance with Section 01015.
- B. Include Operation and Maintenance Manual instructions for the particular unit supplied and not general descriptions of units manufactured by supplier and:
 - 1) Operation and maintenance instructions for engine, alternator, control panel, battery charger, battery, fuel system, exhaust system and accessories, to permit effective operation, maintenance and repair of each unit.
 - 2) Technical data:
 - i) Illustrated parts lists with parts catalogue numbers.
 - ii) Schematic diagram of electrical controls.
 - iii) Flow diagrams for:
 - a) Fuel system.
 - b) Lubricating oil.
 - c) Cooling system.
 - d) Certified copy of factory test results.

- e) Maintenance and overhaul instructions and schedules.
- f) Precise details for adjustment and setting of time delay relays or sensing controls which require on site adjustment.

1.06 Maintenance Materials

A. Include for each unit:

- 1) 2 fuel filter replacement elements.
- 2) 2 lube oil filter replacement elements.
- 3) 2 air cleaner filter elements.
- 4) 2 sets of fuses for control panel.
- 5) Special tools for unit servicing.
- 6) Enclosure c/w hinged cover to house maintenance materials.

1.07 Warranty

- A. Diesel engine generator sets shall be warranty covered for 60 months or 1500 operating hours, whichever occurs first from the date of the Certificate of Taking Over.

PART 2 – PRODUCTS

2.01 Diesel Engines

A. Diesel engines: to ISO 3046/1.

- 1) Engines: standard product of current manufacture, from company regularly engaged in production of such equipment.

B. Engine details:

- 1) For three-phase, 380-415V powered, portable generator for Lifting Stations:
 - i) Turbo charged synchronous speed 1500 rpm, 380-415V, three-phase.
 - ii) 33 kVA at 0.8 power factor rated continuous power at rated speed, after adjustments for system losses in auxiliary equipment necessary for engine operation, or size the loads as actual requirement
 - iii) Rated continuous output generator kW x generator efficiency at full load.
 - a) Under the following site conditions:
 - a1) Altitude: 15 m
 - a2) Ambient temperature: 50°C
 - a3) Relative humidity: 98%
- 2) For three-phase, 380-415V powered, for the Sewerage Treatment Plant:
 - i) Turbo charged synchronous speed 1500 rpm, 380-415V and three-phase.
 - ii) 55kVA at 0.8 power factor rated continuous power at rated speed, after adjustments for system losses in auxiliary equipment necessary for engine operation, or size the loads as actual requirement
 - iii) Rated continuous output generator kW x generator efficiency at full load.
 - a) Under the following site conditions:
 - a1) Altitude: 15 m
 - a2) Ambient temperature: 50°C
 - a3) Relative humidity: 98%
- 3) For three-phase, 380-415V powered, above ground RO plant facility:
 - i) Turbo charged synchronous speed 1500 rpm, 380-415V and three-phase.
 - ii) 150 kVA at 0.8 power factor rated continuous power at rated speed, after adjustments for system losses in auxiliary equipment necessary for engine operation, or size the loads as actual requirement
 - iii) Rated continuous output generator kW x generator efficiency at full load.
 - a) Under the following site conditions:
 - a1) Altitude: 15 m

- a2) Ambient temperature: 50°C
 - a3) Relative humidity: 98%
- 4) Cooling Systems:
 - i) Liquid cooled: heavy duty industrial radiator with flanged duct connection mounted on generating set base with engine driven pusher type fan to direct air through radiator from engine side with ethylene glycol antifreeze non-sludging above minus 46C.
 - ii) To maintain manufacturer's recommended engine temperature range at 10% continuous overload in ambient temperature of 40C.
 - iii) Block heater: thermostatically controlled lube oil or liquid coolant heater 120 VAC single phase, powered from local distribution panel.
- 5) Fuel: diesel.
- 6) Fuel systems: solid injection, mechanical fuel transfer pump, fuel filters and air cleaner, fuel rack solenoid energized when engine running.
- 7) Governors:
 - i) Mechanical hydraulic with:
 - a) Steady state speed band of plus or minus 0.5%.
 - b) Speed regulation no load to full load 5% maximum.
 - c) Electronic type, electric actuator, speed droop externally adjustable from isochronous to 5%, temperature compensated with steady state speed maintenance capability of plus or minus 0.25%.
- 8) Lubrication systems:
 - i) Pressure lubricated by engine driven pump.
 - ii) Lube oil filter: replaceable, full flow type, removable without disconnecting piping.
 - iii) Lube oil cooler.
 - iv) Engine sump drain valve with drip pan.
 - v) Oil level dip-stick.
- 9) Starting systems:
 - i) Positive shift, gear engaging starter 12 V dc.
 - ii) Cranking limiter to provide 3 cranking periods of 10 s duration, each separated by 5 s rest.
 - iii) 12 V storage battery with sufficient capacity to crank engine for 1 min at 0C without using more than 25% of ampere hour capacity.
 - iv) Battery charger: constant voltage, solid state, two stage from trickle charge at standby to boost charge after use. Regulation: plus or minus 1% output for plus or minus 10% input variation. Equipped with dc voltmeter, dc ammeter and on-off switch.
- 10) Vibration isolated engine instrument panels with:
 - i) Lube oil pressure gauge.
 - ii) Running time meter: non-tamper type.
 - iii) Coolant Level switch shutdown in case of hose breakage.
 - iv) Summary output alarm for customer alarm
 - v) 3 Form C contacts for remote control of louvers and engine run status which change state on engine start.
- 11) Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.
- 12) Drip tray.

2.02 Alternators

A. Alternators: to NEMA MG 1-1993.

B. Rating:

- 1) Single-phase, 230V powered pumping stations:
 - i) Single-phase, 230V, no less than 20 kW at 50 Hz and 0.8 PF.

- 2) Three-phase, 380-415V powered, RO plant and treatment facility:
 - i) no less than 30 kW at 50 Hz and 0.8 PF.
- C. Output at 40C ambient:
 - 1) 100% full load continuously.
 - 2) 110% full load for 1 h.
 - 3) 150% full load for 1 min.
 - 4) Revolving field, brushless, single bearing.
 - 5) Drip proof.
 - 6) Amortisseur windings.
 - 7) Synchronous type.
 - 8) Exciter: permanent magnet.
 - 9) EEMAC class F insulation on windings.
 - 10) Voltage regulators: thyristor controlled rectifiers with phase controlled sensing circuit:
 - i) Stability: 1% maximum voltage variation at any constant load from no load to full load.
 - ii) Regulation: 5% maximum voltage deviation between no-load steady state and full-load steady state.
 - iii) Transient: 15% maximum voltage dip on one-step application of 0.8 PF full load.
 - iv) Transient: 25% maximum voltage rise on one-step removal of 0.8 PF full load.
 - v) Transient: 1.55 maximum voltage recovery time with application or removal of 0.8 PF full load.
 - 11) Alternators: capable of sustaining 300% rated current for period not less than 10 s permitting selective tripping of down line protective devices when short circuit occurs.

2.03 Control Panels.

- A. Totally enclosed, mounting base isolated from diesel generator.
- B. Instruments for each unit:
 - 1) Analogue indicating type 2% accuracy, rectangular face, flush panel mounting:
 - i) Voltmeter: ac, scale 0 to 750 V.
 - ii) Ammeter: ac of suitable scale
 - iii) Frequency meter: scale 45 to 55 Hz.
 - iv) kW.h meter.
 - 2) Voltmeter selector switch, rotary, panel mounting, four positions, labelled "Off-Phase A-Phase B-Phase C".
 - 3) Ammeter selector switch, rotary, maintained contacts, panel mounting, designed to prevent opening of current circuits, four position labelled "OFF- Phase A-Phase B-Phase C".
 - 4) Instrument Transformers
 - i) Potential-dry type for indoor use:
 - a) Ratio: 400 to 230.
 - b) Rating: 400 V, 50 Hz, BIL 30kV.
 - ii) Current-dry type for indoor use:
 - a) Ratio: 100 to 5.
 - b) Rating: 400 V, 50 Hz, BIL 30 kV.
 - c) Positive action automatic short-circuiting device in secondary terminals.
 - 5) Controls:
 - i) Engine start button.
 - ii) Selector switch: Off-Auto-Manual.
 - iii) Engine emergency stop button and provision for remote emergency stop button.
 - iv) Provision for transfer switch initiation of Emergency start.

- v) Alternator output breakers: circuit breakers with bolt-on, moulded case, temperature compensated for 40C ambient, dual thermal-magnetic trip.
One 3 pole:
 - a) 200A. Minimum breaker sizes to supply building service loads.
Breakers shall be mounted on control panels with the line side of each breaker fed directly from the alternator.
- 2.04 Steel Mounting.
 - A. Complete generating set mounted on structural Base steel base of sufficient strength and rigidity to protect assembly from stress or strain during transportation, installation and under operating conditions on suitable level surface.
 - B. Assembly fitted with vibration isolators and control console resiliently mounted.
 - 1) Spring type isolators with adjustable side snubbers and adjustable for levelling.
 - C. Sound insulation pads for installation between isolators and concrete base.
- 2.05 Trailer
 - A. Each three-phase, 380-415V generator shall come complete with a trailer suitable for transporting the generator to a pumping station and supporting the generator during operation.
- 2.06 Enclosures.
 - A. B Series weather protective enclosure including the following:
 - 1) Internal silencer system.
 - 2) 8-hour single-walled fuel tank.
 - 3) Single point lift.
 - 4) Panel viewing window.
 - B. Super sound attenuation.
- 2.07 Exhaust Systems
 - A. Heavy duty critical type horizontally mounted exhaust silencer with condensate drain, plug and flanged couplings.
 - B. Heavy duty stainless steel exhausts piping, with flanged connections, size and material as per manufacturer's specifications.
 - C. Fittings and accessories as required.
 - D. Expansion joints: stainless steel, corrugated, of suitable length, to absorb both vertical and horizontal expansion.
 - E. Through wall stainless steel thimbal of suitable length to pass through wall and to absorb both vertical and horizontal expansion.
 - F. Insulate all exhaust components with high temperature (calcium silicate) insulation to 50 mm thickness.
 - G. Support exhaust system from roof structure using vibration isolating pipe hangers.
- 2.08 Finishes
 - A. Alternator control cubicle: paint inside, exterior to match engine and alternator.
 - B. Other ducts and racks grey.
 - C. Supply 0.25 L of grey touch-up enamel.
- 2.09 Equipment.
 - A. Control panels: To be complete with Generator Identification voltage, kW and kVA rating and breaker sizing.
- 2.10 Fabrication.
 - A. Shop assemble generating units including:
 - 1) Base.
 - 2) Engine and radiator.
 - 3) Alternator.
 - 4) Control panel.
 - 5) Battery and charger.

- 2.11 Acceptable Manufacturers.
A. Caterpillar, Kohler, Isuzu.

PART 3 - WORKMANSHIP

- 3.01 Field Quality Control
- A. Perform tests.
 - B. Notify Engineer/Employer's representative fourteen (14) working days in advance of test date.
 - C. Certified manufacturer's representative demonstration:
 - 1) Unit start, transfer to load, retransfer to normal power, unit shut down, on "Automatic" control.
 - 2) Unit start and shut down on "Manual" control
 - 3) Unit start and transfer on "Test" control.
 - 4) Unit start on "Engine start" control.
 - 5) Operation of automatic alarms and shut down devices.
 - D. Run unit on 100% load for minimum period of 12 h to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling. .
 - E. At end of test run, check battery voltage to demonstrate battery charger has returned battery to fully charged state. .
 - F. Provide fuel required for testing and top up tank upon completion of project.

END OF SECTION

Section 16412

MOULDED CASE CIRCUIT BREAKERS

PART 1 - GENERAL

- 1.01 Product Data.
- A. Submit product data in accordance with the General Conditions of the Contract.
 - B. Include time-current characteristic curves for breakers with ampacity of 200 A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

PART 2 - PRODUCTS

- 2.01 Breakers
- A. Bolt-on moulded case circuit breaker: quick- General make, quick-break type, for manual and automatic operation with temperature compensation for 50°C ambient.
 - B. Common-trip breakers: with single handle for multi-pole applications.
 - C. Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
 - D. Circuit breakers with interchangeable trips as indicated.
- 2.02 Thermal Magnetic Breakers Design A
- A. Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.
- 2.03 Solid State.
- A. Moulded case circuit breaker to operate by Trip Breakers means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, Trip Breakers short time, instantaneous tripping for phase ground fault short circuit protection when required.
- 2.04 Optional Features
- A. Include where indicated:
 - 1) shunt trip.
 - 2) auxiliary switch.
 - 3) motor-operated mechanism c/w time delay unit.
 - 4) under-voltage release.
 - 5) on-off locking device.
 - 6) handle mechanism.

PART 3 - WORKMANSHIP

- 3.01 Installation.
- A. The installation of moulded case circuit breakers will be specified under other applicable sections.

END OF SECTION

Section 16491

FUSES - LOW VOLTAGE

PART 1 - GENERAL

- 1.01 Shop Drawings and product data
 - A. Submit shop drawings in and Product Data accordance with Section 01015.
 - B. Submit fuse performance data characteristics for each fuse type and size above 30 A. Performance data to include: average melting time-current characteristics, (for fuse coordination), and peak let-through current.
- 1.02 Maintenance Material
 - A. Three spare fuses of each type and sizes installed up to and including 100 A.
- 1.03 Delivery and Storage
 - A. Ship fuses in original containers.
 - B. Store fuses in original containers in moisture free location.
- 1.04 References
 - A. EC 60269, Low Voltage Fuses.

PART 2 - PRODUCTS

- 2.01 Fuses General
 - A. Fuses: product of one manufacturer.
- 2.02 Fuse Types.
 - A. HRCI-J fuses (formerly Class J).
 - 1) Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - 2) .2 Type J2, fast acting.
 - B. HRCII-C fuses (formerly Class C).

PART 3 - WORKMANSHIP

- 3.01 Installation
 - A. Fuses are to be installed in existing Island power grid's above-ground junction boxes as required.
 - B. Fuse type shall match existing fuses in Island's power grid. Contractor to determine type on site. If the Contractor is unable to determine the fuse type on site, fuses described in Section 2.02 are to be used.
 - C. Contractor is to determine exact fuse sizes on site. Fuse size shall be based on:
 - 1) Load on control panel.
 - 2) Distance from power source to control panel and associated voltage drops.
 - 3) Existing protection in the power grid and short circuit fault considerations.
 - D. Contractor shall receive Engineer's written approval before installing fuses.

END OF SECTION

SECTION 16496D
BYPASS/ISOLATION AUTOMATIC TRANSFER SWITCHES – LOW VOLTAGE

PART 1 GENERAL

1.01 Scope

- A. Furnish and install the bypass/isolation automatic transfer switches having the ratings, features/accessories and enclosures as specified herein and as shown on the contract drawings.

1.02 Related Sections

1.03 References

- A. The automatic transfer switches and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of UL and NEMA as follows:
 - 1. UL 1008 – Transfer Switches
 - 2. UL 991 - Tests for Safety-Related Controls Employing Solid-State Devices
 - 3. NFPA 70 – National Electrical Code
 - 4. NFPA 99 – Essential Electrical Systems of Health Care Facilities
 - 5. NFPA 110 – Emergency and Standby Power Systems
 - 6. NEMA ICS 10 – AC Transfer Switch Equipment
 - 7. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems

1.04 Submittals – for Review/approval

- A. The following information shall be submitted to the Engineer:
 - 1. Front view and plan view of the assembly
 - 2. Schematic diagram
 - 3. Conduit space locations within the assembly
 - 4. Assembly ratings including:
 - (a) Withstand and Closing rating
 - (b) Voltage
 - (c) Continuous current rating
 - (d) Short-Time rating if applicable
 - (e) Short-circuit rating if ordered with integral protection
 - 5. Cable terminal sizes
 - 6. Product Data Sheets
- B. Where applicable, the following additional information shall be submitted to the Engineer:
 - 1. Busway connection
 - 2. Connection details between close-coupled assemblies
 - 3. Composite front view and plan view of close-coupled assemblies

1.05 Submittals – for Construction

- A. The following information shall be submitted for record purposes:
 - 1. Final as-built drawings and information for items listed in section 1.04
 - 2. Wiring diagrams
 - 3. Certified production test reports
 - 4. Installation information
 - 5. Seismic certification as specified
- B. The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.

1.06 Qualifications

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years.
- D. Provide Seismic tested equipment.

1.07 Regulatory Requirements

- A. Provide a certificate of compliance with UL 1008 for the transfer switches furnished under this section.

1.08 Delivery, Storage and Handling

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.09 operation and Maintenance Manuals

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

PART 2 PRODUCTS

2.01 Ratings

- A. The transfer switch shall be 100% equipment rated for continuous duty.

2.02 Construction

- A. The switching panel shall consist of completely enclosed contact assemblies and a separate control or transformer panel. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.

- B. The transfer switch shall be mechanically interlocked to prevent cross connection of sources when operated either automatically, or manually.
- C. Positive mechanical key interlocks shall be provided for bypass and isolation switches to prevent cross connection of services.
- D. Transfer switches shall be capable of being operated manually under full rated load conditions. Manual operation shall be accomplished by a permanently attached manual operator, or by integrally mounted pushbuttons. Removable manual operating handles, and handles that may move in the event of an electrical operation during the manual operation, are not acceptable. Manual operators requiring source or load disconnection prior to manual operation are not acceptable.
- E. Transfer switches shall be four pole design, the neutral shall be fully rated with equal withstand, closing and interrupting ratings to the power poles. Switched neutral poles which are add-on or overlap, or that are not capable of breaking full rated load current are not acceptable.
- F. The transfer switch shall have a multi-tap voltage selection plug for ease of voltage adjustment in the field.
- G. The automatic transfer switch and the bypass isolation switch sections shall be interconnected with copper bus or cable.
- H. Service entrance transfer switches shall be provided with over load, short circuit and earth fault protection. A key-operated selector switch shall be provided to disconnect the power supplies. Indicators shall be provided to show the availability of each source as well as breakers in a disconnected position.

2.03 MICROPROCESSOR LOGIC

- A. The transfer switch shall be microprocessor-based controller. The controller shall be hardened against potential problems from transients and surges. Operation of the transfer switch and monitoring of both sources shall be managed by the controller.
Dual Source, No Tie, Open Transition Automatic Transfer Control System
 - 1. Where indicated on the drawings, provide an automatic transfer control system for control of two circuit breakers. The logic of the transfer control system functions shall be provided via a microprocessor. The set points shall be field adjustable without the use of special tools
 - 2. A digital readout shall display each option as it is functioning. The readout shall display actual line-to-line voltage, line frequency and timers. When timers are functioning, the microprocessor shall display the timer counting down. All set points shall be capable of being re-programmed from the front of the logic panel when the transfer control system is in the program mode. A test pushbutton shall be included as part of the microprocessor. The microprocessor shall be compatible with a twisted pair communication over a network to a computer for control or printer.
 - 3. The transfer control system includes the following features:
 - a. Time delay normal to alternate, adjustable.
 - b. Time delay alternate to normal, adjustable.
 - c. Delayed transition time delay, adjustable from 0 to 120 seconds, to allow disconnection of the load during transfer in either direction to prevent excessive inrush currents due to out-of-phase switching of large inductive loads.

- d. LEDs to indicate normal and alternate position.
 - e. LEDs marked "Source 1" and "Source 2" to indicate that respective source voltages are available.
 - f. LEDs to indicate which source is preferred.
 - g. LED to indicate the load energized.
 - h. Historical transfer information via the front panel.
 - i. Two-position selector switch permitting two modes of transfer control system operation: AUTO-MANUAL.
4. When the alternate source is an engine generator, the following features shall also be provided:
- a. Adjustable time delay engine start.
 - b. Adjustable time delay engine cool down.
 - c. Engine start contact.
 - d. Frequency/voltage relay for alternate source, frequency adjustable from 45 to 60 Hz and voltage fixed at 90% pickup, 70% dropout.
 - e. Plant exerciser.
5. Sequence of Operation – Automatic Mode
- a. The transfer control system shall automatically transfer its load circuit to an emergency or alternate power supply upon failure of its normal or preferred source.
 - b. Upon loss of phase-to-phase voltage of the normal source to 80% of nominal, and after a time delay, adjustable from 0.5 to 15 seconds, to override momentary dips and/or outages, a 10-ampere, 30 volts dc contact shall close to initiate starting of the emergency or standby source power plant. Transfer to the alternate source shall take place immediately upon attainment of 90% of rated voltage and frequency of that source. For systems not involving engine generator sets as the alternate source, transfer shall occur after an adjustable time delay of 1 to 60 seconds to override momentary dips and outages.
 - c. When the normal source has been restored to 90% of rated voltage, and after a time delay, adjustable from 0.5 to 32 minutes (to ensure the integrity of the normal power source), the load shall be retransferred to the normal source.
 - d. A time delay, adjustable from 0.5 to 32 minutes, shall delay shutdown of the emergency or standby power source after retransfer to allow the generator to run unloaded for cool down, after which the generator shall be automatically shut down.
 - e. If the emergency or standby power should fail while carrying the load, transfer to the normal power supply shall be made instantaneously upon restoration of the normal source to satisfactory conditions.
6. Sequence of Operation – Manual Mode
- a. While in manual mode, breakers shall be capable of being opened and closed using control switches. Electrical interlocking shall be provided to prevent the closing of both mains and the tie simultaneously.
7. Provide a control power transformer for each source with control power transfer scheme
8. Provide electrically operated main circuit breakers
9. Provide a microprocessor-based automatic transfer controller

2.04 Drawout design

- A. The bypass/isolation transfer switches shall be provided with a draw-out mechanism to allow easy access for preventive maintenance, testing or inspection. The draw-out mechanism shall provide visual indicators as to the position of the switch/breaker during the draw-out operation.

2.05 Wiring/terminations

- A. Terminal blocks shall conform to NEMA ICS 4. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure. The main transfer switch terminals shall be suitable for the termination of conductors shown on the plans.

2.06 Enclosure

- A. Each transfer switch shall be provided in a *[NEMA 1] [NEMA 12] [NEMA 3R] enclosure suitable for use in environments indicated in the drawings.

2.07 Finish

- A. NEMA 1, 12 or 3R enclosures shall be painted with the manufacturer's standard light gray ANSI 61.paint.

PART 3 EXECUTION

3.01 Examination

3.02 Factory Testing

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
 - 1. Insulation check to ensure the integrity of insulation and continuity of the entire system
 - 2. Visual inspection to ensure that the switch matches the specification requirements and to verify that the fit and finish meet quality standards
 - 3. Mechanical tests to verify that the switch's power sections are free of mechanical hindrances
 - 4. Electrical tests to verify the complete electrical operation of the switch and to set up time delays and voltage sensing settings of the logic
- B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.03 Training

- A. A manufacturer's qualified representative shall conduct the training session. The training program shall consist of the instruction on the operation of the assembly, circuit breakers and major components within the assembly.

3.04 Installation

- A. The contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

- B. All necessary hardware to secure the assembly in place shall be provided by the contractor.
- C. The equipment shall be installed and checked in accordance with the manufacturer's recommendations.

END OF SECTION

Section 16900

INSTRUMENTATION

PART 1 – GENERAL

- 1.01 Work Included.
- A. The work generally includes, but is not limited to the following:
- 1) Supply and installation of pump control panels for each pumping station as indicated.
 - 2) Supply and installation of underground conduits and conductors between pump controllers and pumping stations.
 - 3) Supply and installation of four (4) control floatation devices at each pumping station.
 - 4) Supply and installation of mounting structures as detailed on the drawings.
 - 5) All testing, programming and training required to place all pumping stations into proper working order.
- 1.02 Shop Drawings
- A. Submit shop drawings in accordance with Section 01015.
- 1.03 Operation and Maintenance Data
- A. Provide four (4) copies of complete operation and maintenance data in accordance with Section 01015.

PART 2 – PRODUCTS

- 2.01 General.
- A. Wiring identification:
- 1) Identify wiring with permanent indelible identifying numbers, on both ends of branch circuit wiring.
 - 2) Colour code wiring to BS7671.
- B. Wiring terminations: lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminium.
- C. Manufacturers and UL labels: to be visible and legible after equipment is installed.
- 2.02 Materials
- A. Grounding equipment to:
- 1) Conform to IEE Standards and BS7671 and local amendments to same.
 - 2) Provide insulated ground conductor complete with connectors between ground lugs of controllers and Pumping Station Grounding System.
- 2.03 Level Switches
- A. Power supply 230VAC, powered from pump LSL - 330 control panel.
- B. Contacts to be rated: 250VAC, 5A, DPDT.
- C. Process connection: 25 mm Male NPT, 316 SS, 50 mm to 25 mm reducer will be required for installation.
- D. Suitable for installation in a Class 1, Zone 2, hazardous environment.
- E. Acceptable manufacturers: same manufacturer as pump controller.
- 2.04 Pump.
- A. Supply completely assembled control panel Controller - for each single-phase pumping station for the Single-Phase duplex operation of submersible pumps as Power Feeds follows:
- 1) Pre-packaged, below grade pumping stations - 2 pumps at 1.5 kW, single-phase, 230 volt, 50 Hz.
 - 2) Pump controllers shall be provided with the following features:

- i) Single IP68 rated double door enclosure with locking outer door. Power components shall be arranged for a dead front configuration.
- ii) Service entrance rated main circuit breaker: 30A, single-phase with 14 kA minimum interrupt rating.
- iii) Pump motor overload, over temperature Single-Phase and seal failure protection. Power Feeds.
- iv) Provide phase and ground fault protection.
- v) Provide residual current device protected type G socket.
- vi) Provide panel mounted HAND-OFF-AUTO selector switches, runtime meters, pump alarm pilot lights and reset buttons for each pump.
- vii) Provide individually protected 230 VAC circuits for pump control, ventilation and 15A socket circuit. Use circuit breakers.
- viii) Lightning and surge protection.
- ix) Common alarm output wired to terminals. Provide vandal proof alarm light and silenceable alarm for high water alarm.
- x) Digital inputs for miscellaneous alarms.
- xi) Software pump start staging preventing both pumps from starting at the same time.
- xii) 100A, double throw, manual transfer switch, complete with the following:
 - a) Double break visible rotary blades, quick make/quick break operation.
 - b) Moulded bases: glass based polyester.
 - c) All current carrying parts: copper.
 - d) Lugs: front removable, standard mechanical lugs.
 - e) 10,000 RMS symmetrical amperes short circuit rating.
 - f) Door interlocks so that switch cannot be turned "ON" with door open and door cannot be opened when switch is "ON".
 - g) Form C relay to transmit switch position.
- xiii) Pump motor starters for two (2) capacitor start/capacitor run 1.5 kW motors.
- xiv) Dry contact for remote monitoring of high water and pump monitoring relay alarm conditions.
- Xv) 100A, 4-pin, female pin and sleeve socket, mounted to the exterior of the control panel, for connection to standby generator. Weather-proof and rain tight, with provision for padlocking.
- xvi) Electric heater and temperature sensor.
- xvii) All power and instrument wiring.
- xviii) Mounting structure adjacent to pumping Single-Phase station as shown on drawings. Mounting Power Feeds structure to be constructed using 80 mm hot-dipped galvanized steel channel, security fastened to concrete slab using 104 mm stainless steel anchor bolts. Exact location of mounting structure and control panel is to be determined on site to suite conditions.
- xix) Provide transit assembly for conduits entering the control panel from the wet well. Transit assembly shall be approved to prevent gases from travelling from the classified wet well into the unclassified control panel.

2.05 Pump

A. Supply completely assembled control panel for Controller - each three-phase pumping station for the Three-Phase duplex operation of surface mounted pumps as Power Feeds follows:

- 1) Pump motor overload, over temperature and seal failure protection.
- 2) Provide phase and ground fault protection.
- 3) Provide residual current device protected type G socket.
- 4) Provide panel mounted HAND-OFF-AUTO selector switches, runtime meters, pump alarm pilot lights and reset buttons for each pump.

- 5) Provide individually protected 230 VAC circuits for pump control, ventilation and 15A socket circuit. Use circuit breakers.
- 6) Lightning and surge protection.
- 7) Common alarm output wired to terminals. Provide vandal proof alarm light and silenceable alarm for high water alarm.
- 8) Digital inputs for miscellaneous alarms.
- 9) Software pump start staging preventing both pumps from starting at the same time.
- 10) 100A, double throw, manual transfer switch, complete with the following:
 - a) Double break visible rotary blades, quick make/quick break operation.
 - b) Moulded bases: glass based polyester.
 - c) All current carrying parts: copper.
 - d) Lugs: front removable, standard mechanical lugs.
 - e) 10,000 RMS symmetrical amperes short circuit rating.
 - f) Door interlocks so that switch cannot be turned "ON" with door open and door cannot be opened when switch is "ON".
 - g) Form C relay to transmit switch position.
 - h) Pump motor starters
 - i) Dry contact for remote monitoring of high water and pump monitoring relay alarm conditions.
 - j) 100A, 4-pin, female pin and sleeve socket, mounted to the exterior of the control panel for connection to standby generator. Weather-proof and rain tight, with provision for padlocking.
 - k) Electric heater and temperature sensor.
 - l) All power and instrument wiring.
 - m) Mounting structure adjacent to pumping station as shown on drawings. Mounting structure to be constructed using 80 mm hot-dipped galvanized steel channel, security fastened to concrete slab using 104 mm stainless steel anchor bolts. Exact location of mounting structure and control panel is to be determined on site to suite conditions.
 - n) Provide transit assembly for conduits entering the control panel from the wet well. Transit assembly shall be approved to prevent gases from travelling from the classified wet well into the unclassified control panel.

PART 3 - WORKMANSHIP

- 3.01 General.
 - A. Drawings do not show all conduits. Conduit and cable are indicated in diagrammatic form only.
- 3.02 Installation
 - A. Determine manufacturer's recommendations regarding storage and installation of equipment and adhere to these recommendations.
- 3.03 Primary Elements
 - A. Install devices in accordance with the manufacturer's instructions.
- 3.04 RTU.
 - A. Install RTU in panel and complete all field wiring.
- 3.05 Installation of Cables
 - A. Install fastenings and supports as and required for each type of equipment Cable Supports cables and conduits, and in accordance with manufacturer's installation recommendations.
 - B. Conductors are shown on drawings in approximate locations. Confirm locations of cable and conduit runs with shop drawings and the Employer before installation.

- 3.06 Installation of Conduit
- A. Install conduits to cause minimum interference in spaces through which they pass.
 - B. Use rigid PVC conduit for underground installations in strict accordance to the latest amended edition of the local Electrical Code (BS761:1992).
 - C. Where conduits become blocked, remove and replace blocked section.
 - D. Dry conduits out before installing wiring of Conduit
- 3.07 Pump
- A. Install and wire pump controllers and Controllers auxiliary equipment in accordance with manufacturer's written instruction.
- 3.08 Testing,
- A. Arrange and pay for services of Calibration and manufacturer's factory service representative Start-up to supervise the installation, start-up, check, adjust, balance and calibrate components and systems to the approval of the Engineer.
 - B. Provide services for such period, and for as many visits as necessary to put the installation in working order, and to ensure that the operating personnel are conversant with all aspects of equipment and operation.

END OF SECTION