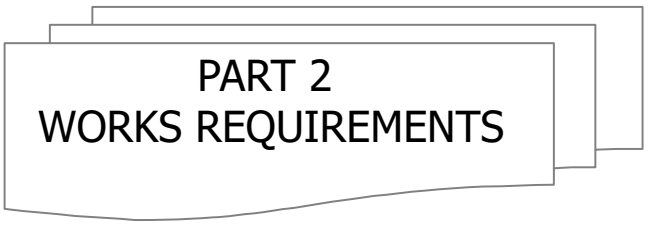
Table of contents


PART 2
WORKS REQUIREMENTS


Section VII
Volume -3: Specifications

Section VII – Volume-3: Specifications

Contents

1 PREAMBLE TO THE TECHNICAL SPECIFICATIONS

1.1 GENERAL

1) The following Specifications are part of the requirements related to the Works which are to be provided according to the stipulations of the Contract. Hence, the instructions given herein form an integral part of, and are applicable to, all technical and Contract Documents issued for the Works.
2) These Specifications shall be read in conjunction with the Conditions of Contract, the Drawings and the Bill of Quantities, and the Contractor shall comply with all provisions contained within the Contract Documents and Engineer's instructions.
3) It is the intent of these Specifications, together with other relevant documents issued as part of the Bid (or Contract Documents to follow later on), to provide the Contractor with complete and detailed information and subsequent instructions necessary to enable him to submit a well-planned Bid, to carry out the design, where and when required, and to execute properly the work prescribed.
4) It is the intent of these Specifications to establish acceptable standards of quality. Minor deviations in details due to manufacturer's standard shop process will be considered for acceptance provided that, in the opinion of the Engineer, the proposed substitutions are equal in quality to those specified. All deviations shall be called out in writing in the Bid and shall be specifically indicated on the shop drawings.
5) All work shall be executed according to the Detailed Design and/or Construction Drawings as approved by the Engineer and requirements released for construction, in a professional and diligent manner, and all supplies and work shall comply with the quality requirements defined in the relevant sections of these Specifications and other Contract Documents. The Contractor shall make all necessary efforts to comply with the intent of these Specifications to the satisfaction of the Engineer.
6) Any approval given by the Engineer of the Contractor's methods and equipment shall not relieve the Contractor of his full responsibility for the proper and safe execution of any work covered by these Specifications, or his liability for injuries to or death of persons, or any other obligation under this contract.

1.2 SUBMITTAL

1) The Contractor shall provide the Engineer with all submittals required by these Specifications and other Contract Documents. Although their extent shall be at the Contractor’s discretion, such submittals shall adequately illustrate all the main aspects of the matter under consideration for an easy understanding by the Engineer.
2) At any time, the Engineer may call either for additional information, completion of the submittal or request the Contractor not to submit some of them.
3) The Contractor shall submit these documents to the Engineer so that, even if not specifically expressed, reasonable time will be given to the Engineer to comment on or approve the submittal.

1.3 STANDARDS AND CODES

1.3.1 GENERAL

1) Standards referred to in these Specifications are considered to form part of these Specifications.
2) All standards and codes employed or referred to shall be the latest current issue in effect at the date 28 days prior to the Bid submission date.
3) One complete set of standards and codes adopted for the Works shall be submitted free of

charge by the Contractor to the Engineer immediately after the Contract has come into force or upon the Engineer's request. Such copies shall also be available at the Contractor's business domicile(s) and at Site, for the use also of the Employer and of the Engineer.

4) In case of discrepancies between these Specifications and national or international standards and codes, these Specifications being part of Contract Documents shall govern, unless otherwise established by the Engineer in each particular case.

1.3.2 NATIONAL STANDARDS, CODES, LAWS AND REGULATIONS

1) Throughout the duration of the Contract, the materials, equipment, services, design and workmanship shall conform to applicable national codes, standards, laws and regulations in force in Republic of Uganda if not otherwise specified.
2) It is the Contractor's duty to acquaint himself with all available national codes, standards, laws and regulations related to the Works in any way and he shall procure and keep at the Site a copy of each of such applicable documents.

1.3.3 INTERNATIONAL STANDARDS AND CODES

1) International standards/codes series may be adopted provided:
   - The standards/codes proposed are at least as stringent as the equivalent national ones relevant to the Works, or if there is no applicable national standard/code for the specific item concerned.
   - The Contractor states, prior to starting the work, the international standard/code he proposes to apply, giving full identification of each of them. The Contractor's proposals are subject to the approval by the Engineer.
2) Where reference is made in the technical documents to standards/codes of the country of origin for a supply item, it shall be a recognized national standard/code of the country where the specific supply item is manufactured. To be acceptable under these Specifications, such standards/codes must comply in all respects with the quality requirements of above mentioned international standards/codes and must be approved by the Engineer.

1.3.4 SYSTEM OF UNITS

1) The SI system of units has been used throughout these Specifications and this system of units shall be used consequently throughout the duration of Contract for all technical or contractual purposes.
2) The following abbreviations are used in these Specifications and related other Contract Documents:

	Unit	Abbreviation
Length	millimeter centimeter meter kilometer	mm cm km
Area	square millimeter square centimeter square meter	mm^2 cm^2 m^2
Volume	cubic meter	m^3
Mass	kilogram ton	kg t
Density	kilogram per cubic meter	kg/m^3

Force	Newton kilo Newton mega Newton	N kN MN
Moment	kilo Newton-meter	kN m
Stress or Strength	Newton per square millimeter kilo Newton per square millimeter kilo Newton per square meter	N/mm^2 kN/mm^2 kN/m^2
Pressure	bar Pascal mega Pascal	bar Pa MPa
Time	millisecond second hour	ms s h
Rate of Flow	liters per second or minute cubic meters per second cubic meters per minute	l/s, l/min m/s m^3/min
Velocity	meter per second	m/s
Velocity of Rotation	revolutions per minute	rpm
Temperature	degree Celsius	°C
Concentration	parts per million	ppm
Illumination Intensity	lux	lx
Energy	kilowatt-hour	kWh
Power	Watt kilowatt Megawatt	W kW MW
Slope and Percentage	percent	%

3) The term "day" as used in these Specifications means the calendar day according to the Gregorian Calendar.
4) Any other system of units utilized shall have only a descriptive value and shall in no case replace the above-mentioned SI system.

1.4 DEFINITION OF TIME AND KEY DATES

The periods of time and key dates used throughout these Specifications have the meanings as assigned to them in the “CONDITIONS OF CONTRACT FOR CONSTRUCTION” by FIDIC, 2017, with amendments.

2 SAFETY PRECAUTIONS

2.1 SAFETY PROGRAM AND ITS IMPLEMENTATION

1) Within 14 days from the date of issue of the Notice to Commence, the Contractor shall submit, in writing, his proposal for a comprehensive safety program covering all aspects of the Works.
2) This safety program shall detail policies, procedures, and plans which the Contractor intends to implement to ensure the safety and health of his employees. It shall comply with the standards and regulations in force in the country of the Works applicable to construction safety.
3) The Contractor shall designate a competent employee specially trained and experienced to act as Safety Officer, who will administer and be responsible for the implementation of the safety program. He shall carry out frequent and regular safety inspections of the working areas, materials, and equipment. The name and qualifications of the Safety Officer shall be submitted for approval to the Engineer prior to his appointment.
4) The Contractor shall be responsible for the enforcement of the health and safety provisions that he himself and his subcontractors shall adopt on Site.
5) Prior to the start of any major construction activity or hazardous operation, the Contractor shall submit to the Engineer for approval, a specific plan for safety precautions covering such operation.
6) All accidental occurrences with serious accident potential such as major equipment failures, contact with high-voltage lines, exposure to hazardous materials, slides, cave-ins, etc., shall be reported to the Engineer as soon as practicable.
7) All serious and fatal injuries and diseases caused by the progress of work shall be immediately investigated by the Contractor and a comprehensive report shall be submitted to the Engineer.
8) In case of a fatal accident, only rescue and emergency teams and operations shall be permitted at the place of the occurrence until the Engineer gives permission to resume normal operations.

2.2 SAFETY STANDARDS

In addition to the requirements specified herein, the Contractor shall comply with applicable safety requirements of the following documents and/or organizations:

a) Safety regulations in force in the country of the Works
b) US Bureau of Mines or equivalent
c) USBR-Construction Safety Standards or equivalent

In addition to the requirements specified herein, the Contractor shall comply with applicable safety requirements in force in the United Republic of Uganda.

2.3 PERSONAL SAFETY EQUIPMENT

1) The Contractor shall provide his and his subcontractor's personnel as well as the Employer's and Engineer's representatives and visitors with appropriate personal safety equipment. The use of such equipment shall be compulsory.
2) All persons entering the working areas wear a protective helmet.
3) Safety footwear with steel toe caps shall be worn by all personnel engaged in work having an inherent danger to the feet.
4) During drilling works and in areas where workers are exposed to harmful noise and dust levels, ear protectors and dust masks shall be worn.
5) Workers engaged in work having an inherent danger of eye or face injury shall be furnished and required to wear protection glasses, goggles or face masks. Where irritants or toxic substances may come in contact with the skin or clothing, employees shall wear protective clothing or apply a protective ointment prescribed by a competent physician.
6) Employees working on steep slopes or otherwise subject to possible falls from levels not protected by fixed guardrail or safety nets, shall be secured by safety belts and lifelines.

7) A suitable protection shall be installed on the upstream face of the dam during construction of the asphaltic concrete facing to limit fall hazard associated with this type of work.

2.4 RESCUE TEAM

1) Prior to the commencement of construction, the Contractor shall organize and train a Rescue Team composed of his employees. This Rescue Team shall be capable to render help after accidents caused by fire, gas, explosion, rockslides, etc.
2) The Rescue Team shall be organized in such a way that a sufficient number of its members will be ready for action at any time until the Completion of Works.
3) The Rescue Team members shall be instructed and trained for their task by a qualified and experienced person. If necessary, the Contractor shall hire an outside specialist to perform such training. A refresher training for all members of the Rescue Team shall be conducted at least every six months
4) Each Rescue Team member shall be skilled in giving the first aid, dealing with the appliances for artificial respiration, and firefighting equipment and shall possess a good local knowledge. Adequate equipment for reaching even the remotest working area shall be at their disposal.
5) The Contractor shall submit the details of the proposed Rescue Team organization to the Engineer for approval.

2.5 ILLUMINATION AND EARTHING

2.5.1 ILLUMINATION

All outdoor working sites, roads, storage and borrow areas, stationary plants, and all other site facilities, shall be adequately illuminated during night work by electrical lights.

2.5.2 EARTHING, WET WORK AREAS, CONTROL OF ELECTRIC DISCHARGES

1) Equipment and appliances which are exposed to lightning shall be electrically earthed and the effectiveness of such earthing shall be periodically checked by the Contractor's specialized personnel.
2) Where electrical blasting will be used, equipment shall be installed to control possible electric discharges in the ground due to storms, electrical motors, etc. As soon as such discharges are noted, electrical blasting operations shall be suspended, or the detonator type changed.
3) No equipment electrically powered by more than 24 Volts shall be operated by personnel standing in water.
4) Only suitable insulated equipment shall be allowed in the very wet areas.

2.5.3 MAINTENANCE OF TRAFFIC AND SAFETY ON PUBLIC ROADS

1) The Contractor shall be responsible for the safety along the roads related to the Site, and he shall take all necessary precautions for the protection of the work and the safety of the public on the roads affected by his activities. Where the work will be carried out at the site of, or close to an existing road, the Contractor shall maintain the vehicular and pedestrian traffic safe at all times. If his operations can cause traffic hazards, he shall repair or fence or take such other measures for ensuring safety which are satisfactory to the Engineer.
2) Public roads subject to interference by the works shall be kept open or suitable detours shall be provided and maintained by the Contractor, who shall provide, erect and maintain all necessary barricades, suitable and sufficient flagmen, danger signals, signs etc.
3) Roads which will be closed to traffic shall be protected by effective barricades on which acceptable warning and detour signs shall be placed. All barricades and all lights shall be kept burning from sunset to sunrise.
4) The Contractor shall submit his weekly activities schedule and the locations of his work along the existing public roads to the authorities concerned and obtain all necessary approvals prior to commencement of the respective work.
5) At the road crossings or in heavy traffic locations, the Contractor shall carry out the work within the working hours as directed by the Engineer, and after the completion of the work

he shall immediately make the necessary backfill and pavement at the crossings.

6) The Contractor shall provide temporary passes and bridges to give an access to the existing villages, houses, etc., to the satisfaction of the Engineer and the authorities concerned whenever he disturbs such existing way during the execution of the Works.

2.6 STORAGE AND TRANSPORT OF EXPLOSIVES

1) The Contractor shall in due time apply for a permit which allows him to buy, store and use the explosives required for the Works. The local security forces or other competent authorities will issue the permit.
2) The Contractor shall strictly comply with the rules and regulations in force in the country of the Works regarding purchase, transport, storage, handling and use of explosives.
3) Explosive magazines shall be reinforced concrete buildings with walls and slabs of a minimum 25 cm thickness. Doors shall be made of double sheets having a minimum thickness of 5 mm each and shall be fitted with safety type locks.
4) Explosives magazines shall be kept at a safe distance from working areas and living quarters. They shall be surrounded with barbed wire, protected by safety locks, ventilated, and fitted with lightning arresters. An air space shall be provided between the ceiling and the roof to prevent temperatures from reaching dangerous levels.
5) Blasting caps and detonators shall not be stored in the same magazines as explosives but shall be located in separate magazines at least 15 m away if barricaded and 30 m if un- barricaded.
6) Explosives shall be stored only in their original containers and with the top side up as designated on the container.
7) Access to the magazines and permission to handle explosives shall be granted exclusively to trustworthy personnel, adequately instructed and experienced in the use and handling of explosives.
8) The Contractor shall provide all reasonable and adequate security measures necessary to prevent loss or theft of explosives. Storage of explosives and detonators outside of the magazines shall not be permitted.
9) The Contractor shall maintain a record of storage and withdrawal of all explosives. This record shall be made available to the Engineer on request. The Engineer shall be promptly notified of any loss or theft of explosives.
10) Between the magazines and the place of use, the explosives and detonators shall be transported separately in lockable metallic containers loaded on a special wagon destined for the purpose of explosives transport only. These wagons shall be painted with striking colours for easy recognition. The inside of the containers shall be lined with wood in order to prevent a direct contact of the explosive or detonators with the metal.

2.7 BLASTING

1) All blasting shall be carried out in a proper and safe manner by a competent and experienced blast-man and no blast shall be fired without his approval.
2) Blasting will be permitted only after adequate provisions have been made for the protection of persons, the Works, and public or private property. The Engineer's approval of any of the Contractor's blasting operations shall not relieve the Contractor of his sole responsibility for the safety of persons and property. Any damage done to the Works or property by blasting shall be repaired by the Contractor.
3) Blasting in the open air shall be carried out only at certain hours of the day agreed upon by the Contractor and the Engineer. Barriers shall be erected, and warning shall be given to the workers at the Site and to the public immediately before blasting, so that no person will enter the danger zone until blasting is finished.
4) Upon completion of blasting, an "all clear" signal shall be given by the responsible blasting engineer after he has satisfied himself that all charges loaded have detonated and that no

delay-explosions or misfiring are to be expected.

5) Such methods of blasting shall be employed that shock and vibration are minimized.
6) No blasts involving charges larger than 200 kg shall be carried without the written approval by the Engineer, who shall be notified at least one hour prior to the blast.
7) No blasting shall be permitted within 30 m of any concrete placed within the previous 7 days. After 7 days, blasting may be performed only with the approval of the Engineer. Blasting will not be permitted within 10 m of structures or installations vulnerable to damage by blasting.
8) No charging and firing will be executed during thunderstorm (except in underground works) and other electrical disturbances which can cause uncontrolled blasting.
9) Mats or rubber tires tied together with rope shall be used as protection from flying debris to cover the charges where blasting may expose persons or property to injury or damage.

2.8 FIRE PRECAUTIONS

1) The Contractor shall organize a fire brigade equipped for the fighting of any fires which could break out on the construction sites, in temporary structures, stores, residential quarters, etc.
2) An adequate number of fire extinguisher shall always be available at each construction site and in each building in camps and in offices and they shall be kept in satisfactory working order.
3) Firefighting equipment shall be of the gas, dry powder or other suitable chemical or pumped water type. Their number, type and location will be subject to the approval of the Engineer.

2.9 DUST ABATEMENT

During the performance of the work and any operations appurtenant there to, the Contractor shall carry out proper and efficient measures, such as sprinkling with water or other means, whenever necessary to reduce the dust nuisance, and to prevent dust which has originated from his operations from damaging crops, cultivated fields, and dwellings, or causing a nuisance to persons. The Contractor will be held liable for any damage resulting from dust originating from his operations.

2.10 POLLUTION OF STREAMS AND RIVERS

1) The Contractor shall take all possible steps to prevent pollution of streams, rivers, and other water supplies, at or in the vicinity of the Site and shall comply with applicable laws, orders and regulations in force in the country of the Works concerning the control and abatement of water pollution.
2) Under no circumstances shall the sewage from the camps, or other contaminated water, be released directly into river or other natural streams or any open areas without prior treatment.

2.11 NOISE DUE TO CONSTRUCTION ACTIVITIES

1) The Contractor shall take adequate measures to keep as low as possible noise caused by construction activities and specially that due to construction equipment and stationary plant. In particular, the following shall be observed.
    a) All engine operated equipment shall be as a minimum provided with standard silencer; however, equipment operating near the Contractor's camps or existing villages and houses shall be provided with high performance silencers, keeping the noise level below 70 dB measured at a distance of 3 m from the equipment.
    b) Motor compressors, motor generators, ventilation fans and other similar equipment if located near camps or existing villages and houses shall also, if necessary, be housed in a building;
    c) Equipment and stationary plant shall be generally located at adequate distance from

camps or existing villages and houses, in such a way to avoid disturbance to personnel working on the project and local inhabitants.

2) The Engineer shall have the right to require additional measures such as sound-dampening screens or more efficient silencers in case the noise level results higher than 70 dB measured at camp or village or house close- to the source of noise.

2.12 LOCAL COMMUNITIES AND RELIGIOUS CUSTOMS

1) The Contractor shall pay care to avoid damage to properties, buildings, artifacts and objects of local communities or individuals during the execution of the Works; similarly, he shall avoid to make use or occupy areas without the prior consent of the owners.
2) The Contractor shall also have due regard to religious and other, customs of local communities, and shall never interfere in any religious or civil ceremony.

2.13 VEGETATION AND WILDLIFE

The Contractor shall care, in planning, constructing, maintaining and operating temporary works, such as camps, roads, spoil, stockpile and construction facilities areas, to avoid unnecessary damage to areas of particular environmental interest, such as patches of remaining forest, valuable trees and erosion sensitive areas.

2.14 FINDINGS OF ARCHEOLOGICAL, HISTORICAL OR CULTURAL INTEREST

1) In case fossils, articles of value or antiquity and/or structures and other remains of things of archaeological, historical or cultural interest are discovered during the activities related to the construction of permanents or temporary works, the Contractor shall notify the Engineer without removing any part of the article or thing found.
2) The Contractor shall take the necessary measures for preventing that any person or equipment may damage the article or thing, and shall provide barricades, fences, signals and, if necessary, protection against atmospheric agents.
3) The Engineer shall agree with the Contractor about the possible required modification of permanent and/or temporary works in connection with archeological or historical findings and deal with the additional costs to the Works, if any, as a Variation.

2.15 ESHS RISKS AND IMPLEMENTATION PLANS

The Contractor shall submit the Implementation Plans to manage the following key Environmental, Social, Health and Safety (ESHS) risks.

- Construction Environmental and Social management Plan, to ensure the compliance with the ESMP findings
- Labour Influx Plan, to avoid negative impacts on the host community,
- Traffic Management Plan, to ensure safety of local communities from construction traffic
- Water Resource Protection Plan, to prevent contamination of drinking water
- Boundary Marking and Protection Strategy, for mobilization and construction to prevent offsite adverse impacts
- Consents/Permits Strategy, to obtain Consents/Permits prior to the start of relevant earth works,
- Occupational Health and Safety Plan, to entails the inclusion of EHS considerations in the implementation processes
- Access Road Plan, to cover the road risks and to avoid erosion effects,
- Material Use, Handling and Storage Plan, for the management for use and disposal of hazardous substances
- Waste management Plan, for the management of waste and dump sites
- Wastewater Plan, to adhere to the national rules and regulations,
- Dust, Air Emission and Noise Pollution Plan, to avoid risks of related accidents and risks,

- Emergency Preparedness Plan, to ensure the efficiency of the safety procedures. The plan should include emergency preparedness during construction and actions to be taken upon emergent situations such as collapse of coffer dam.

The Contractor shall be required to submit for approval, and subsequently implement, the Contractor's Environment and Social Management Plan (C-ESMP), in accordance with the Particular Conditions of Contract Sub-Clause 4.1, that includes the agreed Management Strategies and Implementation Plans described here.

The CESMP will cover the remedial and/or mitigation measures identified and reported in the Environmental and Social Impact Assessment (ESIA), Environmental and Social Management Plan (ESMP), Resettlement Action Plan and the Consent Conditions issued by the regulatory authority and to be attached to any permits or approvals for the project.

Furthermore, it will indicate the strategies to be adopted during the construction and operation phases to be submitted in appropriate Method Statements namely: Work site boundaries and safety area, Access Roads, Site clearing, Materials Use, Handling and Storage, Quarries, Refueling and Workshop management, Waste Management, Wastewater, Fire Control, Dust control and Air Pollution Management, Water Pollution Management, Noise control, Cement and concrete batching, Emergency Procedures, Safety Plan, Traffic Management Plan, Biodiversity protection.

2.16 MEASUREMENT AND PAYMENT

1) Except for items provided for in the Bill of Quantities, no extra measurement for payment or payment will be made for the other items listed in chapter 2 and the entire cost thereof shall be included in the Unit Prices for other items of the Works.
2) Any repair work or any indemnities required due to Contractor's non-compliance with the safety requirements shall be to the Contractor's expense.

3 SURVEYING, SETTING-OUT WORK AND CONSTRUCTION DRAWINGS

3.1 SCOPE OF WORKS

The Contractor shall:

1) verify the accuracy of the existing topographic surveys, provided by the Employer;
2) set-up a network of permanent benchmarks to be used for laying out the project works;
3) perform some additional geological and geotechnical investigations (Drillings, Situ and Laboratory Tests);
4) Prepare Construction Drawings (and relative support calculations); These drawings must take into consideration:
   a. detailed geological conditions that could emerge during excavations;
   b. details (such as weights and dimensions, etc.) provided by the electromechanical and hydromechanical equipment contractors;

These drawings shall be sufficiently detailed to allow construction of each project component.

3.2 SUBMITTALS

The Contractor shall submit to the Employer within one month from the completion of specific survey for establishing the new main benchmarks the following:

1) the survey methods and the instrumentation used for establishing the benchmarks and base lines necessary for the construction of the permanent works;
2) the calculations performed for establishing such benchmarks and base lines.

The Contractor shall submit to the Engineer at least forty-five (45) days before the start of each activity the relative Construction Drawings. The Engineer shall issue his observations within twenty-one (21) days from receipt of such drawings after which time the Drawings will automatically be deemed to be approved.

3.3 GROUND CONTROL POINTS

1) Prior to commencing the work, the Contractor shall undertake the check survey of the reference data provided by the Employer and satisfy himself as to their accuracy. Should he have any objections to this data and the relevant drawings, he shall inform the Engineer in writing within 2 weeks of the hand-over.
2) The Contractor shall realize, in order to locate accurately the setting out points, a net of permanent benchmarks, according to the detailed instructions given by the Engineer.
   The following requirements shall apply:

3.3.1 GENERAL

1) The Contractor shall perform surveys and setting-out necessary to establish the accurate location of the structures as shown on the Tender Design or Construction Drawings and shall carry out all necessary surveys to verify the topographical data used by the Engineer for the tender design and measuring purposes.
2) Within 15 days after the day of receipt of the Notice to Commence, the Contractor shall submit his proposed survey plan to the Engineer. The proposed plan shall indicate the accuracy for all surveys.
3) In advance of any setting-out work associated with all principal project features, the Contractor shall submit to the Engineer for approval a description of the method and procedures he intends to use in establishing Bench Marks and base lines.
4) If the Contractor chooses to use triangulation points or Bench Marks other than those furnished by the Employer, he shall do so at his own expense and risk.
5) The Contractor shall carry out topographical surveys of the original ground surface in each sector of the Works where surface excavation will be necessary, and produce sufficient and

adequate cross-sections which will permit later to evaluate the volume of excavation for the measurement purposes and payment of excavation.

6) The Contractor shall entrust the surveying works only to persons who, by their training and experience, have sufficient qualifications and knowledge to ensure proper fulfillment of the survey tasks assigned to them. For the performance of survey work, the Contractor shall provide a sufficient number of reliable and accurate survey instruments.

3.3.2 BENCH MARKS AND TRIANGULATION STATIONS

1) Permanent survey control points shall be established prior to starting the work and such permanent points shall be preserved and protected during construction operations.
2) A minimum of 2 permanent bench marks shall be established for each major structure, and referenced to data established by survey control points. The location of such points with horizontal and vertical data shall be recorded on the construction record drawings by the Contractor.
3) From the primary survey control points the construction surveys shall be performed as required to locate, set-out and construct each portion of the Works.
4) Complete and adequate logs of all control and survey work shall be maintained as it progresses. Such logs shall be available for the Engineer's inspection at all times.
5) The Contractor shall protect, preserve and keep accessible the bench marks and triangulation stations of the basic survey and those provided by himself. Any damage or removal of bench marks and stations, including such of other parties shall be prevented. Any accidental damage shall immediately be brought to the attention of the Engineer. It is expressly stated that the Contractor will be made responsible for the damage and its consequences.
6) Bench marks shall be of stainless steel or cast iron. In softer soil, the steel bolt shall be embedded in a block of concrete of suitable size, and absolutely stable. Inscriptions shall be durable and clearly legible.
7) Subordinate points may be marked by steel pipes or pegs, subject to the approval of the Engineer. Every newly fixed point shall be checked, as far as possible, through elements other than those used to establish the point.

3.3.3 ACCURACY OF SURVEYING

1) Horizontal distances shall normally be measured with optical or electronic distance measuring instruments. Chaining shall be restricted to measuring of short distances and will not be used in survey of traverse nets.
2) Elevations and angles shall be measured by using an appropriate electronic or optical instrument.
3) Traverse nets shall be executed with the precision as indicated in Table 3-1 at the end of this Section.
4) Levelling shall be checked by closing the loop to the initial bench mark. The elevation difference of the two legs of the loop shall not exceed 12mm √K
5) where K is the total levelling distance in kilometres.
6) The Contractor may adopt GPS differential methods for the measurement of coordinates and levels after prior approval by the Engineer of the proposed procedure and the relative accuracy of the measurements.

3.3.4 AUXILIARY WORKS

The Contractor shall perform auxiliary works with regard to surveying which shall include, but not be limited to, the following:

a) Perform all necessary calculations with clear presentation of calculations and results in order to facilitate verification
b) Expose covered bench marks
c) Provide bench marks in lieu of and/or in addition to the existing ones

d) Remove machinery and obstructions from the required sight-lines
e) If it is hindering the survey work, stop all machinery, drilling, blasting, driving and other work causing ground vibration and stop all smoke, dust, gas, etc., obscuring clear view or causing refraction
f) Restrict or stop traffic of persons and vehicles near instruments or in sight-lines during instrument observations as required
g) Provide adequate lighting or shut off sources of interfering light to ensure the necessary clear view
h) Provide adequate labour, and materials as deemed necessary and suitable by the Engineer for the control and auxiliary surveys
i) Remove all obstructive accumulation of water
j) Carry out additional topographical surveys in cases where the existing topographical data is, in the opinion of the Engineer, insufficient for accurate measurement of the Works
k) Carry out all necessary topographical surveys for the incorporation of measuring equipment and instrumentation located in the Permanent Works
l) Carry out all necessary topographical surveys for the observation of the behavior of structures during construction

3.3.5 DAMAGE TO CROPS AND VEGETATION

1) No trees or crops of economic value existing at the Site shall be damaged or removed by the Contractor during survey and cross-sectioning works prior to their enumeration and evaluation.
2) Throughout the surveying and setting-out the Contractor shall work closely with the authorized local appraisers of crops and vegetation in question and shall provide them with facilities necessary for the expeditious performance of their duties.
3) As soon as a section of work has been defined and valued, the Contractor shall delineate the boundaries of the areas to be cleared by approved markings.

3.3.6 CHECKING OF CONTRACTOR'S WORK BY THE ENGINEER

1) All elements of the Contractor's survey work associated with the setting-out of principal project features will be regularly checked by the Engineer during the course of the work, and the Contractor shall provide assistance at any time as required in the performance of such control work.
2) The Contractor may be required to provide the Engineer with any information, readings or computations for checking.
3) The regular checks will usually be made during work breaks, but in case of urgency, the Contractor shall restrict or stop the affected work.
4) Any checks by the Engineer shall not relieve the Contractor of his full responsibility for the accuracy of structures and parts of them with regard to their position and dimensions.

3.4 CONSTRUCTION DRAWINGS

The Construction Drawings shall completely define each architectural, structural and plant detail of the works to be realised.

The Construction Drawings shall be prepared in full respect of the Tender Design and technical specifications annexed to the contract, or based on the additional Detailed Drawings provided by the Engineer.

The Construction Drawings shall include:

1. structures in reinforced concrete or precompressed reinforced concrete, including the shop drawings;
2. Hydro-Mechanical structures. These drawings shall contain the details regarding joints, connections, number and position of nuts and bolts, weldings, etc.;

The Drawings shall be accompanied by accurate technical reports.

3.5 MEASUREMENT AND PAYMENT

3.5.1 SURVEY AND GROUND CONTROL POINTS

No extra measurement for payment or payment will be made for Contractor's survey and setting-out work and the entire cost thereof shall be included in the Unit Prices for other items of the Works.

Table 3.1-Accuracy of Transverse Nets

	Traverse net for additional fixpoint	Traverse net for setting out
Number of azimuth courses azimuth checks not to exceed	n = 25	n = 50
Max. difference in cm between two measurements of the distance of two points (d = distance in m)	$d = 0.003\sqrt{d} + \frac{d}{5000}$	$d = 0.004\sqrt{d} + \frac{d}{5000}$
Azimuth closure at azimuth: check points not to exceed (centesimal degrees)	$\frac{c}{2\sqrt{n}}$	$\frac{c}{3\sqrt{n}}$
Closing error in position, after azimuth adjustment (d = distance in m) $f_s = \sqrt{f_y^2 + f_x^2}$ (cm)	$f_s = 0.001\sqrt{d} + 10cm$	$f_s = 0.002\sqrt{d} + 10cm$

3.5.2 CONSTRUCTION DRAWINGS

No extra measurement for payment or payment will be made for the above-mentioned drawings. The related cost is included in the Unit Prices for other items of the Works.

4 SITE INSTALLATIONS AND SERVICES

4.1 SCOPE OF WORK

4.1.1 TEMPORARY SITE INSTALLATION

1) The Contractor shall be responsible for providing construction equipment, materials and labour for the provision of all necessary Temporary Site Installations and facilities adequate for carrying out the Works under this Contract.
2) The Contractor shall design, furnish, install, operate and maintain the Site installation, workshops, warehouses, storage areas etc. including the related facilities.
3) Site installation carried out by the Contractor shall conform to the applicable standards, codes and sanitary requirements in force in Republic of Uganda for such purpose.
4) The design, construction, operation and maintenance of the Contractor's temporary installations shall be subject to inspection and approval by the Engineer.
5) All site installations and facilities provided by Contractor, shall at all times remain Contractor's property unless otherwise specified in the Contract or agreed by the Parties.
6) Unless otherwise agreed with the Employer, upon the Completion of Works, the Contractor shall dismantle and remove from the Site the site installations and facilities.

4.1.2 PERMANENT SITE INSTALLATIONS

1) The Contractor shall provide the following:
    a. the Workers' Camp;
    b. the Management's Camp;
    c. Offices.
2) The Contractor shall provide Construction Drawings.
3) The structures shall be used by the Contractor, the Engineer and the Employer during the construction phase.
4) The Contractor shall be responsible for the cleaning, security and maintenance of the camps during the construction period.
5) The Contractor shall be liable for any damage to or deterioration of the structures until the end of the works.
6) At the end of the works, the above structures shall be handed over to the Employer in perfect condition.

4.1.3 SERVICES

1) The Contractor shall be responsible for providing services to the Employer, the Engineer and Employer's other contractors working for the Kabuyanda Project.
2) The services will include the rent of vehicles, the use of the medical care facilities, the use of the communication systems, the use of survey equipment, the cleaning of offices, the disposal of garbage, the availability of site facilities (catering, recreation and commercial concessions), the use of the water supply, ventilation and illumination systems.

4.2 SUBMITTALS

1) Within 21 days from the date of issue of the Notice to Commence, the Contractor shall submit to the Engineer updated layout plans showing at adequate scale the locations and arrangement of all site installations along with the related facilities. These plans shall be consistent with the plan submitted by the Contractor with his Bid as well as with any amendments and additions subsequently agreed to by the Engineer and the Contractor, and shall include:
    a) camps and offices
    b) Parking areas, warehouses, storage areas, and medical care facilities
    c) Temporary roads
    d) Water supply, sewerage, sewage treatment and disposal
    e) Power supply and illumination, telephone and internet services

f) Equipment pools and mechanical workshops
g) Spoil areas, quarry and stockpile areas
h) Concrete aggregates processing plant
i) Concrete batching and mixing plant including cement storage
j) Explosives magazines
k) Security and safety arrangements

2) Within 28 days from the date of issue of the Notice to Commence, the Contractor shall submit to the Engineer the following:
   a) Detailed drawings at scale 1:500 showing the camps layout, buildings, roads, recreation areas, utilities, etc., and drawings at scale 1:50 showing typical construction details of all buildings;
   b) Detailed design of clinic\infirmary;
   c) Detailed design for industrial and potable water supply to the camps and working areas as well as sewerage systems, sewage treatment and disposal;
   d) Detailed layout drawings for electrical installations and distribution systems, at the Site, showing voltages, outlets, and routing of power lines;
   e) Detailed design and drawings including manufacturer's drawings and flow charts for the concrete and aggregate processing plant, in accordance with the requirements of the pertinent Sections of these Specifications.

4.3 SITE INSTALLATIONS

4.3.1 CAMPS

1) The Contractor shall construct, provide furnishings, maintain, and operate the camps necessary for his staff and labour as well as for the staff and labour of hissubcontractors.
2) The camps shall include offices, kitchens, dining rooms, recreation facilities, family dwellings, dormitories, sanitary facilities, medical service, shops, chapel and/or mosque, roadways, drainage, fire control, commercial facilities, and all utility services (potable water, power, lighting, ventilating, sewage treatment and disposal, cleaning and sanitation, garbage collection and disposal, etc.). The camps shall be large enough to accommodate the expected peak work force.
3) The areas approved by the Engineer will be put at the Contractor's disposal free of charge and in their natural conditions. The Contractor shall be responsible for the necessary topographical surveys, clearing, and earthwork required for the landscaping and to provide satisfactory foundations for buildings, streets and auxiliary facilities.
4) No camp construction shall commence until the Contractor's drawings and specifications have been approved by the Engineer.
5) All camp buildings shall be of sound construction and neat appearance, and connected to all utility services.
6) Food handling, preparation and serving shall be arranged by the Contractor in properly equipped canteen buildings for all his, his subcontractors' employees, Engineer’s staff and the Employer.
7) The prices charged by the Contractor for food, beverages, etc., available in the camp shall be calculated on a non-profit basis.
8) The Contractor shall be responsible for keeping the camp, and the buildings within it, in good hygienic conditions. The standards and regulations presently in force in Republic of Uganda with regard to personnel treatment, sanitary conditions, and fire and accident prevention shall be duly taken into account.

4.3.2 AUXILIARY BUILDINGS AND STORAGE AREAS

1) The Contractor shall provide, equip and maintain, for his own and his subcontractors' use, main and secondary offices, warehouses, materials storage areas, fuel storage areas,

explosives magazines and other necessary auxiliary buildings.

2) Listed hereunder are the shops, warehouses, stores and stations expected to be required for the performance of the Works under this Contract, in addition to facilities explicitly specified elsewhere in these Specifications:
    a) Mechanical repair shop
    b) Electrical repair shop
    c) Metalwork and wood fabrication shop
    d) Main warehouse
    e) Bagged cement store
    f) Spare parts store
    g) Gasoline and oil stations
3) The Contractor is required at all times to have at the Site at least one month's minimum reserve of the following materials:
    a) Gasoline
    b) Diesel and lubricants
    c) Cementitious materials (unless any other reserve requirements are given elsewhere in these Specifications)
    d) Explosives
    e) Steel reinforcement
    f) Medical supplies
    g) Main foodstuff and beverages

4.3.3 MEDICAL CARE FACILITIES

1) The Contractor shall comply with laws and health standards presently in force in Uganda. In the event of illness of an epidemic nature breaking out, the Contractor shall carry out and comply with all orders, arrangements or regulations which may be issued by the Government or local authorities.
2) The Contractor shall construct, equip, and maintain at the Site, at least the following medical care facilities:
    a) One clinic/infirmary, with two ambulances and drivers:
    b) One first aid station, near the quarry
3) The clinic/infirmary shall be available and fully operational beginning of the Works. The construction of this facility shall be such as to provide reasonable quiet, privacy, communications, adequate ventilation, air conditioning system, light, hot and cold water, toilet facilities and electrical outlets.
4) The first aid station shall consist of cabinets equipped with apparatus and materials necessary for the treatment of minor injuries and the assistance for transferring the personnel that incurs in major accidents to the site clinic/infirmary.
5) The clinic/infirmary shall have separate rooms for normal and epidemic illnesses and shall be fully equipped and staffed to meet the requirements of the peak anticipated work load and labour force, taking into account the nature of the Works and its occupational hazards.
6) Medical services in the clinic/infirmary shall be under the direction of a licensed physician/surgeon on a 24-hour basis throughout the duration of the construction and shall be available, including drugs, free of charge to all persons and participants engaged in the Works and their families or dependents living at the Site.
7) Treatment facilities and care of seriously ill or injured patients shall be on an emergency basis until their transfer to an established hospital is made. Standing arrangements to this effect shall be made by the Contractor with the nearest general hospital, and the Engineer shall be notified accordingly.
8) Upon the Completion of Works, the Contractor shall hand over the medical care facilities to the Employer.

4.3.4 COMMERCIAL CONCESSIONS

1) Possible commercial concessions such as for laundry, catering, shops, etc., granted to a third party by the Contractor for the use of his personnel resident at the Site, shall be subject to approval by the Engineer. Any concession shall be revoked if the concessionaire violates the law or the provisions governing the granting of the concession. Concessions shall automatically terminate upon completion of the Works or in the event of the termination of the Contract.
2) No concession shall be granted for activities that are contrary to statutory regulations or are declared by the Engineer to be offensive to the community.
3) Concessionaires will be regarded as subcontractors of the Contractor.

4.3.5 STATIONARY PLANTS

1) The Contractor shall install and erect all plants necessary for production of filter material and for aggregate processing and concrete batching-mixing, of sufficient capacity to meet the planned peak requirements during construction. The plants shall be subject to approval by the Engineer and shall be designed and fabricated according to the modern technical criteria.
2) All plants shall be kept in good running order to ensure compliance with the materials quality specifications. All control and measuring equipment shall be regularly serviced and calibrated.
3) Basic characteristics of the required plants are given in the pertinent sections of these Specifications.

4.3.6 MATERIALS TESTING LABORATORY

1) The Contractor will be responsible of all tests for the Quality Control to be performed in connection with the concrete and other materials used for the construction of the Works.
2) The Contractor shall supply, install, operate, maintain and remove at the end of the Works a site laboratory that will have to function as Quality Control of the Works.
3) The laboratory shall be run by Contractor's personnel experienced in sampling and testing of materials, and quality control.
4) The Contractor’s laboratory shall be designed for performing all sampling and tests required in the Technical Specifications.
5) All sampling and testing to be undertaken shall be under the direct supervision of the Engineer.
6) Specialized testing may be required and which cannot be performed in the site laboratory due to unavailability of proper equipment shall be assigned to independent organizations at Contract’s cost.
7) The Contractor shall be responsible for the handling and transport of all materials that will be required specialized testing.

4.3.7 COMMUNICATION SYSTEMS

4.3.7.1 Communications

1) The Contractor shall supply, install, operate and maintain a telephone switchboard, complete with standby power supply, to connect his offices with those of the Employer and Engineer, as well as campsite, laboratory, workshops, stores, aggregate plants, batching plants, medical care facilities and other work areas within the Site.
2) The Contractor shall furnish a directory of the telephones installed at the Site and make it available to the Engineer.
3) In addition to the local telephone system, the Contractor shall supply, install and maintain mobile two-way radio transceiver sets for the Engineer's and for his service vehicles for on-site communications.
4) Upon the Completion of Works, the Contractor shall dismantle and remove from the site the installed site communication. However, the Employer reserves the right to purchase

some or all of the equipment.

4.3.7.2 Long-Distance Communications

1) The Contractor shall supply, install, operate and maintain the access to the national and international telephone grid (Voice and Data).
2) The Employer will endorse the necessary license applications of the Contractor.
3) Upon the Completion of Works, the Contractor shall dismantle and remove from the Site the installed outside communications. However, the Employer reserves the right to purchase some or all of the equipment.

4.3.8 POWER SUPPLY AND ILLUMINATION

1) The Contractor shall provide, install and keep operational throughout the execution of the Works his own electric power generation equipment, with a capacity sufficient to satisfy the requirements of the Works, including electric powered construction equipment, camps, buildings, water supply, de-watering, safety and security systems etc.
2) The power generating station shall be fitted with devices that can automatically govern the operation of the sets according to the actual network load.
3) The Contractor shall install, operate and maintain the electrical distribution systems which he deems necessary, including all necessary transformers, circuit breakers, disconnect and safety switches, voltage regulators, transmission lines, poles, pole hardware, conductors and other equipment necessary for power distribution throughout the work areas and temporary facilities.
4) The Contractor shall ensure adequate illumination for all his working activities and at the camp, including illumination of the streets.
5) Upon the Completion of Works, the Contractor shall:
    - dismantle and remove all power generation and distribution facilities installed by him for the temporary camps;
    - overhaul and handover to the Employer all power generation and distribution facilities installed by him for the permanent camp.

4.3.9 WATER SUPPLY

1) The Contractor shall design, install, operate and maintain water supply facilities for the needs of the works and the camps.
2) Two separate water supply systems for raw water and potable water are foreseen.
3) The raw water will be used for construction activities and therefore it shall be treated to the extent necessary to meet specified requirements for concrete, mortars, aggregates, curing, etc.
4) The potable water will be used for the buildings. The potable water shall be of high quality meeting official requirements for drinking water supply.
5) The water supply systems shall allow for the provision of water to the hydrants of the whole site for fire fighting.
6) The Contractor shall obtain the water from suitable natural local sources, free of contamination and unaffected by the Site construction work approved by the Engineer. For working areas with no natural sources, the Contractor shall provide sufficient number of water-tank trucks to cover the requirements on both the industrial as well as potablewater.
7) The Contractor shall furnish, install, operate and maintain all pumps, piping, fittings, valves, storage tanks, purification plant and chlorination for the water supply and distribution systems, adequate in quantity and pressure. There shall be no cross connections of any kind between the industrial and potable water supply systems.
8) Throughout the duration of the construction, the Contractor shall take regular samples from all water supplies to examine it for suitability and treatment required, and make weekly the bacteriological tests from potable water systems.
9) Drinking points of potable water shall be provided by the Contractor for the use of

personnel in all working areas.

10) Upon the Completion of Works, the Contractor shall:
    - dismantle and remove all water supply systems installed by him for the temporary camps,
    - overhaul and handover to the Employer all water supply systems installed by him for the permanent camp.

4.3.10 SANITATION AND SEWERAGE

1) All offices, workshops, laboratory and other occupied work buildings shall be provided with toilets connected to properly constructed and regularly maintained septic tanks approved by the Engineer.
2) The camp sites shall be provided with a complete, properly maintained and operated sewerage system, including septic tanks, sewage treatment and disposal facilities. Facilities for washing clothes shall also be provided and linked to the sewerage system.
3) Portable chemical toilets shall be provided and maintained by the Contractor for the use of all personnel at all work locations which are remote from fixed sanitary facilities. The Contractor shall arrange for all chemical toilets to be attended to for proper sanitary disposal on a daily basis.
4) Upon the Completion of Works, the Contractor shall:
    - dismantle and remove all sanitation and sewerage systems installed by him for the temporary camps,
    - overhaul and handover to the Employer all sanitation and sewerage systems installed by him for the permanent camp.

4.3.11 WASTE AND GARBAGE DISPOSAL

1) The Contractor shall collect waste material and garbage from camp, offices and workshops on a daily basis and transport them to an area approved by the Engineer where it shall be incinerated and/or buried.
2) The Site shall be kept clean and free of refuse at all times. No waste shall be dumped in areas other than those approved by the Engineer for waste disposal. No waste of any kind shall be deposited in any watercourses.

4.3.12 FENCING AND SITE SECURITY

1) The Contractor's offices, workshops and storage compounds, campsites and all construction areas where exclusion of unauthorized personnel is necessary for safety and security, shall be adequately fenced, gated and guarded.
2) The Contractor shall employ an adequate force of properly trained security guards at the work site and at the construction camp on 24-hour duty including Sundays and holidays. Storage areas shall be fenced, lighted and regularly patrolled by security guards. Warehouse buildings and explosive magazines shall be kept locked and keys accounted for at all times.
3) All employees engaged in the execution and maintenance of the Works shall wear identification badges when at the work site.
4) The Contractor shall be responsible for the losses occurring in his installations.

4.3.13 INSPECTION BY THE EMPLOYER OR ENGINEER

The Employer and the Engineer have the right at any time to inspect any part of the Contractor's temporary facilities, without advance notification, and to require immediate rectification of any contravention of the specified requirements.

4.3.14 FINAL CLEAN-UP

1) Upon the Completion of Works, or when any plant has completed its functions, the Contractor shall dismantle and demobilize all temporary facilities erected by himself or his subcontractors, and remove all debris, objectionable material, and all other refuse which may have been deposited on Site during the construction period. Such materials may be deposited only in areas approved by the Engineer. The Contractor shall also remove from

the Site any plant and equipment which he finds at the commencement of the Works in accordance with the instructions of the Engineer.

2) All excavated areas shall be filled, graded and dressed in a clean and orderly condition acceptable to the Engineer. As far as possible, such areas should conform to the natural appearance of the landscape.
3) No demobilization or removal of temporary facilities and equipment shall be made without prior approval of the Engineer.

4.4 SERVICES FOR EMPLOYER AND ENGINEER

4.4.1 COMMUNICATION SYSTEMS

The Contractor shall make both the site and long-distance communications systems available to the Employer and the Engineer.

4.4.2 SURVEY EQUIPMENT

1) Surveying instruments shall be provided by the Contractor for exclusive use of the Employer's and Engineer's site staff. These instruments shall be brand new, of the latest design and manufactured by reputable manufacturer acceptable to the Engineer. The instruments shall include all items necessary for the Engineer to be able to establish horizontal and vertical control and to check the Contractor's surveying work.
2) The Contractor shall submit to the Engineer for approval the proposed make, type, and models with catalogues, prior to place the purchase order. The following minimum equipment shall be provided:
    - 1 No total station Make TRIMBLE, Model S9 0.5" Robotic, DR HP, Long Range FineLock (with an accuracy of 0.8 mm) or similar complete with all accessory items such as 2 No batteries, battery charger, memory card, power cable, carrying case and other standard accessories supplied with the instrument;
    - 3 No 360 degree TRIMBLE prism complete with telescopic range poles, circular bubbles, extension rods and carry bags;
    - 1 No TRIMBLE hardwood tripod to suit the total station;
    - 1 No TRIMBLE automatic level;
    - 1 No aluminium tripod to suit the automatic level ;
    - 1 No, 4 metre long aluminium staff graduated at 0.005m intervals;
    - 2 No, 50 metre fibron tapes;
    - 3 No, 5 metre steel tapes.
3) The Contractor shall provide the Engineer with any additional surveying equipment and materials such as pegs, mallets, stakes, nails, paint, etc., as required for checking the Works. Any instrument which has been damaged or is non-operational shall be immediately replaced or repaired by the Contractor.
4) Upon the Completion of Works, all surveying equipment will be returned to the Contractor. However, the Employer reserves the right to purchase some or all of the equipment.
5) The Contractor shall make available to the Engineer any surveying instrument owned by his surveying department, but not included in the above list of equipment, which may be necessary for checking the Works.

4.4.3 VEHICLES

1) The Contractor shall provide, repair and maintain the following vehicles for the exclusive use of the Engineer within 56 days after the day of receipt of the Notice to Commence:
    a) 3 Nos Land Cruiser type, 4-wheel drive, minimum 5 passengers capacity
    b) 3 Nos Pickup truck of 1.5 t capacity

    The vehicles shall be of the latest design of Rover, Toyota or other reputable manufacturer acceptable to the Engineer.

    These cars shall be supplied brand new, fully licensed and insured, and shall be replaced

by new ones in case of repeated breakdowns. The estimated number of vehicles and the number of months they will be required are given in the Bill of Quantities.

2) The above vehicles shall be assigned full time to the Engineer, for official and private use. In case of breakdown or if a vehicle is undergoing repair and maintenance at the workshop, the Contractor shall provide a replacement immediately.
3) All service vehicles shall be returned to the Contractor upon the Completion of Works. However, the Employer reserves the right to purchase some or all of the vehicles.

4.4.4 OFFICE CLEANING AND GARBAGE DISPOSAL

1) The Contractor shall provide personnel and perform daily cleaning of the Engineer's site offices.
2) The Contractor shall collect daily and dispose of, in a location and manner approved by the Engineer, all domestic waste and garbage from the Engineer's site offices and housing compound. Collection times shall be arranged for the convenience of the Engineer.

4.4.5 MEDICAL CARE FACILITIES

The Contractor's medical care facilities shall be made available for use by the Employer's and Engineer's site staff and their families or dependents living at the Site.

4.4.6 CATERING, RECREATION FACILITIES, AND COMMERCIAL CONCESSIONS

1) The Contractor's catering and recreation facilities including canteen, and commercial concessions shall be made available for use by the Employer's and Engineer's site staff and their families living at the Site on the same terms and conditions as the Contractor's personnel of equivalent rank.
2) The Contractor shall take care that these facilities and supplies available are suitable for expatriate personnel.
3) The Contractor’s canteen facilities shall be designed and operated in such a way that the Employer’s personnel may have meals which are prepared in accordance with Ugandan customs.

4.5 MEASUREMENT AND PAYMENT

4.5.1 SITE INSTALLATIONS

4.5.1.1 Camp, Auxiliary Buildings, Materials Testing Laboratory and Storage Areas

1) Payment for the camp, auxiliary buildings, materials testing laboratory, storage areas and appurtenant facilities will be made as Lump Sum entered in the Bill of Quantities.
2) Payment shall cover the entire cost of design, delivery, land preparation, earthmoving, fencing, tests, dismantling, removal from Site and reinstatement of the Site.
3) Payment will be made in two instalments. The first, of 85% will be made when the said facilities are, in the opinion of the Engineer, fully installed, commissioned and ready for use. The second, of 15% will be made:
    - for the temporary site installation: upon removal and Site reinstatement to the satisfaction of the Engineer;
    - for the permanent installation: after verification of the efficient working conditions of the installations by the Engineer.
4) Should the Contractor fail to execute the final clean-up to the full satisfaction of the Engineer, the second instalment of 15% will be retained. In the event that this amount proves to be insufficient for financing of the Site reinstatement, all extra costs shall be deducted from the money due to the Contractor.

4.5.1.2 Stationary Plants

1) Payment for the stationary plants (aggregate processing plant and concrete batching and mixing plants), including the related facilities, will be made at the Lump Sum price entered in the Bill of Quantities.
2) Payment shall cover the entire cost of design, delivery, earthmoving, installation and tests, dismantling, removal from Site and reinstatement of the Site.

3) Payment will be made in two instalments. The first, of 85% will be made when the said facilities are, in the opinion of the Engineer, fully installed, commissioned and ready for use. The second, of 15% will be made upon removal and Site reinstatement to the satisfaction of the Engineer.
4) Should the Contractor fail to execute the final clean-up to the full satisfaction of the Engineer, the second instalment of 15% will be retained. In the event that this amount proves to be insufficient for financing of the Site reinstatement, all extra costs shall be deducted from the money due to the Contractor.

4.5.1.3 Exclusions

No separate payment will be made for, but not be limited to, the following Contractor's temporary installations and facilities and the entire cost thereof shall be included in the Unit Prices and Lump Sum of the Bill of Quantities:

a) Medical care facilities;
b) Commercial concessions;
c) Communication systems;
d) Power Supply and Illumination;
e) Water supply;
f) Sanitation and sewerage;
g) Waste and garbage disposal;
h) Fencing and site security.

4.5.2 SERVICES FOR EMPLOYER AND ENGINEER

4.5.2.1 Communication Systems

No separate payment will be made for the use of the Contractor's communication systems, except for the long-distance telephone communications bills, which will be issued by the public service utility.

4.5.2.2 Survey Equipment

1) Payment for the rental and maintenance of survey equipment will be made as Lump Sum entered in the Bill of Quantities, which shall cover the entire cost of furnishing and maintaining of the equipment and accessories.
2) Payment for survey equipment will be made in two instalments. The first, equal to 90% of the Lump Sum, will be made when the complete equipment is handed over to the Engineer. The second, equal to 10%, will be made at the completion of the works.

4.5.2.3 Service Vehicles

1) Payment for the service vehicles will be made under two headings:
   a) Supply of each Vehicle
   b) Operation Cost of each Vehicle
2) Payment for supply of the vehicles will be made at the Lump Sum entered in the Bill of Quantities, at the time of delivery of the requested vehicle, fully licensed, insured and road worthy. The Lump Sum shall include the entire cost for supply, transport to site, taxes, duties and the driver's salary. The driver's salary shall include all compensation for night work, work on weekends or holiday, vacations, social and security contributions, and taxes as prescribed by the rules and laws of Uganda.
3) Payment for operation will be made at the unit price per kilometer entered in the Bill of Quantities, which shall cover the entire cost of servicing and maintaining of the vehicles. In particular the unit price shall include the supply of fuel, lubricants, spare parts and tires.

4.5.2.4 Medical Care Facilities

No separate payment will be made for the use of the Contractor's medical care facilities, and the entire cost thereof shall be included in the Unit and Lump Sum Prices of the Bill of Quantities.

4.5.2.5 Catering, Recreation Facilities and Commercial Concessions

1) The Employer's and Engineer's employees will directly reimburse the Contractor for the use of

Contractor's catering facilities.

2) Payment will be made at the unit price entered in the Bill of Quantities for every meal (breakfast, lunch and dinner) served in the canteen to Engineer's site staff or dependents living at the Site.
3) No separate payment will be made for the use of Contractor's recreation facilities and commercial concessions, and the entire cost thereof shall be included in the Unit and Lump Sum Prices of the Bill of Quantities.

4.5.2.6 Waste and Garbage Disposal

No separate payment will be made for the waste and garbage disposal service performed by the Contractor, and the entire cost thereof shall be included in the Unit and Lump Sum Prices of the Bill of Quantities.

5 CARE OF WATER DURING CONSTRUCTION

5.1 SCOPE OF WORK

1) The Contractor shall provide all labour, material, and equipment necessary to build and maintain the Temporary Works for protecting the Works under construction against flood flows in the rivers and creeks, and to design, build, install, operate, maintain and dismantle the temporary de-watering facilities required to remove service water and natural surface flow or groundwater seepage from the working areas.
2) The temporary works and facilities for the care of water during construction shall be designed by the Contractor, subject to the approval of the Engineer.
3) All such Temporary Works and dewatering facilities shall be removed at the end of the works, so as to give a slightly appearance and not to interfere in any way with the operation or usefulness of the permanent works, except different authorization of the Engineer.
4) The Contractor shall not interrupt or interfere with the flow of the Mishumba River or other streams for any purpose without the approval of the Engineer.
5) The areas of the temporary protection works shall be readily accessible at all times and the Contractor shall make continuous survey of floods to the satisfaction of the Engineer.
6) The hydrology of the Mishumba River and the discharge capacity of the main river diversion facilities shown in the drawings or in the Information for Bidders are to be regarded as merely indicative to aid the Contractor in his planning of the construction works.
7) The Employer and the Engineer do not guarantee the reliability or accuracy of this information and assume no responsibility for any interpretation or conclusion which may be made or drawn by the Contractor.
8) The Contractor shall be fully responsible for any damage or delay to the Works caused by failure of his protective works.
9) The Contractor shall also be responsible for and shall repair or reinstate at his expense any damage to foundations, excavation slopes or any other part of the Works caused by the failure of the protective works and/or pumping installation.

5.2 SUBMITTAL

1) The Contractor shall submit to the Engineer the design, including full details of equipment to be installed and all necessary construction details required for the de-watering purposes, at least 30 days prior to scheduled construction of the particular work.
2) This design shall be consistent with the outline description submitted by the Contractor with his Bid, and shall include the following:
    a) Design assumptions and calculations
    b) Layouts of diversion and drainage facilities
    c) Layout and capacity of pumps and pipes, sumps, drains, etc.
    d) Any other arrangements or installations the Contractor may propose for temporary protection of the Works and de-watering of the surface working areas

5.3 RIVER DIVERSION

5.3.1 GENERAL

A possible solution for river diversion is proposed in the tender documents and drawings. This solution comprises of:

1. Phase 1: EXCAVATION OF INLET AND BARREL WORKS;
2. Phase 2: CONSTRUCTION OF
    - INLET AND BARREL
    - RE-FILLING WITH EXCAVATED MATERIAL:
3. Phase 3: CONSTRUCTION OF APPROACH & TAIL CHANNELs;
4. Phase 4: CONSTRUCTION of the U/S and D/S COFFERDAMS;

5. Phase 5: PLUGGING of the DIVERSION BARREL.

The most suitable choice for the diversion works strongly depends on the means and needs of the Contractor.

The Contractor shall propose his own alternatives and submit them to the Engineer for his approval. Should the Contractor elect to adopt the proposed tender solution, he shall execute it under his own responsibility.

5.3.2 REQUIREMENTS

1) The Contractor shall construct the upstream cofferdam, the downstream cofferdam and the other auxiliary works.
2) The Contractor shall maintain throughout the entire construction period the diversion structures as necessary to keep unchanged the discharge capacity of the diversion canal and the safety conditions of the upstream and downstream cofferdams. In particular, the Contractor shall keep the entrance of the barrel free from all floating debris that may get stuck against the entrance structure.
3) The Contractor shall perform all works necessary to drain the dam, spillway, control building, and intake foundation area of rain, groundwater, seepage water through the bodies of the cofferdams, and service water.

5.4 OTHER FLOOD PROTECTION WORKS

5.4.1 REQUIREMENTS

1) The work shall be executed in accordance with the Contractor's drawings, specifications and sequences as approved by the Engineer.
2) The flood protection works shall be designed in such a way that they will not interfere with any work to be performed or with any permanent structure.
3) The approval given by the Engineer shall not relieve the Contractor from being fully responsible for the design, construction, maintenance, safety and removal of the works as specified herein, and he shall be fully liable for any damages or delays caused by its failure. The Contractor shall indemnify the Employer against claims arising out of any such failure, made by other contractors, landholders or any other persons.

5.4.2 MATERIALS AND EXECUTION

1) The Contractor shall select material and construction methods he considers appropriate for the flood protection works, subject to approval by the Engineer.
2) Seepage through dikes, cofferdams and surface runoff from adjacent areas shall be properly collected and disposed of.
3) Should the Contractor notice that any part of the flood protection works is in such condition that it poses a serious risk, he shall notify the Engineer immediately of the situation, no matter what the causes. Remedial measures approved by the Engineer shall be undertaken without delay.
4) After they have served their purpose, the dikes, cofferdams or other protective works shall be removed as needed to such level as not to interfere in any way with the operation of Permanent Works and with the flow of water.
5) The removal of the flood protection works shall cause no undue interference with other works and the Contractor shall be responsible for any damage to Temporary or Permanent Works caused by the removal of flood protection works.

5.4.3 DIVERSION OF CREEKS

1) Creeks in the stockpile, spoil, and quarry areas or where required by the construction of any permanent structure shall be diverted into culverts or ditches lined as required to prevent ditch erosion. Waters that have become sediment laden due to construction activities shall be handled according to the requirements for soil erosion and pollution control as stipulated, and as follows:

a) Sediment laden water caused by road transport activities shall be diverted through settling ponds
b) Check dams shall be constructed as required downstream from spoil areas to detain sediments laden waters long enough for sediments to settle down

2) The peak capacities of the systems shall be selected taking into account the extent of the sites to be de-watered and the diversion arrangements proposed.

5.5 CARE OF WATER AT CONSTRUCTION SITES

5.5.1 GENERAL

The Contractor shall perform all works necessary to drain and dewater the construction sites of rain, groundwater and service water. The work shall include, but not be limited to the following:

a) Design and construction of drainage, ditches, pits, pump sumps and settlement ponds with oil separators
b) Design, furnishing, operation and maintenance of de-watering equipment
c) Relocation of de-watering facilities required for the performance of other works
d) All auxiliary works required for safe and continuous de-watering of the construction sites

5.5.2 REQUIREMENTS AND DESIGN

1) The Contractor shall design and install complete facilities for all construction sites.
2) The de-watering systems shall be designed to accommodate, without undue disruption to the work, any rainfall event. The peak capacities of the systems shall be selected to satisfy the maximum intensity, taking account of the extent of the sites to be de-watered and the de- watering arrangements proposed.
3) Claims for extension of time due to delays caused by unfavourable weather conditions will not be considered.
4) The Contractor shall provide, install, maintain, and operate adequate pumping and other equipment, including standby units, to handle all water entering into any of surface construction sites. In addition, he shall provide sumps and pumps in the immediate vicinity of the structure foundations using such water conductors as are necessary to conduct the water away from the excavation and concrete placement operations in an approved manner, so that such operation shall be kept free from standing or running water.
5) The Contractor shall ensure that all drainage water will be disposed of without causing interference to his own or other contractors operations elsewhere at the Site and that no drainage water runs into adjacent Works. Water discharged from work areas shall meet the requirements for pollution control referenced above.
6) The de-watering systems shall be designed and installed in such a way that modifications and extensions to the systems are possible while they are in full operation.
7) All the components of the de-watering systems shall be installed and operated in accordance with the agreed method and the construction time schedule, or approved modification thereof.
8) The approval by the Engineer of the de-watering system shall not relieve the Contractor from being fully responsible for the design and operation of the de-watering systems and he shall be liable for any damage or delays caused by its failure. The Contractor shall indemnify the Employer against claims arising out of any such failure, land holders or other persons.

5.5.3 SURFACE EXCAVATION DEWATERING

1) Drainage ditches shall be excavated along the top of excavated slopes and on the berms. Such ditches shall be kept well back from the excavation edges in order to prevent saturating the upper part of the slopes. The ditches shall be regularly cleaned out of all accumulated silt and other matter so that water may flow freely at all times.
2) The Contractor shall take measures to ensure that the foundation surfaces remain free of

standing water and undamaged by the passage of construction traffic. All ditches shall be outside the foundation areas. The water shall be collected and removed by pumping if no outflow by gravity is possible.

3) Where excavation is to be made below the groundwater table in loose material, the Contractor shall lower the water table sufficiently below any working surface in advance of the excavation by proper means.
4) Where concrete is to be placed, the water table shall be maintained below the lowest part of the finished excavation for minimum one day following the raising of structure above the natural groundwater table, and for such additional time as may be necessary to preclude damages to structure foundation.
5) Upon completion of de-watering, temporary pipes and pump sumps beneath permanent structures shall be closed off and completely filled with grout, mortar or concrete as required by the Engineer.

5.6 MEASUREMENT AND PAYMENT

5.6.1 RIVER DIVERSION AND CARE WATER DURING CONSTRUCTION

1) Payment for the diversion works will be made at the appropriate lump sum price entered in the Bill of Quantities. Any alternative proposed by the Contractor for river diversion shall not result in a variation to the lump sum price entered in the Bill of Quantities.
2) Payment for the maintenance throughout he construction period of the diversion structures, for the provision and operation of the facilities required to de-water the culvert, will be made at the single lump sum provided in the Bill of Quantities, which shall include, but not limited to, the provision of all labour, material, plant, equipment and auxiliary works required. Payment of the lump sum will be made as follows:
    a) four (4) equal instalments of 20% each at five months intervals, starting five months after the signature of the Contract.
    b) The balance corresponding to 20% of the lump sum, at the end of the works.
3) Payment for removal of the downstream cofferdams will be made at the appropriate lump sum price entered in the Bill of Quantities.

5.6.2 OTHER FLOOD PROTECTION WORKS

No separate payment whatsoever will be made for other flood protection works and relocation of creeks during construction, and all related costs for the provision of labour, material, plant, equipment and auxiliary works etc. required for design, construction, installation and removal of dikes and other protective works shall be deemed to be included in other items of the works.

5.6.3 CARE OF WATER AT CONSTRUCTION SITES

No separate payment whatsoever will be made for the care of water at construction sites and all related costs for the following shall be deemed to be included in other items of the works.

a) Design of all de-watering systems
b) All labour for excavation, construction and protection of drainage ditches, wells, pits, pump sumps and settlement ponds
c) Capturing and conveying the water into the drainage system
d) Supply, installation, operation, maintenance and removal of all pumps, pipes and equipment for pumping water, regardless of the amount of water
e) Grouting of pipes and pump sumps where required
f) All auxiliary works required

6 EXCAVATION AND FILLING

6.1 SCOPE OF WORK

1) This Section covers the surface excavation and fill works to be performed under this Contract. The excavation shall consist of removing all existing material of whatever nature to the lines and grades shown on the Detailed Design and/or Construction Drawings as otherwise directed by the Engineer and shall include drilling and blasting, loading, hauling and disposal of materials in designated spoil or stockpile or fill areas.
2) Rock support, slope protection, stabilization measures, sprayed concrete, de-watering, and exploratory drilling, which may be needed in conjunction with excavation work, are covered in other Sections of these Specifications.
3) The Contractor shall comply with all safety procedures and requirements as stipulated in the "Safety Precautions".
4) The approval given by the Engineer to the Contractor's methods and equipment shall not relieve the Contractor of his full responsibility for the proper and safe execution of surface excavations, or of liability for injuries to, or death of persons, or any obligations under this Contract.

6.2 SUBMITTAL

1) At least 28 days prior to the commencement of any excavation, the Contractor shall submit to the Engineer details of the proposed excavation methods and sequences, necessary site drainage and safety precautions, including (if necessary) equipment and rock supports.
2) Where the excavation for the main permanent structures involves blasting, the data shall include the following:
    a) Location and area of blast
    b) Diameter, spacing, depth, pattern and orientation of blast holes
    c) Type, strength, amount, column load and distribution of explosives to be used per hole, per delay and per blast
    d) The type of detonators, powder factor, and sequence and pattern of delays to be used per blast
    e) Description and purpose of any special method to be adopted by the Contractor
3) The plans shall be in conformity with detailed requirements for excavation sequencing, for blasting and for precautions in proximity to concrete and grouting operations.
4) At least 14 days prior to dumping or stockpiling any material, the Contractor shall submit the layout of spoil or stockpile areas, which will be within areas approved by the Engineer. All pertinent data of working methods and provisions for the security, stability and temporary and permanent drainage of the areas shall be included. Details of volumes, material types, heights and grades shall be provided.
5) Prior to starting any excavation in any particular area, the Contractor shall confirm in writing his agreement with the existing surveys and topographical data showing the original ground surface for the area in question which will be used for measurement purposes. Should the Contractor have any doubts as to the correctness, or sufficiency, of such data, he shall carry out an independent survey on his own and submit his survey to the Engineer for approval. In case of disagreement, the Engineer and Contractor shall mutually review the existing data. The agreement concerning the location of the original ground surface must be reached before commencing excavation work. Contractor's failure to follow the procedure outlined above will forfeit his right to claim any other locations of the original ground surface than that established by the Engineer.
6) To enable the Engineer to verify all necessary elevations and cross-sections of the original ground surface, prepared by the Contractor, the latter shall notify the Engineer in writing, giving

at least 7 days notice before the commencement of any excavation. The Contractor shall clear, in advance, all vegetation that may interfere with this survey work.

6.3 LINES AND GRADES

1) The Contractor shall be responsible for setting-out all the structures and slopes as shown on the Detailed Design and/or Construction Drawings in accordance with the Section 3, "Surveying and Setting-out Work". All extra work and over excavation caused by improper setting-out by the Contractor shall be corrected by himself immediately upon the request of the Engineer.
2) The final excavation grades are defined by line and grade, the Contractor shall take every precaution, and use the most appropriate method of excavation, to avoid the loosening of material or the breaking of rock beyond the lines and grades shown on the Detailed Design and/or Construction Drawings.
3) All excavated surfaces shall be trimmed to line and grade. Upon request of the Engineer, the final 20 cm of any loose geological formation in excavations where concrete is to be placed, shall be excavated by hand methods to avoid disturbance of rock, at no extra cost.
4) Excavation beyond the lines and grades shown in the Detailed Design and/or Construction Drawings, or as modified by the Engineer, is defined as overbreak.
5) If, for any reason, excavation is carried out beyond the lines and grades shown on the Detailed Design and/or Construction Drawings shall remove the material resulting from the overbreak and backfill with concrete or shotcrete, as directed by the Engineer, the same overbreak.
6) Should the Contractor wish to excavate beyond the limits given on the Drawings for his own convenience, he may do so only with the prior consent of the Engineer.

6.4 SLOPES, SLIDES, GEOLOGICAL OVERBREAK AND UNSUITABLE FOUNDATIONS

1) If geological conditions during the performance of the surface work do not permit excavation of slopes as shown on Detailed Design, or where the material is unsuited to a firm foundation for the structures, the Engineer may modify the drawings accordingly or issue direct order to change the slopes and grades.
2) If, in the Contractor's opinion, the surface slopes as shown on Detailed Design are unsafe or otherwise objectionable, and in his opinion should be changed, he shall ask in writing for technically justifiable modification prior to starting the work, or in the course of the work, but in any case before commencing such modified excavation. Only if consent has been given by the Engineer may he change the slopes.
3) Geological accepted overbreak in surface excavation is defined as overbreak which occurs while both of the following conditions are simultaneously fulfilled:
    a) The Engineer is informed and given an opportunity for inspection while both the cause and the extent of the overbreak are clearly visible;
    b) The overbreak did not occur while, in the opinion of the Engineer, the Contractor was using improper working methods or was otherwise negligent, and it could not have been prevented by prompt and appropriate installation of supports.

6.5 EXCAVATION

6.5.1 GENERAL

1) The Contractor shall conduct his operations so as to produce the required lines and grades.
2) The surface excavation shall be performed by any approved method using any excavating and hauling equipment suitable for the work in accordance with the submitted detailed plans and time schedule, or approved modifications thereof.
    a) The work areas shall be properly drained in accordance with the provisions of the Section 5, "Care of Water During Construction".
    b) The Contractor shall carry out periodic cleaning to ensure that no hazardous accumulation of loose material occurs on the slopes or on any berm or ledges

forming part of the excavation profile.

c) Excavation for dam and structure foundations shall be performed in the dry. Final surfaces shall be protected against damage by erosion and travel of the construction equipment. Any damage caused shall be repaired by the Contractor.

d) Rock surfaces at sensitive locations shall be carefully excavated and preserved during construction. Pre-splitting or smooth blasting techniques shall be used as appropriate. Rock supports shall be installed where indicated on the Detail Design and/or Construction Drawings, or directed by the Engineer, to suit the actual geologic conditionsencountered.

e) The Contractor shall exercise particular care when excavating in the vicinity of existing structures or those under construction. He shall be liable for any damage to structures or equipment caused by his operations. Acceleration due to the blasting shall be monitored as specified hereinafter.

f) The Contractor shall protect the subsoil and particularly the ground water from contamination by fuel or oil from his equipment.

g) When existing obstructions such as buried pipelines and cable ducts are not indicated on the Detail Design and/or Construction Drawings, but are encountered and interfere with required work, relocation or protection will be requested by the Engineer. The Contractor shall not proceed until he receives the written approval and instructions from the Engineer.

h) The Contractor must avoid any alteration to the foundation material. Should this occur, the Contractor shall, at his own expense, deepen the excavation front until a suitable foundation is reached.

6.5.2 CLASSIFICATION OF EXCAVATION

1) Surface excavation is classified according to the method used to carry out the work, as follows:
    a) Clearing and Grubbing
    b) Stripping and Common Excavation
    c) Excavation by Ripping
    d) Rock Excavation by Blasting
    e) Minor Excavation Works
    f) Borrow and Quarry Excavation
2) Miscellaneous excavation includes:
    a) Additional Excavation

6.5.3 CLEARING AND GRUBBING

1) Clearing means the removal, transport and disposal of all trees, brush, stumps, fences, existing structures, debris and other obstructions in the areas to be occupied by Permanent Works, surfaces of borrow and quarry areas, spoil and stockpile areas, and where interfering with the prosecution or functioning of the work.
2) The Contractor shall clear the areas indicated by the Engineer of all trees, stumps and brush which are 1 m or more in height, regardless of diameter, and thicker than 5 cm or more, regardless of height. Trees and stumps shall be cut off not higher than 20 cm above ground. Brush shall be cut off, as far as possible, flush with the ground level. All down timber, branches or other floatable material longer than 1.5 m or thicker than 5 cm shall be removed.
3) The clearing limits shall extend 5 m beyond the limits of excavation, toes of embankments and spoil tips except where otherwise indicated on Detail Design and/or Construction Drawings or directed by the Engineer.
4) No trees shall be cut outside of the clearing limits without prior approval by the Engineer. All trees designated by the Engineer to be left intact shall be protected from damage by the Contractor's operations.

5) Grubbing means the removal, transport and disposal of all roots, buried logs, foundations of structures (except concrete or masonry in mortar) and other materials foreign to the natural topsoil in the areas to be occupied by Permanent Works and surfaces of borrow and quarry areas.
6) No grubbing will be required in the areas not excavated, and in spoil and stockpile areas.
7) Clearing and grubbing work shall be performed either manually or with mechanical equipment. The Contractor shall make every reasonable effort to salvage such material which may be put to beneficial use.
8) All materials from clearing and grubbing work remain at all times the property of the Employer and they shall be prepared for sale, burnt, buried or otherwise disposed of by the Contractor in areas as directed by the Engineer.
9) All wood and vegetation shall be disposed of in such a way that it cannot become floating debris in the future reservoir.
10) Materials to be burnt shall be piled neatly in such a manner and in such locations as to not cause any fire risk and shall be burnt completely so that all material is reduced to ashes.
11) The Contractor shall have suitable equipment and supplies for fighting fire during the burning of material and shall take all necessary precautions to prevent fire from spreading.

6.5.4 STRIPPING AND COMMON EXCAVATION

1) Stripping consists of removing all rubbish, humus, vegetable material and all or part of the organic topsoil in the areas and to the depth as indicated on Detail Design and/or Construction Drawings or as directed by the Engineer.
2) Common Excavation means excavation of material such as organic topsoil, clay, silt, sand, gravel, and boulders of up to 0.75 m3 in volume and soft or disintegrated weathered rock, which can be removed by bulldozer with ripper as specified in subsection 6.5.5.
3) Stripping and common excavation shall be accomplished by proper excavation and hauling equipment suitable for the work which allows for an efficient work progress adapted to the soil conditions encountered.
4) When the bottom of excavation as indicated on the Detailed Design and/or Construction Drawings is not rock and the natural foundation material is disturbed or loosened for any reason, the Contractor shall improve it by compaction or replace it with approved fill and compact as directed by the Engineer.

6.5.5 EXCAVATION BY RIPPING

1) Rippable material is defined as rock which can be loosened or broken down by a bulldozer capable of developing 220 kW (300 PS) of continuous power equipped with a single shank rock ripper, operating in low gear.
2) Material which in the opinion of the Contractor should be removed by ripping shall be exposed, and the Engineer notified before proceeding further. The top of the rock surface shall be surveyed by the Contractor. The survey and classification is subject to approval of the Engineer.
3) Contractor's failure to follow the procedure outlined above will forfeit his right to claim any classification other than that allowed by the Engineer, who, in such case, will classify the excavated quantities.
4) Ripping shall be performed in such manner that the ripper tooth does not damage the material laying beyond the final excavation lines. Any material remaining to the final excavation lines shall be removed by wedging, barring, broaching, or other suitable methods approved by the Engineer.

6.5.6 ROCK EXCAVATION BY BLASTING

1) Rock excavation by blasting includes all solid rock in place which cannot be removed until loosened by blasting or mechanical breakers, and boulders or detached pieces of solid rock larger than 0.75 m3 in volume, which cannot be removed by ripping.

2) Material which in the opinion of the Contractor can be removed only by blasting, shall be exposed, and the Engineer notified before commencing with blasting. The top of the rock surface shall be surveyed by the Contractor. The survey and classification is subject to approval of the Engineer.
3) Contractor's failure to follow the procedure outlined above will forfeit his right to claim any classification other than that allowed by the Engineer, who, in such case, will classify the excavated quantities.
4) Lines shown on the Drawings such as "sound rock", "top of rock" etc., are approximate and for information only. They will not be used for measurement purpose.
5) Drilling and blasting shall be done in such a manner as to ensure that the rock will break along the desired lines and grades. Rock shattered by blasting operations outside the established limits of excavation shall be removed and replaced by concrete if necessary. Rock faces and slopes shall be scaled or cleaned of loose or overhanging rock immediately after excavation. Rock surfaces, both temporary and permanent, shall be regularly inspected by the Contractor and rectified whenever necessary.
6) The diameter and the spacing of the blast holes shall be constantly adapted to the actual conditions at the Site. The Contractor shall develop the blasting techniques as the work progresses to obtain the best possible excavation surface after blasting. The techniques used shall be at all times subject to the Engineer's consent, who may order general blasting tests to be undertaken by the Contractor to substantiate his proposed methods of blasting.
7) Rock excavation close to the final excavated surfaces shall be performed using controlled blasting methods such as "presplitting", or "smooth-wall blasting". Presplitting involves a single row of closely spaced holes along the neat excavation line which are fired before the main charge, with a result of creating of a clean fracture running from hole to the next. Smooth-wall blasting is similar to presplitting exempt that line of holes is fired after the main blast.
8) The excavation shall be made to sufficient depths to secure foundations on rock of adequate quality free from highly weathered materials or other objectionable defects, as determined by the Engineer. The exploratory investigations of the foundations are not sufficiently complete to disclose all seams, defects, and other irregularities that may exist in the foundation rock. The lines of excavation shown on the Detailed Design shall therefore not be interpreted as indicating the final or actual lines of excavation or that no defects exist. The excavations at all elevations shall be so shaped as to produce as uniform and regular a profile as is practicable to obtain using excavation methods described herein.
9) The final excavated surfaces of outdoor works shall have no abrupt changes in slope and sharp projections greater than 50 cm. Projections in excess of 50 cm shall be treated where necessary by supplementary excavation as determined by the Engineer, to produce the desired surface of contact between concrete and rock.
10) Whenever, in the opinion of the Engineer, further blasting may injure the rock upon or against which concrete is to be placed, or is otherwise undesirable, the use of explosives shall be limited to light charges or discontinued, and the excavation shall be completed by wedging, barring, line-drilling or other suitable methods approved by the Engineer.
11) Should the presence of rock make excavation for foundation of structures unnecessary to the extent shown on the Detail Design and/or Construction Drawings, the Contractor shall consult the Engineer before proceeding with such work. The Engineer will issue a direct order in writing whether to proceed with the work as shown or to which extent the work shall be modified.
12) When the excavation has been completed to the approximate grade, as shown on Detail Design and/or Construction Drawings or established by the Engineer, the surface shall be cleaned off by barring, wedging, picking or other approved methods, and with an air and/or

water jet under high pressure for purpose of inspection. If the foundation is found to be not satisfactory, as determined by the Engineer, supplementary excavation shall be made as directed, and the surface again cleaned for inspection. This procedure shall be repeated until a satisfactory foundation is obtained. Just prior to placing the concrete, a final cleanup of the rock surface shall be made. All loose, shattered, or disintegrated material shall be removed, and the final surface cleaned with jets of air and/or water under high pressure.

6.5.7 MINOR EXCAVATION WORKS

1) Minor excavation work consists of excavation, in all materials, of trenches less than or equal to 2 m of width, or excavation in small and restricted areas, which has to be carried out manually or using small equipment.
2) The Contractor shall excavate to the limits, lines and grades shown on the Detail Design and/or Construction Drawings.
3) Bracing, shoring or other methods of supporting the excavation shall be carried out as necessary.
4) Mechanical excavation of trenches, except those in rock, shall be stopped not less than 10 cm above final excavation level. The remainder of the excavated material shall be removed, shaped and graded manually.
5) In rock, the trenches shall be excavated to such depth that space for placing of compacted sand bedding at least 10 cm thick shall be provided between the rock and the underside of any equipment or pipe.

6.5.8 BORROW AND QUARRY EXCAVATION

1) The borrows area and quarries will provide materials for the construction of the dam, as well as the concrete works.

   The dam body will be realized with the following materials:

   - crushed rockfill for upstream facing, for the fine and coarse filters;
   - CL / SC for the dam body.

2) The crushed rockfill for the dam as well as for the concrete aggregates will come from the quarry identified and illustrated in the Geo-technical Baseline Report. At the moment the quarry is already being exploited as a tin mine, but only as far as the tin is concerned and not the rock material so the Contractor will have to make suitable arrangements with the mining company to remove this material. Currently the rock material is crushed and stockpiled as waste. It is estimated that the mine produces approximately 20,000 m3/month of rock.

   The Contractor may however select a different quarry area that will be subject to approval by the Engineer.

   The CL/SC materials will be taken from the flat area of the dam axis (upstream and downstream) if suitable.

   The characteristics of the material are indicated in the Geotechnical Baseline Report.
3) Prior to commencing borrow and quarry excavation, the Contractor shall clear and strip the area and remove all material which is unsuitable for use in the construction of the Works. Topsoil shall be stripped from the excavated areas and stockpiled for future use apart from other excavated material. The Contractor shall, at his own expense, carry out all necessary tests to verify the amount of usable material.
4) The Contractor shall make such tests, use such equipment, and vary his excavating methods and blasting patterns as necessary to produce the required grading, uniformity or mixture of each material, and shall be fully responsible that those materials meet the specifications, and for adequacy and safety of the quarrying and borrowing operations.
5) Borrow excavation will produce material for fills, backfills, road bases and subbases, etc. If required to prevent excessive moisture, the Contractor shall lower the water table in the borrow area by appropriate means, stockpile the excavated material to permit drying or perform such work as necessary to reduce the moisture content.

6) Borrow areas (except those located within the future reservoir) shall be kept graded and drained so that water will not collect or stand there. Upon completion of the work, excavated surfaces shall be left with stable slopes not steeper than two horizontal to one vertical. Unless specifically waived by the Engineer, the slopes and bottoms of the borrow pits shall be evenly graded to present a neat and orderly appearance. Tracks or marks of heavy equipment or other disturbed earth shall be smoothed or filled to the surrounding level. The stockpiled topsoil shall be evenly spread over the subsoil exposed by the excavation.
7) Quarry excavation will produce material for concrete aggregates, road bases and sub-bases, filters, fills, backfills etc. Unsuitable material or material not required for permanent construction purposes found in the quarry shall be left in place, or, with the approval of the Engineer, shall be excavated and disposed of in an approved spoil area. The Contractor shall avoid contamination of construction material by such unsuitable material.
8) During excavation at the quarry, if necessary, berms approximately 3 m wide at 15 m vertical intervals shall be provided.
9) During quarrying operations the Contractor shall take precautions in order not to interrupt the traffic along nearby roads and provide personnel and devices to warn the road users of blasting.
10) On completion of the exploitation the Contractor shall ensure that the quarry is left in a safe and tidy condition to the satisfaction of the Engineer.

6.5.9 ADDITIONAL EXCAVATION

1) The Contractor may be directed by the Engineer to perform excavation beyond the lines and grades of already completed work. Such excavation shall be defined as additional excavation.
2) Additional excavation may consist of any or all classes of excavation stipulated in this Section.

6.6 LINE-DRILLING

1) Line-drilling shall be used where pre-splitting may cause excessive damage to the surrounding rock or where there are structures adjacent to the excavation.
2) Line-drilling is defined as a single row of unloaded holes drilled along the neat excavation line, spaced no more than two times the hole diameter on centers. These will form asurface of weakness to which the primary blast can break. Light blasting with well-distributed charges fired after the main excavation is removed may be permitted in the holes. If, however, in the opinion of the Engineer the blasting may injure the rock, the use of explosives shall be discontinued and the excavation shall be completed by broaching, wedging, or barring.

6.7 PROTECTION AND SUPPORTS

6.7.1 GENERAL

1) The Contractor shall secure the stability of any excavation by using, where necessary, suitable protection and supports in quantities sufficient to avoid loosening, slides, cave-in, and to guarantee the safety of work.
2) The Engineer may order the use of additional protection and supports when he consider that there may be some danger for the safety of workmen or for the good progress of the Works. The responsibility of stability always remains at the Contractor's charge.

6.7.2 TEMPORARY PROTECTION AND SUPPORTS

1) According to the difficulties encountered during the excavation works, the Contractor may select the temporary protection and supports he deems most convenient and suitable to bear and stabilize the unstable material and to facilitate the installation of permanent protection and supports.
2) Temporary protection and supports shall be removed by the Contractor shortly before placing the concrete or when the work is completed and it shall be the Contractor's responsibility to conduct his operations during excavation so that no temporary protection or supports are installed, which cannot be removed when required by the Engineer.

6.8 EXCAVATED MATERIALS

1) All suitable materials from the excavations shall be utilized to the fullest extent practicable as construction materials in Permanent Works.
2) The Contractor's blasting and excavating techniques shall be such that, as much as practicable, construction materials will be yielded. Where possible, suitable materials shall be excavated separately from materials to be wasted.
3) Whenever possible, the suitable materials shall be transported directly from the excavation to the designated final locations.
4) If the immediate placement in the final location is not possible, the materials shall be stockpiled at no additional cost. If the moisture content of excavated materials which would be suitable for embankments or backfill is too high after excavation, such material shall be drained and dried in the stockpile until the moisture content is sufficiently reduced to allow for placement.
5) The Contractor shall remove any cobbles, boulders or rock fragments found in otherwise approved materials which are greater than permitted for fills and backfills and dispose of them appropriately.

6.9 DISPOSAL OF EXCAVATED MATERIALS

1) The Contractor shall create a disposal area to stock material suitable for construction of the dam body. The disposal area will be proposed by the Contractor and submitted to the Engineer for his approval.
2) Excavated materials which are not suitable for, or are in excess of the construction requirements, shall be disposed of in spoil areas studied by the Contractor and submitted to the Engineer for approval.
3) The spoil areas shall be located where they will not interfere with the natural flow of streams or rivers.
4) No rock material may be dumped into rivers or creeks. The earth or soil material may be dumped into natural flows only after written approval by the Engineer.
5) The material proceeding from excavation shall be disposed in the designated areas dividing the rock material by the common and/or clayey material and the topsoil.
6) The Contractor shall shape and trim the spoil tips and stockpiles to the lines and grades as directed or approved by the Engineer. Adequate diversion of water courses in such areas and proper drainage shall be provided.
7) At the end of the works, the rock material not used for the production will be properly graded so that no unstable slopes are left in the permanent deposits of excavated materials. Drainage pipes or ditches shall be disposed so as to guarantee a proper de-watering of the area, and the common material and the topsoil shall be used to cover the rock material.
8) Landscaping of the permanent deposit of the excavated material shall be executed as directed by the Engineer.
9) The Contractor shall be liable for any damage to Temporary or Permanent Works or to the property of third parties caused by poor drainage in the spoil or stockpile areas.

6.10 CLEANING, PREPARATION AND PROTECTION OF EXCAVATION SURFACES

1) Excavation surfaces against or upon which concrete, embankment fill, or backfill will be placed shall be prepared and protected as specified herein and in combination with specifications contained in the pertinent Sections of these Specifications or as shown on the Detailed Design and/or Construction Drawings.
2) If, during excavation work, material beyond the limits of excavation shown on the Detailed Design and/or Construction Drawings is loosened or disturbed, the Contractor shall re-compact the loosened material or remove it altogether and replace it with other compacted

fill as directed.

3) If, during excavation in rock for concrete structures or linings, the rock beyond the limits of excavation shown on the Detailed Design and/or Construction Drawings becomes broken or shattered, the Contractor shall remove all loose material and replace it with concrete or shotcrete as directed.
4) Foundation excavation shall be kept well drained and free of standing water. The Contractor shall provide all necessary drains, ditches and sumps, and use pumps when necessary, in order to ensure that foundation surfaces are not harmed by water. When foundations are thus affected, the affected material shall be removed and replaced with approved backfill.
5) Cleaning of sound rock shall be done by directing a jet of water or air at the surface. Compact, washable rock shall be cleaned with compressed air-water jets. Rock which tends to a quick disintegration, or is interspersed with clay fissures, shall be cleaned with compressed air only. The cleaning shall be carried out to the satisfaction of the Engineer.
6) Sprayed concrete (Shotcrete) shall be applied to finished excavation surfaces where, in the opinion of the Engineer, it is deemed necessary to prevent air slaking, erosion or other deterioration of the surface. The protective coating shall be applied to excavated surfaces either with or without steel wire mesh reinforcement in accordance with the provision of the Section "Sprayed Concrete".

6.11 PROTECTION OF EXISTING STRUCTURES DURING BLASTING

1) The Contractor shall adequately protect existing structures from the effects of blasting, both from impact with rock or debris and from excessive shock. Structures at risk shall be inspected both before and after blasting, and shall be monitored during the blasting operations by appropriate means, if so directed by the Engineer.
2) In any case, the particle velocities shall be limited to 15 cm per second at new concrete structures which have attained design concrete strength; 10-15 cm per second at structures 7 to 28 days old; and 0-4 cm per second for structures 0 to 7 days old, proportionally.
3) The above limits shall be approached gradually with caution using a commercially available velocity seismograph and with immediate inspection of structure for evidence of stress after each blast operation.
4) In the event of stress evidence, the limiting particle velocity shall be reduced to that of the blast prior to the one causing stress evidence and maintained at that level with continued velocity and stress monitoring as described above. If the structure cannot be inspected, particle velocity shall be limited to 5 cm per second.

6.12 FILL

6.12.1 GENERAL

1) The Contractor shall place and compact fill and backfill of the specified type to the lines, grades and dimensions shown on Detailed Design and/or Construction Drawings, or where directed by the Engineer.
2) Material to be used as fill and backfill shall be subject to the Approval of the Engineer, and shall be, as far as possible, obtained from excavations required for temporary or permanent works.
3) The distribution and gradation of fill material shall be such that the finished backfill is free from lenses, pockets, streaks or layers of material differing substantially in texture or gradation from the surrounding material. Backfill material shall include no organic matters, and the Engineer reserves the right to reject entire loads of material which contain a high percentage of organic matter which cannot be satisfactorily removed.
4) Traffic over the fill shall be adequately controlled to avoid rutting or disturbing the placed backfill. Each load of material shall be placed in such a way as to achieve the best practicable distribution of material. The operation of trucks and heavy equipment shall be restricted near

buildings, walls, piers and other facilities to avoid damage to any permanent structure.

5) Any material which in the opinion of the Engineer is objectionable or inadequate shall be removed at the Contractor's cost. If the compacted surface of any layer of material is determined to be too smooth and impermeable to bond properly with the succeeding layer, it shall be loosened by harrowing or by other approved method before the succeeding layer is placed thereon.
6) No filling shall commence until the foundation and permanent works have been inspected and approved by the Engineer.
7) Backfilling adjacent to concrete structures one meter or more in height shall not commence until 7 days after concrete placement. Prior to backfilling, forms shall be removed, and the area cleaned of all waste and debris. Backfill shall be placed in proper sequences so that no differential earth pressure occurs on footings, pipes and other structures.
8) The Contractor shall maintain and protect the finished fill in satisfactory conditions at all times until completion and acceptance of the works. After filling operations have been finished and before final grading, the Contractor shall slope the surfaces to prevent pounding of water.

6.12.2 RANDOM FILL AND BACKFILL

1) The random fills and backfills may consist of any and all types of materials, except clayey mud, loam and high plasticity clay, but including low plasticity clay, sand, gravel and rock fragments.
2) The materials shall in general be placed mixed in them to obtain a well-graded soil having a coefficient of uniformity larger than five (5) suitable to obtain the best compacted stability for the specific fill.
3) The liquid limit and plasticity index of fraction passing No. 40 sieve shall be 40 and 10 maximum respectively.
4) The maximum size of rock fragments, which may be incorporated in the mass of fills and backfills shall not be more than 2/3 of the specified compacted layer.
5) For confined backfills, the quantity of stones over 20 cm in size shall not exceed 30 % by volume.
6) Random fills and backfill mainly composed of materials with a size up to 10 cm shall be placed and compacted in horizontal layers of 30 cm while the random fills and backfill mainly composed of coarse rock fragments shall be compacted in horizontal layers of 50 cm.
7) The moisture content prior to and during compaction of the fills shall be near the optimum moisture content distributed evenly throughout each layer of material as established with laboratory tests.
8) Random fill and backfill mainly composed of fine materials shall be compacted to at least 95 % standard Proctor density in accordance with ASTM Test Method D-698. The in-situ density tests shall be determined in accordance with ASTM D-1556-00 (Sand Cone Method) or by BS 1377-9.2.4 (Core Cutter Density Method).
9) Random fill and backfill mainly composed of coarse materials shall be compacted with not less than six full (6) passes of vibrating rollers having a min. weight of 25 kg per centimeter of drum axis. If a heavier vibrating roller is used the number of passes may be reduced upon the results of compaction site tests.
10) Random backfill to be placed adjacent to structures shall be carefully placed to prevent its displacement or damage

6.12.3 FREE-DRAINING BACKFILL

1) Free-draining backfill material shall consist of a well graded gravel or cobbles with particle size ranging from 100 to 300 mm (except as stated below) with a maximum of 3% by weight passing US Standard Sieve No. 200 (0.075 mm).
2) Material to be placed within one meter of any structure shall contain no material greater than

100 mm.

3) Free-draining backfill shall be placed moist in layers not exceeding 50 cm, after compaction. It shall be compacted to 70% relative density as defined in ASTM Test Method D 4254.
4) Gravel free-draining backfill shall be compacted by vibratory rollers. Where backfill has to be placed adjacent to structures or in other restricted areas, it shall be compacted by mechanical tampers or other approved methods.

6.12.4 SAND-GRAVEL SELCTED BACKFILL AND BEDDING

Reasonably well graded sand and gravel shall be used for backfilling of trenches for pipes, cables, ducts, bedding for ditches etc. The maximum particle size shall not exceed 75 mm and a maximum of 5% by weight shall pass US Standard Sieve No. 200 (0.075 mm). The material shall be spread in layers of 30 cm and compacted by approved vibratory equipment.

Maximum particle size shall not exceed 4.75 mm and a maximum of 5% by weight passing US Standard Sieve No. 200 (0.075 mm).

6.12.5 SAND BEDDING

Reasonably well graded sand shall be used for backfilling of trenches for pipeline. The maximum particle size shall not exceed 20 mm and a maximum of 5% by weight shall pass US Standard Sieve No. 200 (0.075 mm). The material shall be spread in layers of 30 cm and compacted by approved vibratory equipment.

6.13 MEASUREMENT AND PAYMENT

6.13.1 EXCAVATION

6.13.1.1 General

1) Measurement for payment for any class of excavation specified herein, except for clearing and grubbing, will be of the in-situ volume as measured from a survey performed by the Contractor prior to any excavation work and the lines and grades shown on the Detailed Design and Construction Drawings or established at the Site by the Engineer.
2) Payment will be made at the appropriate Unit Price per cubic meter or per linear meter entered in the Bill of Quantities, which shall include the entire cost of, but not be limited to, the following:
    a) Provision of all labour, equipment and materials required for excavation, including any hand work necessary for trimming excavated surfaces; preparation, protection and maintaining excavated surfaces in satisfactory conditions until concrete or fill is placed; all additional excavation for Contractor's convenience; any temporary supports necessary to support the sides of the excavations
    b) Loading, hauling and dumping the excavated material on stockpiles, spoil areas or points of incorporation in Permanent Works; clearing of the spoil areas and formation of spoil tips as specified for use in embankment construction or as backfill
    c) All delays during excavation work resulting from installation of rock supports required by the geotechnical conditions of the material encountered
    d) Complying with all requirements of statutory laws and regulations relating to blasting work and any restrictions resulting therefrom; obtaining all necessary permits and licenses for the purchase, use, storage and transport of explosives or any other material and equipment
    e) Surveying, setting-out, checking of excavated profile and alignment, and any subsequent rectification works resulting from undue or incorrect surveys; provision of suitable equipment for, and delays due to carrying out this work
3) Measurement for payment of possible additional volumes of excavation resulting from modification of lines, slopes and grades shown on the Detailed Design and Construction Drawings, which may be necessary in the course of the work, will be of the in-situ volume as measured between the original and the modified lines and grades. No increase in Unit Prices

will be allowed for such additional excavation.

6.13.1.2 Clearing and Grubbing

Payment for clearing and grubbing in the areas to be occupied by Permanent Works as shown on the Detailed Design and Construction Drawings or as directed by the Engineer will be made at the unit price per hectare entered in the Bill of Quantities. This sum will include all costs of disposing of cleared materials.

6.13.1.3 Stripping and Common Excavation

1) Measurement for payment for common excavation will be of the in-situ volume of the material removed between the original ground surface and the lines and grades shown on the Detailed Design and Construction Drawings or the surveyed lines of material classified as "Rock Excavation".
2) Payment will be made at the Unit Price per cubic meter entered in the Bill of Quantities.

6.13.1.4 Excavation by Ripping

1) Measurement for payment for excavation by ripping will be of the in-situ solid volume of the material removed between the surveyed rock surface and the lines and grades shown on the Detailed Design and Construction Drawings or the surveyed surface for the classification “Excavation by Ripping”.
2) Payment will be made at the Unit Price per cubic meter entered in Bill of Quantities.

6.13.1.5 Rock Excavation by Blasting

1) Measurement for payment for rock excavation by blasting will be of the in-situ solid volume of the rock between the surveyed rock surface and the lines and grades shown on Detailed Design and Construction Drawings or as directed by the Engineer.
2) Payment will be made at the Unit Price per cubic meter, entered in the Bill of Quantities, which shall, in addition to work included under “General”, include the entire cost of removal of any material which cannot be removed by ripping; protection of structures, properties, installations, trees, etc.; drilling holes for blasting and blasting, development and using controlled blasting methods, blasting tests, works underwater and any cost associated with establishing satisfactory blasting techniques.
3) In addition to material actually removed under this title the following shall also be classified as "Rock Excavation by Blasting", and shall be measured and paid for under this item:
    a) Large boulders and rock fragments over one (1) cubic meter that cannot be removed by ripping or by excavation machinery used for loose excavation
    b) Rock removed by mechanical breakers, swelling agents or other approved methods in areas where blasting would be required but not possible or permitted for whatever reason
4) Separate measurement for payment will be made for excavation performed at the final surfaces of excavation by controlled blasting methods. Measurements for payment will be of excavation area for which controlled blasting is required, calculated from the required lines and grades shown on Detailed Design and Construction Drawings or as directed by the Engineer. Payment will be made at the Unit Price per square meter entered in the Bill of Quantities.

6.13.1.6 Minor Excavation Work

1) For payment purposes, minor excavation is divided into two categories:
    a) Excavation in loose materials which can be removed without recourse to blasting.
    b) Excavation in rock.
2) Measurement for payment for either category of minor excavation will be of the in-situ volume removed between the original surface and the lines and grades shown on Detailed Design and Construction Drawings or as directed by the Engineer.
3) Payment will be made at the Unit Price per cubic meter entered in the Bill of Quantities for loose material or rock respectively.

6.13.1.7 Borrow and Quarry Excavation

No extra measurement for payment or payment will be made for borrow and quarry excavation, and clearing, grubbing and stripping in, and trimming, levelling and draining of the borrow and quarry areas. The entire cost thereof shall be included in the Unit Prices for furnishing, placing, mixing, compaction, etc., of such materials as specified in the pertinent Sections of these Specifications.

6.13.1.8 Test Pits and Trench Excavation

1) Measurement for payment for test pits and trench excavation will be of the in-situ volume of material removed.
2) Payment will be mate at the Unit Price per cubic meter entered in the Bill of Quantities, which shall include the use of any special equipment, hand works, supports of the excavation, placing of excavated material, sampling, transport to laboratory and fencing.
3) Separate measurement for payment and payment will be made to the Contractor for underwater excavation, as indicated in the corresponding paragraph.

6.13.1.9 Underwater Excavation

1) Underwater excavation is defined as excavation performed in the water deeper than 50 m.
2) Measurement for payment will be of the volume of material effectively removed.
3) Payment will be made at the Unit Price for the respective excavation as stipulated above, plus additional Unit Price per cubic meter entered in the Bill of Quantities, which shall cover all additional difficulties and equipment necessary for excavating underwater.
4) For payment purposes, the underwater excavation is divided into three categories:
    a) Removal of loose material under water
    b) Removal of material under water by ripping
    c) Underwater blasting and removal of material

6.13.1.10 Geological Overbreak and Unsuitable Foundations

1) Measurement for payment for the removal of material arising from overbreak accepted by the Engineer as occurring entirely for geological reasons, will only be made if the Contractor request measurement directly after excavation, or as long as the overbreak can clearly be determined as being due to adverse geological conditions.
2) Excavation and refill ordered in writing by the Engineer due to cave-ins or overbreak for geological reasons or unsuitable foundations will be measured for payment and paid for as follows:
    a) Removal of material resulting from overbreak accepted by the Engineer will be paid per cubic meter in-situ, at 50% of the Unit Price related to the excavated material
    b) The concrete placed for refilling additional excavation in rock foundation will be measured in cubic meter of the in-situ volume and payment will be made
        - at the Unit Price per cubic meter for the required classes of concrete for the related surface works
        - at 70% of the Unit Price per cubic meter for the required classes of concrete for the related underground work
    c) Payment for excavation, transportation and placing of selected earth fill materials for use in refilling additional excavation in loose material will be made at the Unit Price per cubic meter for random fills and backfills.

6.13.1.11 Line Drilling

1) Measurement for payment for line drilling will be of the length of the holes actually drilled into the rock along the side of the excavation as directed by the Engineer.
2) Payment will be made at the Unit Price per meter of drilled hole entered in the Bill of Quantities, which shall include the entire cost of drilling the holes, light blasting, broaching, wedging, barring, or other methods used in conjunction with line drilling.

6.13.2 DISPOSAL OF THE EXCAVATED MATERIAL

No separate measurement for payment and payment will be made to the Contractor for the disposal in the spoil areas of materials proceeding from required excavations.

Landscaping of the permanent deposits of materials proceeding from required excavations, where required by the Engineer, will be paid according to the items of the Bill of Quantities as indicated in Section 8 of these Technical Specifications.

6.13.3 STOCKPILING

No separate measurement for payment and payment will be made to the Contractor for stockpiling of materials proceeding from required excavations.

6.13.4 FILLS AND BACKFILL

1) Measurement for payment of fills and backfills will be of the in-situ compacted volume in cubic meters of backfill placed.
2) Payment shall be made according to the unit prices entered in the Bill of Quantities for the following categories of backfill:
    a) Random fill and backfill
    b) Free-draining backfill (gravel or boulders)
    c) Sand-gravel selected backfill and bedding
    d) Sand bedding
3) The unit prices shall include the supply of fill material and all costs for placing and compacting as specified.
4) Backfilling with concrete and shotcrete are covered in the pertinent sections of these Specifications.

6.13.5 EXCLUSIONS

1) No extra measurement for payment or payment will be made for the following:
    a) All costs of de-watering and keeping the surface excavation sites dry
    b) Extra work caused by the Contractor's negligence in setting-out the structures and slopes
    c) Surveys to verify the original ground surface, or for recording the top of the rock surface
    d) Removal of the materials resulting from the slides or overbreak caused by Contractor's inappropriate working methods and for the additional materials required to fill the voids so created
    e) Additional work of removing material and backfilling voids with approved material where overbreak due to adverse geological conditions coincides with that due to Contractor's poor working methods or negligence
    f) Excess excavation required for Contractor's convenience and the resulting additional backfilling with approved materials
    g) Additional work resulting from the Contractor changing slopes without prior approval by the Engineer. In such event, payment will be made only to the lines and grades shown on Detailed Design and Construction Drawings
    h) Excavation which is incidental to the installation of Temporary Works
    i) Shoring, bracing, and supporting of excavation surfaces except as specified in the Sections "Rock Stabilization and Supports" and "Slope Protection"
    j) Clearing and grubbing in the borrow and quarry areas, and spoil and stockpile areas
    k) Draining, shaping, and trimming the dumped material in the spoil tips to the lines and grades as directed or approved by the Engineer
    l) Preparation and protection of foundation and slopes with the exception of concrete protective coating, which will be measured and paid for in accordance with the provisions of the Section "Sprayed Concrete"

m) Work or materials required when foundation surfaces have been allowed to become unsuitable due to the action of ground or surface water
n) Extra work or material required to repair damages to the final excavation surfaces caused by the erosion or travel of the construction equipment
o) Monitoring of existing structures during blasting operations
p) Stockpiling of excavated material for later utilization by the Contractor in the Permanent Works, when decided by the Contractor for his own convenience.

2) Any additional excavation in areas where surface excavation has already been completed, which the Contractor may be directed by the Engineer to carry out, will be measured and paid for at the same Unit Prices entered in the Bill of Quantities as for the original excavation. No increase in Unit Prices will be allowed for such additional excavation.

7 SLOPE PROTECTION

7.1 SCOPE OF WORK

1) Work under this Section include all labour, materials, equipment and services required to protect the slopes either excavated or those of fills and backfills.
2) This Section covers the following items:
    a) Riprap
    b) Stone paving
    c) Field sod
    d) Topsoil and seeding
    e) Planting
3) The Contractor shall place the various items specified herein as protection to slopes to the lines and thicknesses and in the locations shown on the Detailed Design and Construction Drawings, or as directed by the Engineer.
4) Shotcrete, rock bolts, wire mesh, and drainage work, which may also be required for the slope protection, are specified in other Sections of these Specifications.

7.2 SUBMITTALS

Thirty days before starting the construction of any slope protection listed hereinabove, the Contractor shall submit to the Employer a statement inclusive of description, drawings and construction method.

7.3 RIPRAP

7.3.1 MATERIAL

Material required for riprap shall be obtained and selected from the quarry shown on the Drawings or other sources as approved by the Engineer.

Rock for riprap shall be sound, dense, resistant to abrasion and weathering and free from cracks, seams and holes. Angular rock fragments shall preferably be used. Well-rounded cobbles and boulders will not be accepted excepted on very flat slopes. The minimum dimension of any single rock shall not be less than one-third to one-fourth of its maximum dimension.

Riprap shall be reasonably well graded within the following limits:

Nominal Thickness of Riprap (cm)	Maximum Weight (kg/block)	Size Range as % by Weight		
		30-40% (kg)	60-70% (kg)	0-10% (kg)
40	250	110 - 250	10 - 110	0 - 10
60	550	275 - 550	20 - 275	0 - 20
80	1,000	500 - 1,000	30 - 500	0 - 30

Sand and rock dust may not exceed 5% of the total weight of the riprap material. Maximum size of boulder shall be limited to the nominal thickness of riprap.

7.3.2 EXECUTION

Riprap shall be dumped in place or placed by backhoe or dragline. It need not to be compacted, but shall be roughly graded to the specified thickness in such a way as to ensure that larger rock fragments are uniformly distributed, with the smaller rocks filling the remaining spaces. Pockets of small stones shall be removed and replaced with larger material such that the required grading is achieved. Placing operations shall be such that the riprap layer is well-keyed, uniform and dense.

7.4 STONE PAVING

7.4.1 MATERIALS

1) Fragments of rock for "Dry Stone Paving" and "Stone Paving in Mortar" specified in this Section shall be selected from required excavation or quarries and shall have the same properties and qualities as material for riprap. They shall be chosen such that they have a reasonably flat upper surface when laid. Stones for dry rock paving shall not have a round or spherical form and shall be of regular shape. Stones for rock paving in mortar shall be not less than 20 cm thick and not less than 50 cm2 in area.
2) Bedding material for dry rock paving shall consist of a mixture of sand and gravel reasonably well graded between 0.5 and 25 mm.
3) Mortar for rock paving in mortar shall comprise 3 parts of clean fine aggregate to one part of cement by volume. Fine aggregate and cement shall comply with the requirements specified in the Section "Concrete".

7.4.2 EXECUTION

7.4.2.1 Dry Stone Paving

1) The Contractor shall place dry stone paving on a bedding of sand and gravel of minimum thickness of 15 cm.
2) Rocks fragments shall be hand placed in a regular pattern such that no continuous vertical or horizontal joints occur, and the spaces between the stones shall be filled with smaller rocks or gravel.
3) The surface of complete paving shall be even with surface projections not exceeding 20% of the specified layer thickness.
4) The nominal thickness of this paving shall be 40 cm, of which 15 cm for bedding and 25 cm for stones.

7.4.2.2 Stone Paving in Mortar

1) The Contractor shall place selected pieces of rock on a mortar bed and fill the joints with mortar. The work shall be performed by experienced masons, duly qualified in their trade.
2) Prior to placing, the rock shall be cleaned of all adherent soil, dust and earthy or organic impurities, and wetted sufficiently to saturate it, but leaving the surface in a damp condition.
3) Rocks shall be placed on a mortar bed of minimum thickness of 5 cm and carefully arranged in such a way that the minimum of voids remain between rocks, no continuous horizontal or vertical joints exist, and the largest rocks are evenly distributed.
4) After rock placing, the joints shall be completely filled with mortar. Splashing of exposed rock surfaces with mortar shall be avoided, and where splashing does occur, the surface of the rock shall immediately be cleaned down with a sponge and clean water.
5) Finished surfaces shall be adequately protected against rainfall until the mortar has set. After setting, mortar shall be raked out to a depth of approximately 15 mm from the face of the rock, and the rocks sponged off along their edges.
6) Joints and weepholes shall be provided in the locations and in accordance with the details shown on Detailed Design and Construction Drawings, or as directed by the Engineer.
7) The nominal thickness of this paving shall be 30 cm, of which 5 cm for mortar bedding and 25 cm for stones.

7.5 FIELD SOD

7.5.1 GENERAL

The Contractor shall furnish and place the field sod as protection of excavated surfaces and slopes of fills where shown on Detailed Design and/or Construction Drawings or directed by the Engineer.

7.5.2 MATERIALS AND EXECUTION

1) Field sod shall consist of a dense and well rooted growth of permanent and desirable grass.

When sod is lifted, it shall be covered with grass recently cut to a length of not more than 7 cm.

2) Areas to be sodded shall be fine graded to an uniform surface and loosened to a depth of 3 cm. Where directed, the topsoil shall be placed on the prepared surfaces. Field sod shall be placed over a whole area (not in strips) of the designated slope. Field sod, excluding grass depth, shall be at least 5 cm thick. When laid on the slopes steeper than three horizontal to one vertical, it shall be pegged with wooden stakes.
3) The Contractor shall be responsible for all completed sodding for a period of 30 days and shall water the sodding whenever necessary to ensure rooting. During this period any break which may occur through slippage of sod shall be repaired and any sod which is dead shall be removed and replaced by the Contractor.

7.6 TOPSOIL AND SEEDING

7.6.1 GENERAL

1) The Contractor shall prepare the ground for, and load, transport, place, spread and roll the selected topsoil material, water the areas, furnish and plant approved seed, furnish and spread mulch, and furnish and spread approved fertilizer. Application techniques such as hydroseeding and hydromulching will be acceptable.
2) The topsoil shall be placed and seeding performed as protection of excavated surfaces and embankment slopes where shown on Detailed Design and Construction Drawings or directed by the Engineer.
3) Topsoil shall not be placed on excavation surfaces with slopes of 1:1 or steeper.

7.6.2 MATERIALS

1) Topsoil shall be obtained from stockpiles of material stripped from excavated or borrow areas. The material shall contain the fertile loam suitable for plant growth containing at least 6% organic matter with pH range 6.5 to 7.0. It shall be free from excessive quantities of grass, roots, weeds, sticks, stones, or other objectionable objects.
2) Seeds and seeding mixture shall be free of all harmful or prohibited weed seeds. The kind of seeds and its distribution in kg per hectare shall be carefully established by an expert, depending on the geographic, climatic and ecological conditions.
3) All different kinds of seeds shall be separately packaged, sealed, and labeled when received on the Site.
4) Chemical fertilizer shall be a mixed, general purpose commercial product and shall be approved by the Engineer prior to applying. Percentages of nitrogen, phosphoric acid and potash to be 10/10/10 of total weight. Fertilizer shall be packaged, scaled, and labeled when received on the Site.
5) Animal fertilizer shall be well composed cattle and/or horse manure free from sawdust or refuse of any kind.

7.6.3 EXECUTION

1) The areas over which topsoil is to be placed shall be clean of debris. Surfaces shall be leveled to within 20 cm of the final lines or grades before topsoil is applied. Topsoil shall be evenly placed and spread over the area with the required thickness. Topsoil shall not be placed when subsurface is detrimental to proper seeding.
2) The seeding mixture shall be sown by drilling with either an approved disc or grass drill, hydroseeders, or by mechanical or hand broadcasting. The method of seeding shall be proposed by the Contractor and subject to Engineer's approval. Suggested methods are as follows:
    - Hydroseeding: Seeding with an approved hydroseeder will be acceptable providing the wind velocities permit uniform distribution of the seed and fertilizer slurry on the areas to be seeded. The mixture of seed and fertilizer shall be properly mixed with water to form a slurry. The slurry mixture shall be prepared immediately prior to application, and

shall be promptly applied on the designated areas. Slurry mixtures prepared more than 1 hour prior to application will not be acceptable. The hydroseeder shall be designed in such a way as to insure that seed and fertilizer are distributed uniformly. The hydroseeder shall be equipped with a paddle-type agitator and recirculation pump that will continuously stir and mix the slurry to prevent settling of solids in corners and at the bottom of the tank, and maintain a uniform mixture of seed, fertilizer, and water at all times during the entire seeding operation.

Broadcast Seeding: In areas inaccessible by methods described above, the seed and fertilizer may be applied by either mechanical or hand broadcasting. When either of these methods are used, the seed and fertilizer shall be applied separately.

- Hydromulching: Wood-cellulose fiber mulch or other approved material to be used in hydromulching shall contain no germination or growth-inhibiting factors. It shall be dyed an appropriate colour to allow visual metering of its application. The mulching shall have the property of becoming evenly dispersed and suspended when agitated in water. When sprayed uniformly on the surface of the soil, the fibers shall form a blotterlike ground cover which readily absorbs water, and allows infiltration to the underlying soil. Weight specifications from the suppliers, and for all application, shall refer only to air-dry weight of the fiber, a standard equivalent to 10% moisture. The mulch material shall be supplied in packages marked by the manufacturer to show the air-dry content. Suppliers shall be prepared to certify that laboratory and field testing of their product has been accomplished and that it meets all the forgoing requirements. For the application, the mulching material shall be added to the water slurry in the hydraulic seeder after the proportionate quantities of grass seed and fertilizer materials. All slurry ingredients shall be mixed to form a homogeneous slurry. Slurry mixtures prepared more than 1 hour prior to application will not be acceptable. Using the colour of the mulch as a metering agent, the operator of the hydraulic seeder shall spray the slurry mixture uniformly to the prepared seedbed to correspond with the hectare requirements of all materials.

3) Fertilizer may be applied prior to seeding by mechanical spreaders, blowers, or hydraulic equipment or may by applied during seeding if seeding equipment is provided with fertilizer attachment.
4) After seeding the Contractor shall provide and cover the seeded area with hay or straw mulch of minimum 5 tons per hectare. Mulch shall be free of mold and weed seeds and a major proportion shall exceed 25 cm in length.
5) Seeded areas shall be watered. The frequency and quantities of water shall be approved by the Engineer.

7.7 PLANTING

1) The Contractor shall furnish all plants, labour, materials, tools and equipment necessary for the performance of planting as directed by the Engineer.
2) Where required, landscaped areas shall be planted with trees to provide protection against erosion.
3) Trees shall have a well-developed root system, straight trunks, well-branched with dense foliage, free from plant disease. The height of the trees shall be not less than 2 m.
4) Trees shall be planted on the day of delivery. Plant pits shall be excavated circular with vertical sides and flat bottom. Tree pits shall be at least 60 cm greater in diameter than spread of roots and 15 cm below depth of roots. Bedding soil shall consist of 3 parts topsoil to 1 part animal fertilizer. Backfilling soil of pits shall consist of 3 parts topsoil and 1 part peat by volume with uppermost layer treated with 0.15 kg/m2 chemical fertilizer. Plants shall be watered immediately after planting operations have been completed.

7.8 MEASUREMENT AND PAYMENT

1) **RIPRAP**
   a) Measurement for payment will be of the volume of material placed to the lines and thicknesses shown on Detailed Design and Construction Drawings or those determined by the Engineer. The actual volume will be determined by survey.
   b) Payment will be made at the appropriate Unit Price per cubic meter for bedding or riprap entered in the Bill of Quantities, which shall include the entire cost of all operations required to furnish, select, blend, transport and place the required materials, irrespective of source.
2) **STONE PAVING**
   a) Measurement for payment and payment will be made separately for dry stone paving and for stone paving in mortar.
   b) Measurement for payment will be of the area of stone paving, placed to the lines and thicknesses shown on Detailed Design and Construction Drawings or those determined by the Engineer. The actual surface area will be determined by survey.
   c) Payment will be made at the appropriate Unit Price per square meter entered in the Bill of Quantities, which shall include for the cost of furnishing, handling, transportation, and placing of paving materials including sand and gravel or mortar bedding.
3) **FIELD SOD**
   a) Measurement for payment of the field sod will be of the area actually sodded.
   b) Payment for the field sod will be made at the Unit Price per square meter entered in the Bill of Quantities, which shall include furnishing, transportation, preparation of surfaces, placing and watering of field sod.
4) **TOP SOIL AND SEEDING**
   a) Measurement for payment for topsoil will be of the volume placed within the lines shown on Detailed Design and/or Construction Drawings or as established by the Engineer. Payment will be made at the Unit Price per cubic meter entered in the Bill of Quantities, which shall include all cost of labour, loading, transportation, placing, compacting, and excavating of additional material if necessary.
   b) Measurement for payment for seeding will be of the surface area actually seeded. Payment will be made at the Unit Price per hectare entered in the Bill of Quantities, which shall include the cost of furnishing, sowing, and covering of the seed, furnishing and spreading of fertilizer, furnishing and placing of mulch, and watering.
5) **PLANTING**

   Measurement for payment for planting will be of the number of trees planted, as shown on Detailed Design and/or Construction Drawings or directed by the Engineer. Payment will be at the Unit Price per plant entered in the Bill of Quantities.

8 CONCRETE

8.1 GENERAL

1) The work under this Section includes all labour, materials, equipment and services related to the concrete work to be carried out by the Contractor under this Contract.
2) The concrete work shall be performed to the dimensions as shown on Detailed Design and/or Construction Drawings or as otherwise directed by the Engineer. Lift drawings shall be prepared by the Contractor.
3) The approval given by the Engineer to the Contractor's Equipment or their operation, or of any construction methods shall not relieve the Contractor of his full responsibility for the proper and safe execution of concrete work or any obligations under this Contract.

8.2 STANDARDS

1) Concrete materials, methods and procedures shall conform to the applicable standards of the American Society for Testing and Materials (ASTM) or, where not covered by ASTM Standards, shall conform to the applicable standards or recommended practices of the American Concrete Institute (ACI) and those contained in the US Bureau of Reclamation "Concrete Manual".
2) In cases of conflict between these Specifications and the above, these Specifications shall take precedence.

8.3 COMPOSITION AND CLASSES OF CONCRETE

1) Concrete shall be composed of cement, water, fine and coarse aggregate and possible admixtures.
2) The design of concrete mixtures will be aimed to securing a plastic, workable mixture suitable for the specific conditions at placement and, when properly cured, a product having durability and strength in accordance with all the requirements of the structures covered by the Contract Documents. The water content of all concrete mixtures shall be the minimum necessary to produce a workable mixture. Admixtures shall only be used with the approval of the Engineer.
3) According to the use of the different structures of the Works and the stresses expected to be acting upon them, various concrete classes have been designated. Denomination of concrete classes is based on the nominal cylinder compressive strength (in Newton per square mm) and maximum aggregate size.
4) The cylinder compressive strength is defined as the strength as measured on the test cylinders 150 mm diameter and 300 mm high tested at 28 days. The nominal strength is defined from a sequence of samples produced and used in standard conditions so that 85% of all samples exceed the nominal strength, assuming a normal statistical distribution for the majority of test values. No test value, however, may lie below a minimum, which is at 70% for concrete of less than 20 N/mm2, and at 85% for concrete of more than 20 N/mm2 of the corresponding nominal strength. With very large numbers of test values a 1-2% below the minimum will be acceptable, providing they do not compromise the safety of structure.
5) Concrete mixes with the indicated nominal compressive strengths and maximum aggregates sizes which will be required for the construction of the Permanent Works are indicated in the following Table. The class of concrete required to be used in any specific location shall be as shown on the Detailed Design and/or Construction Drawings, or as directed by the Engineer.

Class of Concrete	Characteristic Strength		Max. Size of Aggregates (mm)
	MP	2 kg/cm	
C15D32	15	150	32
C20D32	20	200	32

C20D76	20	200	76
C25D20	25	250	20
C25D32	25	250	32
C25D32 W(1)	25	250	32
C30D20	30	300	20
C30D32	30	300	32
C35D20	30	300	20
C35D32	30	300	32

Differs from previous by impermeability (letter W added)

6) The final design of concrete mixes will be established by the Engineer, at the Site laboratory. The execution of all testing on concrete and its constituent materials, both before and during placing, will be the responsibility of the Contractor.

8.4 SUBMITTAL

1) Submittal listed herein are related to items which require the consent of the Engineer and are to be made by the Contractor before the appropriate work may proceed.
2) Within 28 days from the date of issue of Notice to Commence, but before procuring or mobilizing to the Site the equipment, the Contractor shall submit to the Engineer updated and detailed plans and descriptions, consistent with those submitted with his Bid and any subsequent amendments and additions agreed to by the Engineer and the Contractor, of the following:
    a) Aggregates Processing Plant: description, flow diagrams and drawings in sufficient details to indicate layout, type and capacity of crushing, screening, washing, conveying and other aggregate processing and handling equipment
    b) Batching and Mixing Plants: description, flow diagrams, and drawings of the plants, and details of the equipment the Contractor intends to use to determine and control the amount of each separate concrete ingredient and mixing thereof into uniform mixture
    c) Transport and Placing of Concrete: full details of the equipment and methods for transporting the concrete from the concrete plant to the final point of placing, including numbers, type and capacity of transport vehicles a concrete pumps, and details of standby plants to be installed
    d) Sampling and Testing of Materials: list and details of equipment for sampling and testing, detailed program for quality control of concrete work, and qualification and experience of the proposed personnel.
3) At least 28 days in advance of any concrete work being carried out at the Site, the Contractor shall submit to the Engineer following notifications based on the results of the preliminary material testing:
    a) Notification of the mill or mills from which cement will be obtained and whether cement will be ordered in bulk or bags. If cement is to be obtained from several factories, the estimated amount of cement from each factory and the proposed schedule of shipment shall be stated
    b) Notification of the source, analysis, method of delivery, and storage of water for concrete manufacture
    c) Notification of the admixtures which the Contractor will supply along with the catalogs and laboratory analyses. Should the Contractor intend to use admixtures in any concrete work for his own convenience, he shall give full details of the type, dosage, and influence on durability
    d) Details of the materials for formwork and surface finishes, treatment of

construction joints, and construction techniques which the Contractor proposes to use in order to achieve the required concrete surfaces and allowable tolerances

e) Notification of the factory or factories from which steel reinforcement will be obtained. If reinforcement is to be obtained from several factories, the estimated weight from each factory and the proposed schedule of shipment shall be stated.

4) At least 28 days prior to procuring or dispatch to the Site of the particular item of work to which the submittal relates, the Contractor shall submit to the Engineer the following:
   a) Details covering the properties and performance, including the certified copies of reports of all tests made by the manufacturers of waterstops, expansions joint fillers, and joint sealing compounds along with material samples of the products
   b) Details of curing compounds
   c) Details of epoxy mortar for concrete repair
5) Drawings showing the location of construction joints proposed by the Contractor which differ from those shown on the Detailed Design and/or Construction Drawings, including formwork and reinforcement details, shall be submitted to the Engineer at least 15 days prior to commencement of work on that particular structure.
6) During the performance of the concrete work, the Contractor shall keep a diary where he shall record the construction procedures related to concreting. This diary shall be made available to the Engineer upon request. The records shall contain at least the following:
   a) Commencement and termination of concreting of various parts of the structures
   b) Quantities and quality of aggregates and cement provided, and the storage from which they were drawn
   c) Temperature of air, water, cement, aggregates, and concrete
   d) Meteorological conditions and humidity of air
   e) Sampling and testing performed and summary of results
   f) Personnel employed during various stages of the concreting operation and name of the responsible inspector or foreman
   g) Equipment used
   h) Directives received from the Engineer
   i) Any special material or procedures employed
7) The Engineer reserves the right to require any additional information deemed necessary to be included in the submitted documents.

8.5 TESTING

8.5.1 TESTS PRIOR TO THE START OF CONCRETE WORK (TRIAL MIX STAGE)

8.5.1.1 General

1) At least 2 months prior to commencement of any concreting of Permanent Works, the Contractor shall start the testing of materials, propose the composition of concrete mixes and prepare trial mix of each of the proposed concrete class. The Contractor shall prepare the trial mixes using the cement, water, aggregates and admixtures intended for the work and which conform to the requirements specified in this Section.
2) This preliminary test program shall include the determination of following parameters:
   a) Cement properties
   b) Characteristics of aggregates
   c) Mix water properties
   d) Admixture properties
   e) Proportion of aggregate ranges in the mix
   f) Proportion of un-crushed to crushed aggregates
   g) Cement dosage
   h) Water-cement ratio (W/C)
   i) Workability of concrete mixes

j) Compressive and tensile strength
k) Entrained air
l) Density
m) Water tightness

3) These test shall be carried out until the concrete mixes show appropriate strength, workability, density, and water tightness without the use of excessive cement.

8.5.1.2 Cement

1) Cement shall be sampled and tested for strength and physical properties, and chemical analysis under method EN 196.
2) The Contractor shall obtain the cement samples for testing at the cement mill as the bins are being filled. Tests for false set shall be made on samples taken at the latest time prior to shipment.

8.5.1.3 Aggregates

1) Aggregates shall be sampled and tested as set out in ASTM Specification C33.
2) Tests shall be made on samples that are representative of the grading that will be used in the concrete.

8.5.1.4 Water

1) The suitability of the water for concrete shall be evaluated and the permissible amount of silt or suspended solids established in accordance with ASTM Test Method C-1602/C-1602M-06.
2) Water which quality is questionable or suspected of having detrimental amounts of sulfates shall be chemically analyzed in a specialized laboratory designated by the Engineer.
3) For the examination of mixing water, the Contractor shall deliver to the laboratory at least one liter in a thoroughly cleaned and tightly sealed bottle.

8.5.1.5 Admixtures

1) Admixtures proposed by the Contractor shall be tested for their suitability with the cement and materials to be used in the Works and under proposed construction conditions.
2) Admixtures shall be sampled and tested as set out in ASTM Specification C494.
3) Air-Entraining admixtures shall be tested in accordance with ASTM Test Method C233.

8.5.1.6 Concrete

1) Concrete test cylinders shall be made and cured in accordance with ASTM Standard Method C31. Sixteen test cylinders 150 mm diameter, 300 mm high shall be made from each mix proposed for the different classes of concrete. Compressive strength of concrete shall be tested on four test cylinders at 3, 7, 14 and 28 and 90 days in accordance with ASTM Test Method C39.
2) Splitting tensile strength of concrete shall be tested in accordance with ASTM Test Method C496. Cylindrical beams of concrete for testing shall be made and cured in accordance with ASTM Standard Method C31.
3) The consistency of the proposed mixes shall be tested by means of slump test in accordance with ASTM Test Method C143. Specimen for slump tests shall be taken from each batch of concrete used to make the test cylinders and beams.
4) Time of setting of concrete mixes shall be determined in accordance with ASTM Test Method C-403.
5) Static modulus of elasticity and Poisson's ratio of concrete in compression shall be determined in accordance with ASTM Test Method C-469.
6) Prior to execution of large scale concreting work at the Site, test shall be performed to determine the temperature development due to hydration within the concrete with various types of cement. The temperature rise shall be recorded and corresponding diagrams established.
7) Air content shall be determined in accordance with ASTM test method C-231.

8.5.1.7 Aggregates Processing Plant and Concrete Plant

The performance of aggregates processing plant and concrete plant shall be tested by carrying out a trial concrete production run prior to any concreting of Permanent Works.

8.5.1.8 Waterstops

1) All types of waterstops shall be tested in a recognized laboratory prior to shipment to the Site. Test specimens shall be furnished by the manufacturer and the tests shall be carried out at the place of waterstop manufacture.
2) Waterstop shall be tested as to their tensile strength, elongation, duration, water absorption, specific gravity, effect of alkali and impact resistance.

8.5.2 TESTS DURING EXECUTION OF THE WORK

8.5.2.1 General

1) The Contractor shall carry out tests on materials and samples of concrete during the execution of work in order to provide proper quality control of the concrete production. The test program shall be as stipulated hereinafter and the Contractor shall comply with the requirements and give all needed assistance in the performance of test program.
2) The Contractor shall keep records of test results which shall be presented to the Engineer upon request.
3) Should the Contractor wish to reduce his approved testing program he shall notify the Engineer of these changes 2 weeks in advance.
4) Aside from Contractor's testing program, the Engineer will make control test to the extent as he deems necessary. The Contractor shall give all required assistance in sampling and provide for the proper storage and transport of the specimens to be tested by the Engineer.
5) The Contractor shall make any arrangements needed or purchase new equipment, should the test results prove that changes in the aggregates or concrete plant are necessary to obtain the required concrete quality.

8.5.2.2 Cement

1) Cement shall be inspected for contamination and for lumps caused by moisture after arrival on the Site.
2) When cement is delivered in bags, sufficient checks shall be made to assure that the bag weights conform with the stated weight. Packages that vary more than 3% from the stated weight or when the average weight of 50 packages taken at random from any shipment is less than stated, the entire shipment may be rejected by the Engineer.
3) Cement shall be sampled and tested for strength and physical properties under method EN 196

8.5.2.3 Aggregates

Sampling and testing of aggregates in accordance with ASTM Specification C 33 shall be carried out at the frequency shown in the table below.

a) Coarse Aggregate

Test Description	ASTM Test No.	Frequency
Gradation	C 136	Not less than twice per week or per 500 Cum of concrete
Amount of material finer than 75 mm sieve	C 117	Not less than twice per week or per 500 Cum of concrete
Soundness	C 88	per 1,0000 Cum of concrete
Clay lumps and friable particles	C 142	per 1,0000 Cum of concrete
Lightweight Pieces in Aggregate	C 123	per 1,0000 Cum of concrete
Abrasion Test	C 131	per 5,000 m3 of concrete
Alkali Reactivity	C 289	Once for each source of aggregates
Petrographic Analysis	Designation 7 of USBR Concrete	Once for each source of aggregates

	Manual	
Specific Gravity of Coarse Aggregate	C 127	In early stages of work, and when changes in aggregates, but not less than every 10,000 Cum of concrete

b) Fine Aggregate

Test Description	**ASTM Test No.**	**Frequency**
Moisture Contents	C 70	Twice per shift or as necessary
Gradation	C 136	Twice per shift or as necessary
Amount of material finer than 75 mm sieve	C 117	Twice per shift or as necessary
Fineness Modulus	Designation 4 of USBR Concrete Manual	Twice per shift or as necessary
Organic Impurities	C 40	per 5 000 Cum of concrete
Soundness	C 88	Every 10,000 Cum of concrete
Clay lumps and friable particles	C 142	Every 10,000 Cum of concrete
Lightweight Pieces in Aggregate	C 123	Every 10,000 Cum of concrete
Alkali Reactivity	C 289	Once for each source
Petrographic Analysis	Designation 7 of USBR Concrete Manual	Once for each source
Specific Gravity of Fine Aggregate	C 128	In early stages of work, and when changes in aggregates, but not less than every 10,000 Cum of concrete

8.5.2.4 Water

Testing of water after the sources have been established shall be carried out at the frequency shown in the table below.

Test Description	**Standard Specifications**	**Frequency**
Total Suspended Solids	ASTM – C 602 M EN - 1008	Once per month or when necessary
Chemical Test: PH-Chloride-Sulphate-Ammonium-Magnesium-Total Hardness-Carbonate Hardness-Calcite Dissolution Capacity	ASTM -C-1602 M	Once per month or when necessary

8.5.2.5 Admixtures

Each shipment of admixtures to the Site shall have a quality certificate. The quality certificate inclusive of all the main tests performed shall be issued by the manufacturer.

8.5.2.6 Fresh Concrete

1) All concrete samples shall be obtained in accordance with ASTM Standard Method C172 for

sampling fresh concrete.

2) The Contractor shall make three sets of 3 cylinders from each 300 m3 of fresh concrete placed in the Works during the day (or shift), but not less than 6 cylinders for each class used for each day (or shift) of concreting. The test cylinders shall be 150 mm in diameter and 300 mm high.
3) Each set of cylinders shall be composed of a single batch of concrete and then cured in accordance with ASTM Standard Method C-31. The sets of cylinders shall be tested at 3, 7 and 28 days for concrete having the characteristic strength established at 28 days, and at 7, 28 and 90 days for concrete having the characteristic strength established at 90 days.
4) The Contractor shall take slump tests in accordance with ASTM Test Method C- 143 of each concrete class throughout the duration of concreting work with a frequency of one slump test each three mixer trucks at the batching plant and at the pouring location. Whenever a concreting operation is started, a slump test of the first two mixes shall be made for each class of concrete
5) Unit weight shall be determined for each concrete batch placed in the work or each day. The air content shall be determined according ASTM C-231 in principle once per week or when necessary the class of concrete to be tested shall be determined by the Engineer.
6) The Contractor shall furnish the batching plant laboratory with all facilities and apparatus to carry out all the prescribed tests. The sampling of the fresh concrete will be at the batching plant.

8.5.2.7 Placed and Hardened Concrete

1) Where considered necessary by the Engineer, in-situ characteristics of placed concrete shall be tested in accordance with ASTM Standard Method C 42. The Contractor shall obtain samples and perform such tests. Samples found to be defective shall not be deemed to be included in this amount and shall be replaced by new ones by the Contractor.
2) Holes left after the cutting or core drilling shall be carefully filled with dry-pack mortar or epoxy mortar as directed by the Engineer.
3) Specific gravity, absorption, and voids in hardened concrete shall be tested in accordance with ASTM Test Method C 642, and compressive strength in accordance with ASTM Test Method C 39.
4) When required by the Engineer, the Contractor shall test the placed and hardened concrete by means of "Schmidt Concrete Test Hammer".

8.5.2.8 Reinforcing Steel

Reinforcing steel shall be accompanied by a factory certificate and, when directed by the Engineer, tested in a recognized laboratory to demonstrate compliance with ASTM Specification A 615 M or ASTM Specification A 185.

8.5.2.9 Curing Compounds

Curing compounds shall be tested in accordance with ASTM Test Method C 156 to demonstrate compliance with ASTM Specification C 309 or EN 8656 when directed by the Engineer.

8.5.2.10 Concrete Plant

Monthly checks, or when requested by the Engineer, of the concrete plant's weight-batching accuracy, including the accuracy of any admixture dispenser, shall be made by the Contractor in the presence of the Engineer. When checked by standard weights and volumes its accuracy shall be within 0.5% or as specified by the manufacturer.

8.6 PRESCRIPTIONS TO BE FOLLOWED IN CASE THE STRENGTH IS NOT ATTAINED

1) When the results of the tests carried out do not comply with the specifications, the Engineer shall have the right to require that one or more of the following measures are taken:
    a) Extraction of a sufficient number of concrete samples (core taken with the rotary drilling method) from the structure for which a compressive test, or group of

compressive tests, have given unsatisfactory results. These samples shall be taken and tested according to ASTM C 42.

b) Performance of load tests, where possible, on the structure whose compression tests were found unsatisfactory.

c) Other tests ordered case by case.

2) If, after carrying out such investigations, the Engineer finds out that the concrete in the structure is not of the specified quality, he may order the strengthening or replacement of all or part of the entire volume of hardened concrete represented by the test failure, or any other part of the Work whose safety in the opinion of the Engineer is prejudiced or whose strength is impaired, either by virtue of the faulty concrete or the remedial measures ordered.
3) The expenses borne for the above mentioned investigations and tests as well as for strengthening, demolition and reconstruction of defective works shall be at Contractor's expenses whenever it is proved that the concrete in place after 28 days has a strength less than the specified one for its class.

8.7 CONCRETE MATERIALS

8.7.1 CEMENT

1) The Contractor shall supply ordinary Portland cement Type I conforming to ASTM Specification C150. The use of other cements shall be subject to the approval of the Engineer and they shall be stored separately.
2) The alkali content of the cement shall not exceed 1% by weight.
3) Each consignment of cement delivered to the Site shall be accompanied by a test certificate issued by the manufacturer in quadruplicate. The Engineer will have the right to attend the sampling and testing at the manufacturer's plant at any time. If delivery is not directly from the manufacturer, the intermediate storage and delivery arrangements shall be subject to the approval of the Engineer.
4) Cement which does not comply with ASTM Specification C150 or is damaged in consignment, handling or storage shall be promptly removed from the Site.
5) All facilities for transport and storage of cement shall be subject to approval of the Engineer and shall be such that easy access for inspection is assured.
6) Bulk cement shall be transported from the port or factory to the Site in adequately designed weather-tight trucks, or other means where cement will be protected from exposure to moisture. Immediately upon receipt at the Site, cement shall be stored in a dry, weather-tight and properly ventilated structure with adequate provisions for the prevention of absorption of moisture, and constructed in such a way that there will be no dead storage. The vents of the bins and silos shall be equipped with dust collectors to reduce loss of cement during handling and inconvenience to the personnel.
7) Cement bags shall be stored in weatherproof buildings with a raised, well ventilated wooden floor, and placed so that each consignment can be segregated if required and used in order of its age. Bags shall not be stacked more than 1.5 m high. Cement shall not be stored out of doors, except for immediate use, and in such event shall be protected during storage and handling by waterproof covers and a raised floor. Unused cement shall be placed back into the storage buildings.
8) Cement shall be used in approximately chronological order in which it has been received at the Site. Storage of cement shall be limited to 90 days in bags a 150 days in bulk. Cement that has been in storage for longer than these periods or which may have absorbed moisture shall not be used unless it has been retested by the Contractor and approved by the Engineer. Cement that has become lumpy shall not be used. The cements coming from different mills or of different makes shall be stored separately.
9) The temperature of cement upon arrival to the Site shall not exceed 70°C and when entering

the mixers shall not exceed 50°C unless otherwise approved.

10) The maximum heat of hydration for Portland cement Type I shall not exceed 80 and 90 calories per gram at ages 7 and 28 days respectively, and 70 and 80 calories per gram at same ages for Portland cement Type II.
11) The Contractor shall keep and make available to the Engineer records of the date, amount, and storage location of each delivery of cement and of the part of the Works in which it was used and shall provide facilities for checking the stock of cement.
12) The Contractor is solely responsible for the timely supply of cement meeting the requirements of these Specifications and the Works. The delay due to the lack of suitable cement will not give the Contractor any right for the extension of time for the Completion of Works, or any claims resulting here from.

8.7.2 AGGREGATES

8.7.2.1 General

1) Fine and coarse aggregates shall conform to the requirements of ASTM Specification C 33. They shall consist of clean, hard, dense, durable and un-coated materials, and shall have a stable moisture content and grading when delivered to the batching plant. Aggregates shall not contain substances which may impair the quality of the concrete, attack reinforcing steel or reduce bond. The following substances are regarded as being harmful: loam, clay, pieces with large cavities, foam-like or vitreous pieces, and organic materials such as topsoil, roots, wood, coal, lignite, etc. The deleterious substances are defined in ASTM Standards C117, C142, C123, C40. In doubtful cases the effects of harmful substances shall be established by tests.
2) The shape of the particles shall be generally spherical or cubical. The amount of flat or elongated particles shall not exceed 25% by weight. A flat or elongated particle is defined as one in which the width to thickness, resp. length to width ratio is greater than 3.
3) The Contractor shall make provisions for crushing and processing of material in accordance with recommendations contained in ACI 221 R-61 "Selection and Use of Aggregates for Concrete" to meet the gradation and other requirements of these Specifications, in order to obtain the total amount of aggregate required for concrete manufacture. Crushing, screening and washing operations, bonification of aggregates, and blending of crushed and natural aggregates shall at all time be subject to the approval of the Engineer. The secondary crushers shall be of the cone type.
4) The optimum proportion of crushed to natural aggregate, and in particular the possibility to use crushed sand, shall be determined at trial mix stage. During the construction of the Works, the Contractor may use a greater proportion of crushed to natural aggregate than used in the approved trial mixes only with the consent of the Engineer, providing that no claim for reimbursement for additional cement used will be raised by the Contractor.
5) Natural and crushed aggregates shall be stockpiled and batched separately.
6) The handling, transporting, and stockpiling of aggregates shall be such that there will be a minimum amount of fines resulting from breakage and abrasion of material resulting from free fall and improper handling. Excess in any of fine or coarse aggregate sizes shall be disposed of in approved manner.

8.7.2.2 Source

1) Coarse and fine aggregates shall be produced from suitable material obtained from required excavation for Permanent and Temporary Works and from the approved quarry and borrow areas shown on the Final Design and described in the Information to Tenderers or from other sources as may be designed or approved in the course of the work.
2) The Contractor shall carefully clear and prepare the stockpile areas so that excavated materials are free of unsuitable materials and other objectionable matter. All materials removed from the area and not used in the work shall be disposed of as directed.
3) The disposal of excavated materials shall be selective. The suitable rock for aggregates shall be

unloaded in the approved stockpiles, while the rock not suitable for aggregates shall be unloaded in the approved disposal areas.

4) The suitability of the rock for aggregates shall be established with laboratory tests carried out by the Contractor.
5) Alternative sources developed by the Contractor shall be subjected to approval by the Engineer. The Contractor shall carry out tests to furnish satisfactory evidence that aggregates from such alternative sources comply with the requirements of this Section.
6) The approval of the sources shall not be construed as constituting the approval of all materials taken from the deposits. The Engineer reserves the right to reject certain localized areas, strata, or channels within the approved areas and zones, when the material is unsatisfactory for use.
7) The Contractor shall prepare and submit to the Engineer a detailed report concerning the quarry exploitation within 60 days from the date of issue of Notice Commence.

8.7.2.3 Fine Aggregate (Sand)

1) The term "fine aggregate" is used to designate aggregate in which the maximum size of particles is 4.75 mm.
2) The gradation of fine aggregate shall be as given below:

US Standard Sieve	Square Mesh Sieve Opening	Square Mesh Sieve Opening
No. 4	4.750 mm	95 - 100
No. 8	2.360 mm	80 - 100
No. 16	1.180 mm	50 - 85
No. 30	0.600 mm	25 - 60
No. 50	0.300 mm	10 - 30
No. 100	0.150 mm	5 - 15
No. 200	0.075 mm	0 - 5

3) Fine aggregate shall have a fineness modulus in a range between 2.5 and 3.0. The fineness modulus is calculated by adding the cumulative percentages retained on US Standard Sieves Nos. 4, 8, 16, 30, 50 and 100 and dividing the sum by 100. The grading shall be controlled so that at any time the fineness modulus of at least 9 out of 10 consecutive test samples of finished sand will not vary more than 0.20 from the average fineness modules of the 10 test samples.
4) The amount of deleterious substances in fine aggregate shall not exceed the limits given below:
   - Organic matter Limits: as per Table 9.2 of ASTM C40-04
   - Clay lumps and friable particles (as per Table 1 of ASTM C-33-03) 3 % by weight
   - Lightweight material 2 % by weight
   - Total of other deleterious substances 2 % by weight

   The sum of percentages of all deleterious substances shall not exceed 5 % by weight. The percentage passing the75 µm shall be limited in accordance with BS 882:1992 Section 5.4.
5) Sand producing a colour darker than the standard set out in the test for organic impurities (ASTM C 40) may be rejected.
6) Should the loss of weight of portion retained on No. 50 Sieve, when subjected to five cycles of soundness test by use of sodium sulfate (ASTM C 88), exceed 10% by weight, the fine aggregate may be rejected.

7) Fine aggregate, upon delivery to the batching plant, shall have a uniform and stable moisture content. The amount of moisture shall be less then 6% by weight, and shall not vary by more than 0.5% per hour.
8) Fine aggregate shall be stored in such a manner as to avoid the inclusion of any foreign materials and segregation.
9) The Contractor shall provide suitable drainage facilities to secure that the sand delivered to the batching plant shall have uniform and stable moisture content. If required, two or three separate stockpiles shall be maintained, one for wet sand, eventually one in the process of draining, and one where the drained sand shall remain for a minimum 48 hours prior to the use.
10) No fine aggregate from the bottom 50 cm of the stockpile shall be used for mixing concrete.
11) The Contractor shall maintain at all times sufficient storage of fine aggregate to permit continuous placement of concrete.

8.7.2.4 Coarse Aggregate

1) The term "coarse aggregate" is used to designate aggregate which is retained on sieve No. 4 (4.75 mm). The coarse aggregate shall conform to ASTM Specification C-33. The coarse aggregate may be rejected if the specific gravity (bulk, saturated surface-dry basis) is not in accordance with ACI 207.1R (par. 2.5.5) and tested in accordance with ASTM Standard Test C-127.
2) The coarse aggregate shall be processed, stockpiled, and used in groups designated by the maximum size aggregate. The gradation of aggregate in each group shall be as given below unless site laboratory tests prove that a different gradation is more suitable for concrete mix:

US Standard Sieve (mm)	Percent by Weight Passing Individual Sieve		
	20 mm	32 mm	76 mm
76	-	-	100
50	-	100	90-100
37.5	-	90-100	20-45
25	100	22-45	0-10
19	90-100	0-10	0-5
9.5	30-55	0-5	-
4.75	0-5	-	-

3) The amount of deleterious substances in coarse aggregate shall not exceed the limits given below:
    - Organic matter Limits: as per Table 9.2 of ASTM C-40-04
    - Clay lumps and friable particles
    - (as per Table 1 of ASTM C-33-03) 1.0 % by weight
    - Material passing No. 200 sieve 1.5 % by weight
    - Lightweight material 2.0 % by weight
    - Total of other deleterious substances 1.0 % by weight

    The sum of the percentages of all deleterious substances in any category shall not exceed 3% by weight.
4) Should the loss by weight, when the aggregate is subjected to abrasion test by use of the Los Angeles machine (ASTM C131), exceed 10% at 100 revolutions or 40% at 500 revolutions, the coarse aggregate may be rejected.
5) Should the weighted average loss by weight exceed 10%, when the aggregate is subjected to

five cycles of soundness test by use of sodium sulfate (ASTM C88), the coarse aggregate may be rejected by the Engineer.

6) Coarse aggregates, upon delivery to the batching plant, shall have a uniform and stable moisture content.
7) The nominal maximum aggregate size in relation to the structure dimension shall not be larger than:
    a) 1/5 of the narrowest dimension between the side of forms
    b) 3/4 of the minimum clear spacing between the reinforcing bars
    c) 1/3 of the slab depth
8) Stockpiles of coarse aggregate shall be formed in such manner as to avoid the ingress of any foreign matter and to prevent segregation. Sufficient storage shall be maintained at all times to permit continuous placement of concrete.

8.7.3 WATER

1) Water for mixing and curing of concrete, mortar, plaster, and grout shall be taken from an approved source and shall be clean, colourless, free from deleterious substances including salt, oil, alkaline or organic matters, sugar compounds, and shall not have brackish or saline taste. When shaken no permanent foam may be formed.
2) The limits of the content of sulphates, chlorides, alkali and turbidity shall conform with ASTM C-1602/C-1602M-06.

8.7.4 ADMIXTURES

8.7.4.1 General

1) Water-reducing, water-reducing-retarding, air-entraining and super plasticizer admixtures shall be used for cast-in-situ and precast concretes. Only admixtures that have been commercially used with satisfactory service in a similar type of concrete work shall be considered for approval. All admixtures shall be manufactured by a reputable company(ies) such as Sika, Grace, Master Builders supported by a fully staffed technical service organization and research group.
2) Admixtures shall be stored and handled so as to avoid contamination or damage to their properties by temperature or moisture changes or other influences.
3) The quantity of admixture used, and the method of mixing shall be strictly in accordance with the manufacturer's printed instructions, or as required to produce specified results and approved by the Engineer.
4) The Contractor shall be held liable for any damages and difficulties resulting from the selection and use of admixtures such as delay in concrete placing or damage to concrete during forms removal and shall not be entitled to any time extension or claims resulting here from.

8.7.4.2 Accelerators

1) Only non-chloride accelerators meeting the requirements of ASTM Specification C 494, Type C may be used if permitted by the Engineer. The use of calcium chloride or other admixture in which chloride is added or serves as an active ingredient shall not be permitted.
2) Accelerators shall not be used in hot weather concreting.

8.7.4.3 Air-Entraining Admixtures

1) Air-entraining admixtures shall conform to the requirements of ASTM Specification C 260.
2) Air-entraining admixture shall be used to achieve the following air content in concrete:

Maximum size aggregate in concrete	Total air Percentage by volume of concrete
20 mm	6.0 ± 1
32 mm	4.5 ± 1
76 mm	3.5 ± 1

8.7.4.4 Water-reducing, Set-controlling Admixtures

1) Water-reducing, set-controlling admixtures shall conform to the requirements of ASTM Specification C 494, Type A, D, E, F or G.
2) The dosage to be used shall be within the range recommended by the manufacturer and as determined by tests or as directed by the Engineer, but type and quantities will vary with changing climatic conditions at the Site and/or other job conditions.

8.7.4.5 Combined Admixtures

Combined air-entraining, water-reducing admixtures shall be used where required to increase the watertightness and strength of the concrete (e.g. Plastocrete-DM of SIKA).

8.8 STEEL REINFORCEMENT

8.8.1 GENERAL

1) The Contractor shall furnish, fabricate, and install all reinforcement steel as shown on the Detailed Design and/or Construction Drawings and bar lists. The work shall further include the furnishing and installation of all tie wires, clips, supports, chairs, spacers, and other appurtenances necessary to produce finished concrete structures.
2) All reinforcing bars shown on the Detailed Design and/or Construction Drawings shall be identified on the bar lists and all bars shall be defined and given dimensions in a clear and unambiguous way. All bar lists shall be referenced to the relevant reinforcement drawings. The Contractor shall be responsible for the correctness of the reinforcement drawings and bar lists.
3) The Contractor shall submit to the Engineer prints and electronic files of the reinforcement drawings and bar lists.

8.8.2 QUALITY REQUIREMENTS

1) Reinforcing bars shall be Grade 60 (420 MPa) deformed billet-steel bars conforming to ASTM Specification A-615-M. Plain bars may only be used where shown on the Drawings. Minimum yield strength of the bars shall be 400 N/mm2 (4,077 kg/cm2).
2) Wire for tying reinforcement shall be smooth wire conforming to ASTM Specification A82.
3) Welded wire fabric for in-situ or sprayed concrete reinforcement shall be made from electrically welded smooth wire and shall conform to the requirements of ASTM Specification A185.

8.8.3 STORAGE

1) Reinforcement shall be stored at the Site and separate into the various sizes in such a manner that it is not contaminated with deleterious matter. Reinforcement coming from different manufacturers shall be stored separately.
2) Reinforcement fabric supplied in rolls shall be straightened into flat sheets before being placed.

8.8.4 CUTTING AND BENDING

1) Steel bars shall be accurately cut and bent to the dimensions and shapes as shown on the Detailed Design and/or Construction Drawings and Bar Lists.
2) The bars shall be bent cold at temperature greater than 5°C. Bending below that temperature or warm bending will only be permitted when adequate precautions are taken to comply with the corresponding direction issued by the steel manufacturer for such bending.
3) Temporary bending and subsequent straightening of bars partially embedded in concrete shall not be permitted, except when shown on the Detailed Design and/or Construction Drawings or with the written approval of the Engineer.
4) Should the necessity of welding of reinforcement arise, the provisions of the American Welding Society "Reinforcing Steel Welding Code" (AWS D 12.1) shall be followed.

8.8.5 SPLICING

Reinforcement bars, other than tie bars, shall not be spliced at points other than those shown on the Detailed Design and/or Construction Drawings without the consent of the Engineer. On occasions when it becomes necessary to alter the position of such splices, the new position and the type of splice shall be subject to the written approval of the Engineer.

8.8.6 PLACING

1) Reinforcing steel, before being positioned, shall be free from loose mill and rust scale, and from any coating that may destroy or reduce the bond between the steel and concrete.
2) As a rule, the same type of reinforcement from the same source shall be used in any one part of the structure.
3) Reinforcing steel shall be accurately positioned and secured against displacement by using ties made of annealed iron wire of not less than No. 16 gauge, dobies, or suitable clips at intersection.
4) The metal chairs, bar spacer and similar reinforcement support devices that touch the forms shall be galvanized or shall have plastic tips at the point where the support device touches the forms.
5) The bottom layer of reinforcing steel in slabs on the ground shall be supported by means of pre-cast concrete blocks (dobies). The concrete blocks shall have a horizontal surface approximately 7x10 cm and be of concrete quality at least equivalent to that which is to be placed. The upper layer of reinforcement in slabs on ground and all other slabs and in beams shall be supported by means of metal chairs. In all cases, sufficient supports for horizontal reinforcement shall be used so that there will be no sagging of the bars.
6) All reinforcement shall be inspected in place and approved by the Engineer before placing the concrete. Concrete placed in violation of this provision may be rejected and removal required.

8.8.7 CONCRETE COVER OF THE REINFORCEMENT

The cover of the reinforcement shall be as indicated below or as shown on the Detailed Design and/or Construction Drawings:

1) In-situ concrete:
   - Concrete cast directly against soil or rock and being permanently exposed to it 60mm
   - Formed concrete permanently exposed to backfill or water 50 mm
   - Outside exposure 40 mm
   - Inside exposure 30 mm
2) Pre-cast concrete:
   - Outside exposure 40 mm
   - Inside exposure 30 mm

8.9 SURFACE FINISHES

8.9.1 GENERAL

1) The quality of the surface finish shall be appropriate to the classification as described hereunder. Generally it shall be free from areas of honeycombs, segregation, loss of cement or fine material, from damage due to stripping of forms, from boltholes, abrupt irregularities caused by movement of forms or components, loose knots and similar features and bulges or depressions in the general plane of the surface.
2) Only one type of formwork shall be used for all parts of a concrete structure which is visible from any direction.
3) The classes of finish shall be as shown on the Detailed Design and/or Construction Drawings or as directed by the Engineer.

8.9.2 FORMED SURFACES

The classes of finish for formed surfaces are designated by the use of symbol F and the shape of the formwork panels required for concrete work shall be either plane (F1, F2, F3 and F4) or curved (F1C, F2C, F3C and F4C).

a) Finish F1, F1C: this finish shall be for surface concealed from view, including surface upon or against which backfill, or concrete is to be placed, formed surfaces of expansion and contraction joints, and blockouts for equipment embedding or other parts which are to be built in. It may be obtained by the use of properly designed formwork or molds of closely- jointed rough sawn boards. The surfaces will be imprinted with the grain of the sawn boards and their joints. Small blemishes caused by entrapped air or water may be expected, but the surface shall be free from voids, honeycombs, or other large blemishes. The surfaces require no treatment after formwork removal, with the exception of the filling of form-tie holes, correction of surface depressions deeper than 3 cm, the repair of defective concrete and curing as specified.

b) Finish F2, F2C: this finish shall be for all surfaces exposed to view not in contact with flowing water. It is achieved by the use of properly designed forms of closely jointed wrought boards. The surfaces will be imprinted with the slight grain of the wrought boards and their joints. Alternatively, steel or other suitable material may be used for the forms. Fascia boards consisting of 25x25 mm timber strips shall be fixed to the tops of forms to ensure the formation of straight and even horizontal construction joints. After removal of forms, the surface shall be improved by carefully removing all fins and other projections, thoroughly washing down, and then filling the most noticeable surface blemishes using methods described hereafter in "Repair of Defective Concrete". Form-tie holes shall be filled, and all voids, honeycombs, and other defective concrete repaired before curing as specified. When filling holes and repairing defective areas, every effort shall be made to match the colour of the concrete. The use of release agents which may permanently stain or discolour the finished surface will not be permitted.

c) Finish F3, F3C: this finish shall be for surfaces in contact with flowing water where cavitation, head loss, freeze/thaw or erosion are of concern. The standard of finish required is similar to an F2 finish, but with no surface bubbles or holes larger than 3 mm diameter allowed, and with more stringent tolerance requirements measured along a line parallel and transverse to the direction of flow. Variations in concrete colour as a result of concrete repairs or staining due to release agents will be allowed. Fascia boards will not be required.

d) Finish F4, F4C: this finish shall be for surfaces where plaster, stucco, or wainscoting is to be applied. Formwork shall consist of rough-faced form boards. Steel lining or steel sheathing shall not be permitted. No form oil may be used. Forms shall be removed as soon after pouring as conditions will permit. Surfaces shall be roughened with a heavy wire brush, cleaned of all materials that might prevent satisfactory bond and washed thoroughly. Immediately prior to plastering, concrete surfaces shall be recleaned and damped by means of a fog spray.

8.9.3 UNFORMED SURFACES

1) The classes of finish for unformed concrete surfaces are designated by the use of symbol U:

a) Finish U1 (screeded finish): this finish shall be applied to unformed surfaces that will be covered by fill material or concrete. Finishing operations shall consists of sufficient leveling and screeding to produce even, uniform surfaces. Surface irregularities shall not exceed those specified for Finish F1. This finish is also the first stage of finishes U2 and U3.

b) Finish U2 (floated finish): this finish applies to unformed surfaces not permanently concealed by fill material or concrete. Finishing operations shall consist of sufficient leveling and screeding to produce even surfaces in which the surface irregularities shall not exceed those specified for Finish F2. Floating with hand or power-driven equipment shall be started as soon as the screeded surface has stiffened sufficiently, to produce a surface that is free from screed marks and is uniform in colour and

texture. This finish is also the second stage of finish U3. If finish U3 is to be applied, floating shall be performed until a small amount of mortar without excess water is brought to the surface, so as to permit effective trowelling.

c) Finish U3 (steel troweled finish): this finish shall be for surfaces in contact with flowing water where cavitation, head loss, freeze/thaw or erosion are of concern, as well as inside floors of buildings except where a bonded concrete finish or tile floor is foreseen. The standard of this finish is similar to U2, but with more stringent tolerance requirements parallel and transverse to the direction of flow. Steel troweling shall start when the floated surface has hardened sufficiently to prevent an excess of fine material from being drawn to the surface. It shall be performed with a firm pressure that will produce a dense, uniform surface free of blemish, ripples, and trowel marks.

d) Interior surfaces shall be sloped for drainage where shown on the Detailed Design and/or Construction Drawings. Exterior surfaces, which will be exposed to the weather, shall be sloped for drainage even if there is no such indication on the Detailed Design and/or Construction Drawings. In such case the slope shall be at least 1% but not exceed 3%.

8.10 TOLERANCES

8.10.1 CONCRETE

1) Concrete surface irregularities caused by the roughness of the formwork facing or by inaccurately aligned joints between the formwork panels shall not exceed the following tolerances:

Specified Finishes		Permissible Irregularities	
		Abrupt	Gradual
F1, F1C, U1		6 mm	12 mm
F2, F2C, F4, U2		3 mm	6 mm
F3, F3C, U3			
a) Measured along direction	A line parallel to the flow	3 mm	6 mm
b) Measured along flow direction	A line perpendicular to the flow	1 mm	3 mm

2) Abrupt irregularities are offsets caused by displaced or misplaced form sheathing or lining or form sections, or by loose knots in forms or otherwise defective form lumber. They shall be tested by direct measurements.
3) Gradual irregularities are all other irregularities and shall be tested by a 2 m long template. The templates will be a straight edge for plane surfaces or a "shaped" template for curved or warped surfaces.
4) Further limitation for allowable abrupt irregularities for surfaces of structures with high velocity water flow shall be as follows, if not otherwise shown on the Detailed Design and/or Construction Drawings or directed by the Engineer:
    a) Abrupt irregularities parallel to the flow direction shall be eliminated completely by grinding to bevel of 1 to 20 ratio of height to length.
    b) Abrupt irregularities transverse to the flow direction shall be eliminated

completely by grinding to bevel of 1 to 50 ratio of height to length.

5) Deviations of concrete structure outlines from the lines and grades shown on the Detailed Design and/or Construction Drawings shall not exceed 20 mm.
6) Variations in thickness of slab, columns and walls shall be within the limits 5 mm and +10 mm.
7) The Contractor shall repair hardened concrete which is not within specified tolerances as stipulated in "Repair of Defective Concrete" later in this Section. Such repair shall, however, be done only after consultation with the Engineer and after his consent.
8) Concrete surface which may be in contact with high velocity flow shall be, without exception, brought within the specified tolerances. Grinding shall be limited in depth so that no aggregate particles remain exposed more than 2 mm in cross section at the finished surface. Where grinding would cause exposure of aggregate greater than the above limit, concrete shall be removed from the area affected and replaced by new concrete.

8.10.2 REINFORCEMENT

1) The center-to-center distance between parallel bars shall be as shown on the Detailed Design and/or Construction Drawings, with a tolerance of 20 mm, or as directed by the Engineer.
2) In placing reinforcement steel, the tolerance from indicated protective cover shall be:
   - for 40 mm cover and less: ± 5 mm
   - for 50 mm cover and more: ± 10 mm

8.11 FORMWORK

8.11.1 DESIGN

1) The Contractor shall assume full responsibility for the adequate design of all formwork, falsework, and all accessories.
2) For the purpose of formwork and falsework design, the Contractor shall assume a value of 2.5 t/m3 for the density of concrete.
3) Formwork shall be designed to withstand the full hydrostatic head of concrete.

8.11.2 WORKMANSHIP

1) All forms shall be true to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete.
2) Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Forms shall be tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete.
3) Any forms which in the opinion of the Engineer are unsafe or inadequate in any respect may, at any time, be rejected and the Contractor shall promptly remove the rejected forms from the Works and replace them.
4) An adequate number of temporary clean-out holes or short pipes shall be provided in the forms to secure the draining of rainwater.
5) All exposed finished edges of concrete shall be chamfered 20 mm (at 1:1) unless otherwise shown on the Detailed Design and/or Construction Drawings.
6) When a second lift is placed on hardened concrete, the number, location and tightening of ties at the top of the old lift and bottom of the new shall be such as to prevent any damage to concrete. The form of a new lift shall overlap the hardened concrete by 10 cm, to prevent abrupt irregularities.
7) Forms for sloping concrete surfaces shall permit their placing board-by-board or panel-by-panel immediately ahead of concrete placement so as to enable access for placement, vibration, and inspection of the concrete.

8.11.3 MATERIALS

1) Materials used for form sheathing and lining shall be of wood, steel, plywood, or fiberglass.

2) Forms for concrete surfaces exposed to flowing water shall be lined with sanded, un-coated, plywood veneer. Steel or impermeable plastic liners will not be permitted.
3) Except as expressly approved by the Engineer, all timber brought to the Site for use as forms, shoring or bracing shall be new material. Plywood for use as form shall be mill-oiled and edge-sealed.
4) Rough sawn boards may be used only for the lowest grade of surface finish (F1).
5) Where required, expanded metal fixed to the formwork shall be used in vertical construction joints.

8.11.4 FORM TIES

1) The type, number and positions of internal formwork supports, and ties shall be to the approval of the Engineer.
2) The whole or part of such formwork supports, and ties shall be removed without damage to the concrete so as to leave no part embedded nearer the surface of the concrete than the designed cover of the reinforcement or 50 mm in the case of un-reinforced concrete. Only metal portions of formwork support and ties shall be allowed to remain in place.
3) Through-bolts will not be permitted in water retaining walls.
4) Holes left after the removal of supports and ties shall be filled as described hereinafter in "Repair of Defective Concrete" and shall be finished off neatly to the standard of the concrete surface. Such filling shall be adequately cured.

8.11.5 MAINTENANCE OF FORMWORK

1) Forms shall be maintained at all times in good condition, particularly as to size, shape, strength, rigidity, tightness and smoothness or surface.
2) All timber forms shall be given a preliminary oil treatment by the manufacturer or shall be oiled by the Contractor at least 2 weeks in advance of their use.
3) The surface of the forms shall be free from encrustation of mortar, grout, or other foreign matter at the time of concrete placement.
4) Before concrete is placed, the forms shall be thoroughly cleaned and treated with a nonstinging mineral oil or other lubricant approved by the Engineer. Any excess lubricant shall be removed before placing the concrete. Care shall be exercised in keeping oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.
5) Forms may be reused provided that they are in good condition, and that the required concrete form and finish may be achieved with their use. The Engineer will, at any time, have the right to reject formwork which he considers to be no longer fit for such use.

8.11.6 REMOVAL OF FORMWORK

1) Removal of forms shall be performed with care so as to avoid injury to the concrete and as soon as permissible in order to avoid delay in curing and repair of surface imperfections. Forms shall not be removed without the consent of the Engineer.
2) Forms shall not be removed until the concrete has attained sufficient strength to prevent damage to concrete. Damaged concrete shall be repaired or treated by the Contractor as soon as possible, but not before the Engineer has inspected such damage and agreed to the remedial works.
3) The minimum period before the removal of formwork shall be in accordance with the following table:

Type of Formwork	Days	% of 28-day compressive strength
Vertical formwork to columns, walls and	2	40%
large beams		

Ceiling formwork to slab	7	70%
Props to slabs	12	85%
Ceiling formwork to beams	10	80%
Props to beams	14	90%

4) The minimum periods in days are only indicative. The governing rule to be observed is the percentage of the required 28-day compressive strength, which shall be determined by the cylinder test in addition to those required by the provisions as described in aforesaid "Test During Execution of the Work". When fixing the minimum period for formwork removal, the shrinkage and creep of the concrete shall be taken into consideration.

8.12 JOINTS IN CONCRETE STRUCTURES

8.12.1 CONSTRUCTION JOINTS

8.12.1.1 General

1) Concreting shall be carried out continuously up to construction joints, the arrangement and positions of which shall be as shown on the Detailed Design and/or Construction Drawings, or as approved by the Engineer. Also, whenever concreting is forced to be interrupted and placed concrete has become so hard that it does not permit the entry of a vibrator, a new construction joint shall be formed conforming to these Specifications.
2) The position of certain construction joints shown on the Detailed Design and/or Construction Drawings as mandatory may not be altered. The Contractor may propose for approval different locations of other construction joints for reasons of concrete placement. Necessary rearrangement of steel reinforcement arising from such modifications shall be to the Contractor's debit.
3) Construction joints shall be approximately horizontal or vertical. The joints shall appear as straight lines, produced by a board fixed to the formwork, at exposed faces.
4) The faces of vertical joints shall be shuttered with expanded metal or other approved rough material. The expanded metal shall be removed as far as possible, before the adjacent lift is poured. If required, the surface shall be cleaned by wet sandblasting and roughened by light bush-hammering.
5) The surface of construction joints upon or against which new concrete is to be placed and to which new concrete is to adhere shall be clean, rough, and free of water when covered with fresh concrete. The laitance, loose or defective concrete and foreign material shall be removed from the surface of existing concrete. The previous concrete lift shall be saturated by water but surface dry when the successive lift is placed.
6) The surface of the hardened concrete shall be cleaned and roughened by wet-sandblasting and washing thoroughly with air-water jet. Care shall be taken to prevent undercutting of aggregate in the concrete during sandblasting.
7) Wet-sandblasting equipment shall be operated at an air pressure of approximately 7 bars. Sand to be used for blasting shall be dense, hard, not easily broken and sufficiently dry.
8) In lieu of wet-sandblasting the Contractor may propose high-pressure water blasting utilizing pressures not less than 400 bars, provided that such high-pressure water blasting produce equivalent results to those obtainable by wet-sandblasting.
9) The horizontal surfaces of construction joints may be treated by cutting with an air-water jets ("green-cutting"). This shall be performed after the initial set has taken place but before the concrete has become too hard for effective cutting. The fresh concrete surface shall be cut with air-water jets to remove all laitance and to expose clean, sound aggregate. After cutting, the surface shall be washed with clean water. Care shall be taken that the treated surface does not become contaminated before new concrete is placed upon it. Should the surface become

contaminated that a satisfactory joint with new concrete is not ensured the Contractor shall clean it by means of wet sandblasting.

10) Water used in cutting, washing and rinsing of concrete surfaces shall be disposed of in such a way that it does not stain, discolour or affect exposed surfaces of the structures.
11) When necessary, as determined by the Engineer, structural concrete placement in forms shall be started with an over-sanded mix with 19 mm maximum size aggregate, an extra 50 kg of cement per cubic meter and a 10 cm slump. This mix will be referred to as a starter mix and shall be placed approximately 5 cm deep.
12) In the heavy concrete structures and mass concrete, the construction joint surface shall receive layer of mortar approximately 10 mm thick immediately prior to placing of the new lift. This mortar shall be of the same proportions as those in the concrete with coarse aggregate omitted and shall have the same air content, by volume.
13) The mix or mortar shall be spread over the whole surface except in case of permanently visible construction joints where it shall be kept 5 cm back from the exposed surface. It shall be worked thoroughly into all irregularities of the surface. In inaccessible locations it shall be spread by means of air-suction gun.
14) Concrete shall not be placed upon mortar which has dried out or become contaminated by water, debris or other deleterious material. Mortar which has been so contaminated or dried out shall be removed from the surface of the construction joint, the surface shall be re-cleaned, and a fresh layer of mortar spread on the surface prior to placing of a new concrete lift.
15) Where indicated on the Detailed Design and/or Construction Drawings, construction joints shall be formed with shear keys. The Contractor's proposed method for forming such keys shall be subject to the approval by the Engineer.
16) Where indicated on the Detailed Design and/or Construction Drawings or where directed by the Engineer, flexible PVC water stop shall be placed in construction joints.

8.12.1.2 Cold Joint

1) Cold joint is an unplanned joint which is the result of hardening of the concrete surface before the next batch is placed against it. Cold joints are undesirable and should be avoided. However, in the event of equipment breakdown, prolonged heavy rainfall, or other unforeseen prolonged interruption the continuous placing may not be reasonable.
2) When such event become apparent, and the unconsolidated concrete may harden to the extent that later vibration would not fully consolidate it, the Contractor shall immediately consolidate such concrete to a stable and uniform slope.
3) If delay in placement is short and it is still feasible to penetrate the underlying concrete, placement shall resume with care to thoroughly penetrate and re-vibrate the concrete surface placed before the delay.
4) If the concrete cannot be penetrated with the vibrator, the cold joint shall be treated as a construction joint, if the design requirements tolerate such joint. If such joint would impair the structural integrity of the structure, as determined by the Engineer, the concrete, or a part of it, shall be repaired or removed as directed by the Engineer.

8.12.1.3 Construction Joints for Stage Concreting

1) Constructions joints for stage concreting are joints, or joint systems where in-fill concrete or bays shall not be placed before one or two months after placing of the first stage concrete.
2) Where indicated in the Detailed Design and/or Construction Drawings or where directed by the Engineer, waterstops shall be provided in construction joints for stage concreting. Waterstops shall be joined and fixed in place strictly in accordance with manufacturer's recommendations.

8.12.2 MOVEMENT JOINTS

8.12.2.1 General

1) Movement joints in the concrete structures shall be constructed at such locations and to such dimensions as shown on the Detailed Design and/or Construction Drawings or as directed by

the Engineer. The Contractor shall supply and install the various joint components as specified herein, as shown on the Detailed Design and/or Construction Drawings and in accordance with the manufacturer's recommendations.

2) Expansion joints are joints provided in concrete structures to prevent transfer of forces from structure to structure or to accommodate volumetric changes due to temperature rise. Expansion joints may be comprised of the following elements:
    a) Flexible neoprene or PVC waterstop
    b) Concrete shear keys
    c) Expanded polystyrene joint filler (alternative: preformed expansion joint filler)
    d) Joint sealing compound
3) Contraction joints are joints placed in concrete to provide for volumetric shrinkage of a monolithic unit, or to allow movement between the units. No bond between the concrete surfaces is acceptable. Contraction joints may be comprised of the following elements:
    e) Flexible PVC waterstop
    f) Concrete shear keys

8.12.2.2 Materials

1) Waterstops shall be an Elastomer (an artifical rubber compound based on long chain polymers), cross linked to control their shape and deformation / movement under stress possibilities, by vulcanising them. The Elastomer waterstops shall have the following properties:

Physical Properties (DIN 7865 Part 2)			
No.	Property	DIN Standard	Performance level
1	Tensile Strength in N/mm²	53504	≥10
2	Elongation at break in %	53504	≥380
3	Shore-A-Hardness	53505	62±5
4	Tear Strength in N/mm²	53507	≥8
5	Behaviour at low temperatures (-20 °C), Shore-A-Hardness	53505	≥90
6	Dimensional stability when exposed to hot bitumen	7865	No change in shape
7	Metal adhesion	7865	Structural fracture in the Elastomer

2) Expanded polystyrene joint filler shall consist of panels 10 and 20 mm thick of specific weight approximately 20 kg/m3. They shall be waterproof and shall not absorb water.
3) Joint sealing compound shall be:
    a) Plasto-elastic, one-component, hot-poured sealant on bitumen/rubber for horizontal floor joints.
    b) Elastic two-component, non-sagging sealant on polyurethane-tar.

8.12.2.3 Construction

1) Where grouting is not required, the movement joints shall be formed with F1 finish. If grouting is required, joints shall be formed with F2 finish.
2) Waterstops shall be joined and fixed in place in accordance with manufacturer's recommendations to form a continuous watertight barrier. All cross-pieces, T pieces and corner-pieces shall be factory produced. All joints shall be welded with approved, thermostatically controlled electric heat equipment. The temperature at which the splices are made shall be sufficient to melt but not char the plastic material. All splices shall be neat with the ends of the joined waterstops in true alignment. A miter-box guide and portable knife shall be provided for cutting the ends to be joined to ensure good contact between joined surfaces. The Contractor

shall supply all necessary supports and ties required for placing the waterstop and shall position it so that its central axis coincides with the joint center. Care shall be taken that waterstop does not bend or deflect during concreting. Concrete adjacent to the waterstop shall be thoroughly worked to ensure full contact with the waterstop but without damaging it. Prior to commencement of concrete placing, the waterstops placed shall be inspected by the Engineer.

3) Before casting the second part of a movement joint, the whole surface will be covered with expanded polystyrene panels, bituminous roofing felt, bituminous coating, or other approved bond breaker as shown on the Detailed Design and/or Construction Drawings. The panels or felt shall be cut to the size and shape of the joint and shall be glued onto the joint face and tightly joined. Holes and joints in the filler shall be filled with mastic to prevent passage of mortar or concrete from one side to the other. Particular care shall be taken to ensure that all surfaces of the shear key are covered.
4) Before applying the joint sealant, the joint shall be raked out to a depth as specified. All laitance, dirt, oil and foreign matter shall be removed from the joint by sandblasting, compressed air, grinding discs, or other effective means, and the concrete surfaces coated with an approved suitable primer. Joint sealant shall be placed after the concrete curing period in accordance with manufacturer's instructions. The concrete surface temperature shall not be higher than 30°C at the time of placing, and the concrete shall be surface dry. After placing, the sealant shall be protected from the effects of water for a period of 10 hours.
5) Plastic tape shall be used to ensure that no bond develops between the sealant and the plastic foam joint filler.
6) Sealant that becomes un-bonded from the concrete, or cracks, or shows any other defects before final acceptance of the work, shall be replaced by the Contractor.

8.13 PREPARATION FOR CONCRETE PLACING

8.13.1 GENERAL

1) Concrete shall not be placed until all formwork, installation of embedded parts, reinforcing steel, and surfaces against which concrete is to be cast have been accepted by the Engineer.
2) All surfaces of forms and embedded items that have become encrusted with dried material from concrete previously placed shall be cleaned of all such material before the surrounding or adjacent concrete is placed.
3) Concrete shall not be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or diverted by pipes, or by other means, and carried out of the forms clear of the work. Water shall not be allowed to stand on any concrete surface until it has attained its initial set. Water flow over the concrete, which may injure the surface finish, will not be allowed.
4) Pipes, conduits, dowels and other items to be embedded in concrete shall be so positioned and supported prior to placement of concrete to be stable and provide sufficient clearance (min. 50 mm) between said items and steel reinforcement to allow proper concreting. Securing such items in position by wiring or welding to reinforcement will not be permitted.
5) Where excavated surfaces which are to form the foundations for structural concrete, are absorptive or likely to become otherwise unsuitable, or where shown on the Final Design and /or Construction Drawings, the Contractor shall place a 'blinding course' consisting of a layer of Class C15D32 concrete 5 to 10 cm thick, as directed by the Engineer, uniformly over the foundation such that the upper surface is at grade elevation. Blinding concrete shall be placed before installing reinforcement or formwork.
6) Immediately before concreting, the forms and all other surfaces which will be in contact with the fresh concrete shall be cleaned of all loose material and debris including shavings, wood chips, sawdust, pieces of wire, nails, fragments of hardened concrete and mortar. Clean-out holes which may be needed for this purpose shall subsequently be securely closed in order to obtain

the required surface finish.

7) The use of compressed air for cleaning will be allowed only if adequate precautions are taken to avoid the deposition of suspended oil on construction joint surfaces, reinforcement or other items which are to be bonded to concrete. The Contractor shall provide such personnel and equipment so that the performance of the concrete work is in a satisfactory manner. The transporting and placing equipment shall be clean and in good condition, adequate, and properly arranged to proceed with the placing without undue delays. The number and condition of vibrators for use and standby shall be ample for the requirements during placement. The lighting system shall be sufficient to illuminate the inside of the forms when concrete is placed at night.
8) The Contractor shall have protective coverings available for fresh concrete surfaces if there is a possibility of rain, hail or sleet.

8.13.2 CONCRETE ON EARTH FOUNDATION

All concrete placed on earth shall be placed upon clean, damp surface, free from standing or running water.

8.13.3 CONCRETE CAST AGAINST ROCK

1) Rock surfaces against which concrete is to be placed shall be clean and free from oil, standing or running water, mud, loose rock, objectionable coating, debris, and loose or unsound fragment. Faults, fissures and seams shall be cleaned to sound rock, and if directed, backfilled with dental concrete, shotcrete or dry pack as appropriate.
2) Immediately before concrete is placed, all surfaces shall be cleaned thoroughly by the use of high velocity air-water jets, brooming, wet sandblasting, bush-hammering, or other satisfactory means including combinations of the above.
3) Where gravel drains are used to control seepage water, the drains shall be covered with low slump concrete which shall be allowed to reach its final set before placement may begin.
4) Rock surface against which concrete is to be placed shall be kept wet for at least 12 hours during the 24-hour period prior to placing concrete and shall be in a damp condition at the time of placing, with all pools of water removed.

8.13.4 CONCRETE CAST AGAINST OR UPON PREVIOUSLY PLACED CONCRETE

Before any concrete is cast against previously placed concrete, the surface of the old concrete shall be prepared as described in aforesaid "Construction Joints".

8.14 PRODUCTION OF CONCRETE

8.14.1 CONCRETE MIXES

1) The mixes for different classes of concrete shall be selected jointly by the Engineer and the Contractor during the initial tests period (Trial Mix Stage).
2) During the progress of the work, the mixes may be adjusted whenever, in the opinion of the Engineer, such change is necessary or desirable to secure the required strength, workability, watertightness, density, economy, or to limit shrinkage. Adjustments of the mixes proposed by the Contractor will be subject to the Engineer's approval.
3) The consistency as measured by the slump test shall be determined according to its class, for which the range will be defined by laboratory tests. The slumps for the various classes of concrete, in principle, will be within the limits given in the following table:

Concrete Class	Slump (cm)
C15 D32	10 ± 3
C20 D32	10 ± 3
C20 D76	10 ± 3
C25 D32	12 ± 3

C30 D32	12 ± 3
C35 D32	12 ± 3
C25 D20	13 ± 3
C30 D20	13 ± 3

4) The value of slump will be defined by the site laboratory on the basis of requirements and the results obtained on strength. The above values may therefore be varied in accordance with laboratory and the Engineer instructions.
5) To maintain the proper consistency, the amount of water and sand batched for concrete shall be adjusted to compensate for variation in the moisture content or gradation of aggregates as they enter the mixer.

8.14.2 BATCHING

1) The Contractor shall provide, operate, and maintain at the Site automatic batching equipment to determine and control the amount of each individual material entering the concrete. Batching equipment shall be designed for such capacities which will permit performance of the concrete work in accordance with Contractual Construction Program and conforming to ASTM Specification C94.
2) Bulk Portland cement silos shall be plainly marked as to their contents. Delivery slips shall be reviewed by the plant operator prior to unloading of each material, and extreme care shall be exercised to see that these are unloaded into their respective silos.
3) The bulk cement, sand, and each size of coarse aggregate shall be weighted separately. Water shall be measured volumetrically or by weight as proposed by the Contractor. When cement in bags is used the weight will be measured by number of bags multiplied by stated bag weight. Powdered admixtures shall be measured by weight, paste or liquid admixtures by weight or volume.
4) Aggregate batch bins shall be self-cleaning during draw-down. Finish-screening of coarse aggregate will not be required provided that the aggregate meets the grading requirements stipulated in this Section. Coarse aggregate not meeting the grading requirements, shall be finish-screened over vibration screen connected to the batching plant or on the ground adjacent to the batching plant. The finish screens, if installed on the batching plant, shall be so mounted that the vibrations of the screens will not affect the accuracy of the batching scales. The finished products shall pass directly to the batching plant bins.
5) Each weighing unit shall be spring-less and will register the scale load at any stage of the weighing operation from zero to full capacity. For water measuring, two water meters shall be installed in parallel so that no delay due to faulty operation shall occur. No leakage may occur when the valves are closed. Liquid admixtures dispenser shall be of the visual type and shall be interlocked with the batching plant to prevent overdosing.
6) The Contractor shall provide standard test weights and any other equipment required for checking the operating performance of each scale or other measuring device. Periodic tests according to the manufacturer's instructions shall be made in the presence of the Engineer. Facilities for obtaining representative samples of concrete materials, between batch bins and the weighing hoppers or between the batch hopper and the mixer, shall be provided with the batching equipment. The Contractor shall make such adjustments, repairs, or replacements as may be necessary to meet the specified requirements for accuracy of measurement.
7) The scales shall be interlocked so that a new batch cannot be started until the weighing hoppers have been completely emptied of the last batch and the scales are in balance. Provisions for easy removal of excess materials, adjustment for compensating the weight variations of aggregates due to moisture content and changing the mix proportions shall be incorporated in the equipment. All weight indicators shall be in full view of the operator.

8) The batching equipment shall be computerized and shall include a printer listing weights of all materials, or an accurate recorder for making a continuous visible combined record on a single chart of the separate measurement of each concrete ingredient, including all mixing water. Summary of material batched at the end of each shift or a day shall also be provided. The quantities recorder shall be located in an enclosed room adjacent to the batching and mixing plants where it can be viewed without interfering with batching operation and where it is isolated from vibration and dust. The capacity of the computer shall be to store a minimum of 20 mixes.
9) The batching plant shall be equipped with an instrument to check the consistency of the batch in the mixer, and the equipment shall be capable of adjustment to compensate for the varying moisture content of the sand and coarse aggregates and to adjust the mix proportions as needed.
10) Admissible errors in batching shall be as follows:

Material	Cement	Water and Ice (if any)	Admixtures	Aggregate
Error in Percent	1.5%	1%	3%	2%
Measured by	Weight or volume	Weight or volume	Weight	Weight

11) Conveying batched materials from weighing hoppers into the mixer shall be so constructed and operated that spillage of the batched materials and overlap of batches is prevented.
12) Construction and operation of the cement and pozzolan handling equipment shall be such that no noticeable dust will be raised during measuring and discharging of each batch of material.

8.14.3 MIXING

8.14.3.1 General

1) Concrete shall be mixed in a power-driven stationary batch mixer of approved type and size. They shall be kept clean and in proper working order. The mixing blades in the drum shall be replaced when worn by 10% of their design dimensions.
2) Movable truck mixers shall not be permitted for mixing concrete mixes.
3) Concrete mixing equipment shall be capable of combining the aggregate, cement, admixture and water into a uniform mixture within the time limit specified hereafter and of discharging this mixture without segregation. If more than one liquid admixture is used, these shall be discharged separately into the batch. The plant assembly shall be such as to facilitate the inspection of all operations at all times.
4) Batching and mixing of concrete shall not commence unless due notice, at least 24 hours in advance, has been given to the Engineer and written approval has been obtained for the placing arrangements, and for the preparation and accuracy of the part of the Works in which concrete is to be placed.
5) The quantity of material in each batch shall not exceed the normal continuous rated capacity of the mixer and the speed of rotation shall be within 1 rpm of the manufacturer's recommended speed.
6) Components shall be fed into the mixing drum so as to ensure the most efficient use of the mixing period and to avoid any loss of material. Into case shall the mixers be overloaded by more than 10% of their rated capacity recommended by the manufacturer. Uniformity in concrete consistency from batch to batch will be required.
7) Mixing is considered to have started when all solid materials are in the mixer drum, provided that all the mixing water is introduced within one fourth of the mixing time. The further addition of water shortly before completion of mixing and excessive over-mixing, requiring addition of water to preserve the required concrete consistency, will not be permitted.

8) The first batch of concrete materials in the mixer shall contain sufficient excess of cement, sand and water to coat the inside of the drum without reducing the required mortar content of the mix. The entire content of the mixer shall be removed from the drum before materials for a succeeding batch are placed therein.
9) Mixing of concrete shall not commence without ensuring that the stocks of materials are adequate, with a reasonable safety margin, for the completion of the particular pour of concrete.
10) The mixing time of each batch shall be determined by the batching and mixing tests based on manufacturer's recommendations. Suggested mixing times for various mixer capacities are as follows:

Capacity of mixer	Mixing time
< 1.5 Cum	1½ minutes
2.0 Cum	2 minutes
3.0 Cum	2½ minutes
> 4.0 Cum	3 minutes

11) Each mixer shall be equipped with a mechanically operated timing and signaling device which will indicate and ensure the completion of the required mixing period and will count the batches.
12) The Engineer reserves the right to vary the mixing time or to limit the batch size when the batching and mixing operations fail to produce a concrete conforming to the requirements set out during the trial mix stage.

8.14.3.2 Trial Run and Performance Control

1) Prior to any Permanent Works concreting, the Contractor shall carry out a trial concrete production run.
2) All plants and materials used shall be those to be used for the actual production of concrete in the Permanent Works.
3) The Contractor shall make all adjustments necessary to produce concrete of the quality of the agreed trial mixes of each class. Only when this has been achieved will the Engineer give consent to proceed with Permanent Works concreting.
4) The performance of mixers shall be controlled in accordance with the provisions of ASTM Specification C94 and Designation 26 of USBR "Concrete Manual".

8.14.4 TRANSPORTING

1) The method and facilities for concrete transport shall be selected by the Contractor within the limitations of these Specifications, and he shall be responsible for adequacy and suitability of the transporting system. The time elapse between mixing and the initial set of the concrete shall be taken into consideration.
2) The concrete transporting methods and facilities shall be such that will prevent segregation of coarse aggregate, excessive loss of slump, and loss of ingredients. All equipment shall be kept clean and in good working condition.
3) Concrete mixed in central stationary mixers and transported by equipment others than truck mounted agitators, shall be placed within 30 minutes (of loading into the transport equipment) in its final position.
4) The capacity of bucket haulers shall be of the concrete batch size or a multiple thereof in order to prevent the splitting of batches. The dumping mechanism shall permit discharge of small portion of concrete in one place. Buckets shall be capable of prompt discharge of low- slump, lean-mix concrete with maximum aggregate size to be used.
5) Transportation of concrete by non-agitating cars or trucks shall be limited to a distance of 3 km

unless remixing facilities are provided at the place of final placement. Free water shall not stand on the surface of concrete when delivered in cars or trucks.

6) If concrete is to be poured by tipping, chutes shall be used to keep it coherent, their ends being placed just above the placing point. The slopes of chutes for conveying fresh concrete shall be chosen so that the concrete with minimum water content flows in a steady stream without segregating. Effective end control that will produce a vertical drop and prevent segregation of ingredients shall be provided. The chutes and belt conveyors shall be protected from wind and sun.

8.14.5 COMMUNICATIONS

1) The Contractor shall furnish, install, maintain and operate a telephone system or radio, linking the points of placing concrete with the concrete batching and mixing plant. These facilities shall also be available to the Engineer at all times.
2) When placing the concrete by pumping, direct communication shall be maintained between the concrete placing crew and the pump operators.

8.15 TEMPERATURE OF CONCRETE

1) The Contractor shall make the necessary provisions in the concrete materials storage, handling and batching facilities, as required to comply with the hot weather concreting requirements. The proposed methods of temperature control shall be approved by the Engineer.
2) Hot weather conditions shall be considered to be in effect whenever the temperature is above 30°C and is expected to exceed this value over a prolonged period.
3) The temperature of concrete when being placed in hot weather shall be as follows, unless otherwise permitted by the Engineer:
    a) Mass concrete, thickness ≥ 3.00 m, not more than 28°C
    b) Structural concrete, not more than 30°C
4) To meet these requirements, the Contractor shall be prepared to undertake any, or all of the following measures:
    a) Carry out batching and placing operations at night,
    b) Supply cooler mixing water, or add ice to the concrete during mixing,
    c) Cool the fine and coarse aggregates before mixing operations,
    d) Spray the coarse aggregate stockpile with cool water,
    e) Prevent exposure of batching, mixing and conveying equipment to direct sunlight,
    f) Spray the forms and reinforcing steel with cool water.
5) Use of ice for mixing water shall be carefully controlled to ensure complete melting before mixing is terminated.

8.16 CONCRETE PLACING

8.16.1 GENERAL

1) No concrete shall be placed until the construction site, forms, reinforcement, and embedded parts have been inspected and a written approval given by the Engineer. This approval shall be obtained before each and every concrete pour.
2) Written approval shall consist of a triplicate "Concrete Pour Advice Form" prepared by the Contractor and approved by the Engineer, listing at least the following:
    a) Date and times of commencing and finish of placing
    b) Location
    c) Composition of concrete mix
    d) Volume placed
    e) Foreman in charge
    f) Equipment used
    g) Cleaning and preparation of foundation performed
    h) Reinforcement placed

i) Formwork used
j) Reference drawings

3) Concrete shall be placed before initial set as per ASTM Test Method C 403 has occurred, i.e. 60 to 90 minutes after adding water to the mix.
4) No concrete shall be placed when the atmospheric conditions are, in the opinion of the Engineer, such that proper placing and hardening of the concrete are not guarantied. Specifically, the Contractor shall have the responsibility for meeting the hot weather concreting requirements and for postponing concreting whenever such requirements cannot be met or, based on weather forecast, probably cannot be met. Even if the above requirements are fulfilled, the Contractor has the responsibility of delivering concrete product that meets specified requirements.
5) Concrete, which is found not to be in conformity with the requirements specified herein or has been placed without the knowledge and authorization of the Engineer, shall be rejected and removed from the Works and replaced by the Contractor.

8.16.2 CASTING SEQUENCES

1) The time between successive lifts and maximum permissible depth of concrete placed in one lift, unless otherwise directed or shown on the Detailed Design and/or Construction Drawings, shall be as follows:

Location	Maximum permissible depth of one lift	Minimum time between successive lifts
Mass concrete in massive structures	250 cm	72 hours
Walls and piers less than 5 m thick	400 cm	48 hours
Other structures	As approved by the Engineer	48 hours

2) The Engineer may change the minimum time elapsing between the pouring of successive lifts and/or the maximum permissible depth of one lift for temperature control purposes or similar reasons.
3) Concrete for beams, slabs and similar members shall be poured to the full depth in a single operation.
4) Outdoor concreting shall not be started during rain. If concreting is already in progress during the rain, it shall be suspended if the rain adversely affects the quality of the placed concrete.
5) Concrete that has been allowed to harden to the extent that additional concrete placed on it will not satisfactorily bond shall be treated as a construction joint. When stoppage of concreting operations occurs for any reason, construction joints shall be placed either horizontally or vertically as needed.

8.16.3 PLACING AND COMPACTION

1) Concrete shall be carefully placed in position. Where dense reinforcement or deep forms may cause segregation of concrete while placing, chutes shall be used to prevent segregation. The free fall of concrete shall not exceed 1.5 m for structural concrete and 3.0 m concrete walls and piles.
2) Concrete shall be placed directly in its permanent position and shall not be worked along the forms to that position. Vibrators shall not be used to move concrete laterally.
3) The addition of water into concrete after batching to compensate for stiffening of the concrete before placing shall not be permitted. Concrete corrections to the batching plant are permitted keeping unmodified the design parameters (i.e. W/C ratio).
4) All concrete shall be placed in continuous approximately horizontal layers. The thickness of the

layers shall not exceed 40 cm for mass concrete, and 50 cm for structural and all other concrete. Each layer shall be soft when a new layer is placed upon it so that no seams or planes of weakness within the section can form, and the two layers shall be made monolithic by penetration of vibrators.

5) The Engineer reserves the right to order a reduced thickness of layers where the layers as stated above cannot be placed in accordance with the requirements of these Specifications.
6) Each layer of concrete while being placed shall be compacted by mechanical vibration to form a dense, homogeneous material free from voids. The concrete shall be worked up hard against adjoining surfaces. Each concrete layer shall be vibrated completely before another layer of concrete is placed upon it.
7) Vibration of concrete shall be carried out by means of immersion-type vibrators, supplemented if necessary by external vibrators of suitable design and capacity. Immersion vibrators, having head diameters equal to or less than 100 mm, shall have a minimum speed of 7,000 vibrations per minute when immersed in concrete. Those with head diameters more than 75 mm shall have a minimum speed of 6,000 vibrations per minute when immersed in concrete. Formwork vibrators shall operate at not less than 8,000 vibrations per minute when vibrating concrete.
8) Immersion vibrators shall penetrate the full depth of the layer and shall enter the underlying layer so as to ensure proper integration of successive layers. They shall be inserted in a near-vertical position at sufficiently close intervals for long enough time to ensure proper compaction and shall be withdrawn slowly to prevent the formation of voids. The concrete shall be vibrated until it presents a compact reflecting surface and the bubbles of entrapped air cease to escape. Over-vibration causing segregation, surface laitance, or leakage through formwork shall be avoided. Vibrators shall not be allowed to come into contact with formwork and contact between vibrators and the reinforcement is to be avoided.
9) Vibrators shall be operated by experienced workers only. A spare vibrator of the appropriate type and capacity shall be available and shall be tested to ensure that it is working before concreting commences. At least one spare vibrator shall be available at each concrete pour, and a minimum of one spare for each 5 vibrators in service at each construction site.
10) The Contractor shall modify his vibrating equipment if it does not perform satisfactorily under operating conditions.
11) Internal struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment impeding the placing of concrete, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary.
12) The Contractor shall take care to prevent formation of cold joints during placing concrete in any part of the Works. His concrete-placing rate shall be such that the concrete is placed while the previously placed adjacent concrete is still plastic and the concrete can be made monolithic by normal use of vibrators.

8.16.4 PUMPING CONCRETE

1) Positive displacement pumping or other approved methods may be used to place concrete in locations approved by the Engineer. The type and arrangement of equipment shall be subject to approval by the Engineer, and the equipment shall be operated only by experienced persons. Pneumatic placing will not be allowed.
2) The equipment and its method of operation shall allow the concrete to enter the forms at a low velocity.
3) Concrete pumps and auxiliary equipment shall be in good condition and shall be maintained as such throughout the duration of the work. Thorough washing down of all parts that come in contact with concrete shall be performed after each concreting operation.
4) Pump lines shall consist of rigid steel pipe or flexible pipe made of rubber, spiral-wound flexible metal or plastic, or combination of both. Use of aluminium pipe for pump lines shall not be permitted. Couplings shall be leak-proof and strong enough to withstand handling during

erection and poor support along the lines. They shall provide a full internal cross section with no constrictions of the smooth flow of concrete.

5) Immediately prior to the start of all concrete pumping, the pump and pump lines shall be primed by pumping an approved grout mixture through the equipment.
6) Concrete pumping operations shall be planned in such a way that concrete does not set before the succeeding layer is place thereon. An adequate supply of fresh concrete shall be provided at all times.

8.17 PROTECTION AND CURING

8.17.1 PROTECTION

1) The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, over-stress, or any other cause until final acceptance by the Engineer.
2) Fresh concrete shall be protected from damage such as due to drying, sunshine, rain, hail, sleet, and traffic. The Contractor shall provide such protection while the concrete is still plastic and whenever such precipitation, either periodic or sustaining, is imminent or occurring.
3) Care shall be taken not to disturb the concrete by direct or indirectly loading, striking of forms or otherwise, until it has hardened sufficiently.
4) Construction loads shall not be allowed on beams, decks or slabs until the concrete has attained its design strength, nor shall the Contractor impose loads exceeding the design loading.
5) All fresh concrete surfaces shall be protected from contamination and from foot traffic until the concrete has hardened. Surfaces which have received the U2 or U3 finishes shall be protected by covering with protective mats, plywood, or other effective means approved by the Engineer.

8.17.2 CURING

8.17.2.1 General

All concrete shall be moist cured for a period of not less than 14 consecutive days by an approved method or combination of methods applicable to local conditions. The Contractor shall have on hand, and ready to install, all equipment needed for adequate curing of concrete before actual concrete placement of each pour begins. The curing medium and method, or the combination of mediums and methods, will be subject to approval of the Engineer.

8.17.2.2 Water Curing

1) Water used for curing shall meet the requirements of mixing water, free of deleterious materials and substances that will stain or discolour the concrete.
2) Water curing shall start as soon as the concrete has hardened sufficiently to prevent damage by erosion and shall continue for the duration of the entire curing period or until covered with fresh concrete. All surfaces shall be kept continuously wet during curing. Wetting the surfaces only periodically will not be permitted.
3) Water curing shall be carried out by following methods:
    a) Spraying or sprinkling by a system of perforated pipes, lawn sprinklers, soaking hoses or by other approved methods. Intermittent sprinkling will not be acceptable
    b) Covering the concrete surfaces with burlap, cotton mats, or rugs which will hold water on the surface either horizontal or vertical. The covering materials shall be kept continuously water-saturated during the curing period
    c) Covering the horizontal construction joints and finished surfaces with a minimum thickness of 50 mm of sand which shall be kept uniformly distributed and continuously saturated during the curing period.

8.17.2.3 Membrane Curing by Sealing Compound

1) Sealing compounds shall be used for concrete curing only if approved in writing by the Engineer. Sealing compounds will generally be accepted on manufacturer's certification of

compliance with specifications, but such acceptance shall in no way relieve the Contractor of the responsibility for furnishing a compound which meets the requirements of these Specification. Sealing compounds will be subject to sampling and testing.

2) The liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM Specification C309. The compounds shall be of uniform consistency and quality within each container and from shipment to shipment. When approved, the membrane curing shall be performed by application of the sealing compound which forms a water-retaining membrane on the surfaces of the concrete. The sealing compound shall be white-pigmented except that compound used on surfaces that will be exposed permanently to view shall be a gray-pigmented sealing compound.
3) Sealing compound shall not be used on concrete surfaces to which additional concrete, paint or tile is to be bonded, unless the Contractor has demonstrated that the membrane can be satisfactorily removed before subsequent application or can serve satisfactorily as a base for the application.
4) When sealing compounds are used on unformed concrete surfaces, application of the compounds shall commence immediately after finishing operations are completed. When sealing compounds are to be used on formed concrete surfaces, the surfaces shall be moistened with a light spray of water immediately after the forms are removed and shall be kept wet until the surfaces will not absorb more moisture. As soon as the surface film of moisture disappears but while the surface still has a damp appearance, the sealing compound shall be applied.
5) Special care shall be taken to ensure ample coverage with the compound at edges, corners, and rough spots of formed surfaces. After application of the sealing compound has been completed and the coating is dry to touch, any required repair of concrete surfaces shall be performed. Each repair, after being finished, shall be moistened and coated with sealing compound in accordance with the foregoing requirements.
6) Equipment for applying sealing compounds and the method of application shall meet with the approval of the Engineer. Traffic and other operations by the Contractor shall be such as to avoid damage to coatings of sealing compounds for a period of not less than 14 days. Any sealing membrane that is damaged or that peels from concrete surfaces, within 28 days after application, shall be repaired without delay.
7) Sealing compounds used for surfaces exposed to view shall degrade completely when exposed to air for more than 3 months. They are to remain at least 80% impermeable for 1 month after application.

8.18 REPAIR OF DEFECTIVE CONCRETE

8.18.1 GENERAL

1) Concrete which is damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established position, line or grade, or which, for any other reason, does not conform to these Specifications, shall be satisfactorily repaired, or removed and replaced with acceptable concrete by the Contractor.
2) The Contractor shall correct all imperfections on the concrete surface as necessary to produce the specified finish within the time as specified below:
    a) Minor formed surface repairs, such as surface grinding, shall be completed within 2 hours after form removal
    b) Concrete replacement less than 25 cm thick, mortar and dry-pack repairs shall be completed within 7 days after the original concrete placement
    c) Concrete replacement more than 25 cm thick, epoxy-resin bonding repairs, and all other repairs shall be completed after 7 days, but before 56 days after the original

placement.

3) All repair work shall be finished to the same standard as the surrounding concrete and shall be adequately cured. Plastering or rendering of surfaces to produce a smooth surface finish shall not be permitted.
4) No repair work shall be carried out before the Engineer has inspected the defective area and given consent in writing for remedial work to begin.
5) Concrete requiring F1, F1C, U1, F2, F2C or U2 finish that is honeycombed, fractured, that contains surface depressions which exceed the allowable tolerance specified in this Section or that is otherwise defective shall be cut back to a minimum depth of 25 mm into sound concrete in all directions, and the edges undercut. The area to be removed shall be outlined to a depth of 15 mm with a diamond or Carborundrum saw prior to removing the defective concrete. The fresh concrete surface shall then be cleaned, washed down and thoroughly soaked with water until the concrete becomes saturated. The concrete surface should be damp. Repairs to the surface shall then be carried out using the materials and methods described hereafter.
6) For bonding new concrete to older one, a bonding medium of epoxy, formulated for this purpose, shall be used in accordance with manufacturer's instructions. Alternatively, a neat cement paste may be used. A paste of Portland cement and water mixed to a thick cream consistency shall be applied to damp, clean concrete. The concrete shall have no free water on the surface.
7) Concrete requiring F3, U3 or U3C finish that is honeycombed, fractured, that contains surface depressions which exceed the allowable tolerances specified in this Section or that is otherwise defective shall be repaired as follows:
    a) Minor areas of defective concrete: The Contractor shall drill a hole of such diameter in the defective area into sound concrete, that the defective concrete is completely removed. The minimum diameter of such hole shall be 50 mm, the minimum depth shall be equal to the diameter of the hole drilled and the maximum depth shall be 70 mm. The hole shall then be reamed out such that the diameter at the bottom of the hole is at least 20 mm larger than the hole at the surface. Finally, the hole shall be cleaned and washed out, the surplus water removed, and then filled with concrete incorporating a non-shrink agent approved by the Engineer.
    b) Large areas of defective concrete: concrete which contains defective areas too large to be repaired as described above shall be cut to the far face of surface reinforcement or further if necessary, to remove all the defective material, and the edges undercut. The fresh concrete surface shall then be cleaned, washed down and thoroughly soaked with water until the concrete becomes saturated. The concrete surface should be damp. Finally, the hole shall be filled with concrete which may incorporate a non-shrink agent approved by the Engineer.
8) Concrete which will be exposed to public view shall be repaired in a manner which will result in a concrete surface with a uniform appearance.

8.18.2 DRY-PACK MORTAR

1. The dry-pack mortar shall consist of 1-part cement to 2½ parts of sand, by volume, that will pass a US Standard Sieve No. 16 (1.18 mm). Only enough water shall be used to produce a mortar which will stick together when molded into a ball by a slight pressure of the hands and will not exude water but will leave the dry pack in thin layers.
2. Dry-pack mortar shall be placed and packed in layers. Each layer shall be solidly compacted over its surface by use of a hardwood stock and hammer.
3. Dry-pack mortar shall be used for filling holes having at least one surface dimension less than the hole depth, for narrow slots cut for repair of cracks, for redrilled grout holes and grout pipe recesses, and for tie-rod fastener recesses.

4. Dry-pack mortar shall not be used for filling behind reinforcement or for filling holes that extend completely through the concrete section.

8.18.3 MORTAR FILLING

1. Mortar to be used for repair work shall have the same sand, cement and air proportions as the mortar in the mix of the concrete to be repaired. The Contractor shall place mortar filling with a mortar gun or by hand.
2. Mortar filling shall be used to repair defects which are too wide for dry pack filling and too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest the surface.
3. Mortar filling in concrete surfaces destined to be in contact with flowing water shall be used only together with the application of epoxy coatings using a procedure approved by the Engineer.

8.18.4 CONCRETE FILLING

1. Concrete filling shall be used for holes extending entirely through concrete sections, for holes in which no reinforcement is encountered and which are greater in area than 0.1 m2 and deeper than 100 mm and for holes in reinforced concrete which are greater in area than 0.05 m2. Holes in reinforced concrete which extend beyond the reinforcement shall be enlarged as necessary to permit satisfactory filling of the hole with concrete.
2. Concrete filling shall be tightly packed and completely bonded to the surfaces of the holes. The mix proportions of the filling materials shall be such as to provide a strong, dense repair which will avoid colour variations in surfaces exposed to view.
3. On surfaces permanently exposed to view, and where required by the Engineer, the Contractor shall supply white cement in sufficient amount, as determined by trial, which when blended with normal cement, will produce a finish of similar appearance to the adjacent concrete. Non-shrink agent shall be used where a watertight joint is required. The surface of patches shall be smooth and flush with the surrounding concrete.

8.18.5 EPOXY-RESIN BONDING

1. Any repairs made more than 7 days after the original concrete placement for thicknesses less than 25 cm thick shall utilize epoxy-resin bonding system. The locations where epoxy-resin will be used will be determined by the Engineer, who will approve the type and brand to be used.
2. The method of repair shall be as recommended by the manufacturer. The product used may contain no toxic elements.
3. In areas exposed to public view, the concrete surfaces repaired with epoxy-resin bonded system shall be lightly ground to eliminate gloss of the finished epoxy mortar surface and to produce a surface colour and texture that closely matches the surrounding concrete surface.

8.18.6 STAINS AND DISCOLOURATION

Stains or discolouration of exposed (Class F2, F2C and U2) concrete surfaces shall be removed. The procedure or method or removing the stains and/or discolouration will be subject to approval. The removal of stains or discolouration shall not be started until the work that originally caused the stains or discolouration is completed.

8.19 PARTICULAR REQUIREMENTS FOR INDIVIDUAL CONCRETE STRUCTURES

8.19.1 SPILLWAY CHUTE

1) Concrete used for construction of the spillway chute shall be class C35D32 containing Ordinary Portland cement Type 1.
2) Drainage system shall be installed under the chute slab and behind the side walls prior to casting any concrete, as shown on the Detailed Design and/or Construction Drawings and/or specified by the Engineer.
3) Where the overbreak in excavation below the theoretical lines and grades exceeds acceptable limits, as determined by the Engineer, the Contractor shall place blinding unreinforced concrete

class C15D32 over the rock foundation in such thickness that the upper surface is at the theoretical grade elevation. Surface shall be roughened before placing the structural spillway concrete.

4) The lower layer shall be formed as shown on the Drawings with Porous Concrete Class C15 D32.
5) If slipforms are used, they shall be of rigid construction capable of resisting the working loads imposed upon them and of a configuration approved by the Engineer. The length of the slipform along the slope shall be such that with the proposed concrete mix and slipform speed, concrete emerging from the slipform will not slump.
6) No construction joints shall be allowed in the chute slab, unless otherwise approved or directed by the Engineer. In case such joint is permitted, additional steel reinforcement shall be placed across the joint and the joint surface shall be shuttered with expanded metal.
7) Contraction joints shall be executed in the chute walls at the distances as shown in the drawings. Steel dowels shall be placed through these joints and the surface shall be painted with bituminous coat or other approved bond breaker.
8) All movement joints exposed to flowing water shall be chamfered 1:1 on upstream side and 1:10 on downstream side.
9) Tolerances of the concrete surface in the chute and overflow weir shall conform to surface finishes F3, F3C, U3 and U3C.

8.19.2 CONCRETE GRAVITY STRUCTURES

1) Concrete used for the construction of mass concrete gravity structures shall be class C20D76 unless otherwise approved or directed by the Engineer. However, concrete surface exposed to weathering, freezing/thawing, and standing or flowing water shall be constructed of higher strength concrete as indicated on the Final Design and /or Construction Drawings. Where such higher strength concrete is used, part of each lift will normally be composed of two classes of concrete. Water-cement ratio shall not exceed 0.52.
2) Reinforcement shall be provided at the surfaces in contact with standing or flowing water and at all openings in mass concrete.
3) Mass concrete of gravity structures shall be water cured for at least 7 days unless otherwise directed by the Engineer. When curing compound is used as a bond breaking membrane at contraction joints, it shall be also be considered acceptable in meeting the curing requirements.

8.19.3 CONTROL BUILDING

General

1) Blockouts, holes, pipes, pits, pedestals and embedded metalwork for equipment, cables, anchor bolts and other accessories shall be detailed by the Contractor on the basis of the indications given by the supplier. The Contractor shall then prepare the Construction Drawings as previously described.

Embedment of Equipment

1) Parts of the equipment to be installed in the buildings shall be encased in concrete and the first stage concrete shall be formed to the openings required for the installation of the equipment. As the installation of the equipment proceeds, and the second stage concrete is required to be placed around the equipment or any part thereof, the Contractor shall place the reinforcement and concrete.
2) The units to be embedded shall be checked for alignment immediately before, during and after concrete placing operations.
3) At point where an inspection (e.g. by sounding) indicates that a cavity exists between steel liners and the surrounding concrete, the Contractor shall drill and tap the liners to provide grouting points. Backfill grouting shall be performed after the concrete has cooled and achieved sufficient strength to resist the grouting pressures. After grouting, all grout holes shall be sealed by welding.

8.19.4 BLOCKOUTS FOR EQUIPMENT EMBEDDING

1) The Contractor shall form blockouts, place reinforcement and concrete as shown on the Final Design and /or Construction Drawings or as directed by the Engineer, and in such manner as to ensure good bond with the existing concrete, to secure complete contact with the metalwork to be embedded in the blockout concrete and to avoid displacement of the metalwork.
2) Before placing concrete, all parts to be embedded shall be checked to ensure that they are firmly fixed in their required position. The surfaces of blockouts or holes shall be thoroughly cleaned and wetted. Oil or grease shall be removed by brushing and chipping of affected surfaces to a sufficient depth, or by application of approved chemicals and flushed with clear water.

8.19.5 GROUTING OF THE EQUIPMENT BEARING PLATES AND ANCHORS

1) Limited spaces and small blockouts where equipment bearing plates, anchors, rails, etc. are placed shall be grouted under pressure.
2) The mixture shall consist of non-shrink grout as specified in Section "Miscellaneous and Ancillary Works".
3) Before placing grout, the surfaces of the base concrete to which the grout will be bonded shall be roughened and cleaned of all laitance, loose or defective concrete, any coatings or other foreign material, followed by thorough washing with water. Forms for grouting shall be installed where necessary and care shall be taken that the grout fill all spaces under the plates leaving no voids. The exposed surfaces of the grout shall be cured as recommended by the manufacturer and no loads shall be applied until the grout has reached the design strength.

8.19.6 POROUS CONCRETE

1) Porous Concrete shall be placed where free drainage is required and shall be produced by gap grading or single size aggregate grading.
2) The strength requirements for porous concrete shall be as for class C15D32 concrete. The porosity shall be such that water will pass through a slab 30 mm thick at a minimum rate of 500 l/min/m2 with a constant depth of water on the slab of 10 cm.
3) Porous concrete shall not be vibrated but only placed and lightly rammed. Formed surfaces shall be Class F1 finish. Exposed surfaces of the porous concrete shall be sealed in an approved manner, such as the use of polyethylene or rendering with sand and cement, before structural concrete is placed against it.

8.19.7 PRE-CAST CONCRETE

8.19.7.1 General

1) The Contractor shall investigate the possibility of obtaining and utilizing standard pre-cast concrete products available in the local market, before commencing any such production on his own.
2) When producing on his own, the pre-cast concrete units shall be manufactured and cured in a properly equipped casting yard or shop. The facilities shall be subject to the Engineer's inspection and approval.
3) The quality of the materials used in the manufacture of precast concrete units shall conform to the applicable requirements of these Specifications.
4) Details of the design, concrete components and mixes, and test results shall be made available to the Engineer.
5) Precast units which will be used in composite construction shall contain interlocking devices welded or formed into the steel member for connection with the subsequently cast-in-situ concrete to prevent a slip between the two materials and normal steel reinforcement. Such connections shall be designed so that they can resist 1.8 times the working load to which they will be subjected and that the ensuing movements cause no distress to the joint. The Contractor shall submit design details and calculations for approval before commencing any production.

6) Each unit is to be cast in one continuous operation and no construction joints will be permitted unless expressly approved by the Engineer.
7) Care shall be taken during storage, hoisting and handling of precast units to prevent cracking or damage. Units damaged by improper storing or handling shall be replaced by the Contractor.
8) Pre-cast units shall remain undisturbed until the concrete has developed at least 70% of the required compressive strength at 28 days and shall not be installed until the unit has developed the full required strength at 28 days, unless explicitly approved by the Engineer.

8.20 MEASUREMENT AND PAYMENT

8.20.1 CONCRETE

8.20.1.1 General

1) Measurement for payment of concrete, unless specified otherwise hereafter, will be of the volume placed within the lines, grades, and pay-limits shown on the Final Design and /or Construction Drawings or as established at the Site by the Engineer.
2) Unless otherwise stated, no payment will be made for concrete placed outside these limits, other than in additional excavation directed by the Engineer, and the measurement shall not include any filling of overbreak unless recognized as due to geological conditions conforming to the limits defined in other Sections of these Specifications.
3) Payment will be made at the Unit Prices for different structures of concrete entered in the Bill of Quantities, which shall include, but not be limited to, the following:
    a) Drilling, blasting, loading, transportation, stockpiling, crushing, screening, washing, blending, and storage of aggregates
    b) Batching, supply of mixing water, mixing, transportation, placing, and compacting the concrete
    c) Labour, tools and equipment for cleaning, and preparing surfaces prior to concreting
    d) Forming and treatment of construction joints including furnishing and spreading of mortar layers, or starter mixes before concrete placing
    e) Surface finishing
    f) Attaining the concrete temperature as specified, and hot weather precautions
    g) Protection and curing of concrete
    h) Repair of defective concrete
    i) Communication system connecting the points of placing concrete with the relevant mixing plant or delivery equipment
    j) Provision of material samples and all activities required in connection with the performance of the tests including their transportation to the testing laboratory
    k) Removal and disposal of waste concrete and test samples.
    l) Preparation of contact surfaces for second stage concrete and blockouts for equipment embedding.
4) No separate payment is provided in the Bill of Quantities for second stage concrete and concrete in blockouts for equipment embedding as the unit prices of each structure include first stage, second stage and blockouts.

8.20.1.2 Backfill Concrete Directed by the Engineer

1) Where backfilling with concrete is directed by the Engineer, payment will be made for concrete placed as backfill in geologically accepted overbreak, dental excavation and in additional excavation directed by the Engineer.
2) Payment will be made at the Unit Price entered in the Bill of Quantities for the specific backfill concrete or for the structure with which it is associated.

8.20.1.3 Slush Grout

1) Measurement for payment of slush grout will be of the area of the foundation surface treated

accordingly.

2) Payment will be made at the unit price per square meter entered in the Bill of Quantities.

8.20.1.4 Placing Concrete in Water

Payment for concrete placed in water will be made at the Unit Price for the specified concrete class plus additional Unit Price per cubic meter entered in the Bill of Quantities, which shall cover the entire cost of labour equipment and additional cement required for placement of concrete underwater.

8.20.1.5 Non-shrink Grout

Measurement for payment for the non-shrink grout will be as specified in Section "Miscellaneous and Ancillary Works".

8.20.1.6 Pre-cast Concrete

1) Measurement for payment for pre-cast concrete units will be by the volume in cubic meters of the units installed, as determined from the Final Design and /or Construction Drawings.
2) Payment will be made at the Unit Price per cubic meter entered in the Bill of Quantities, which shall include, in addition to works included under "General", the entire cost of curing, storage, transportation and erection. Cement, admixtures and reinforcing steel will be paid for separately as specified here below.

8.20.1.7 Exclusions

No extra measurement for payment or payment will be made for the following:

1) Any rounded or beveled edges, fillets, scoring, chamfers, or any deduction made for voids or embedded items which are either less than 0.10 m3 in volume or 0.05 m2 in cross section. No allowance will be made for approved temporary openings, drains, embedded pipes, or recesses created by the Contractor for his own convenience during construction provided they are filled as directed
2) Any collecting of seepage water or water inflow from rock surfaces and diverting it into the drainage systems as specified in the Section "Care of Water During Construction"
3) Any defective and wasted concrete. Concrete which has to be removed and replaced due to Contractor's noncompliance with the Specifications or Engineer's directions, and all related cost shall be at the Contractor's expense.
4) Any pre-cast concrete unit produced by the Contractor in excess of the number required, damaged before the installation or otherwise rejected by the Engineer.
5) Any concrete which the Contractor places or uses for his own installations or for his own convenience
6) Developing alternative sources of aggregates by the Contractor and the resulting additional material testing

8.21 CEMENT

1) Measurement for payment for Portland cement used for concrete will be of the quantities, by weight, of cement approved for the different classes of concrete specified and computed on the basis of the number of cubic meters of concrete measured and approved for payment. The amount of cement required per cubic meter of concrete of each class will be as established at trial mix stage or the approved modifications thereof as established by the Engineer in the course of concrete work.
2) Payment will be made at the Unit Price per metric ton entered in the Bill of Quantities, which shall include the entire cost of supply, delivery, transportation, storage and mixing, and test for complying with all requirements specified.
3) No measurement for payment or payment will be made for cement used for:
    a) Contractor's own convenience
    b) Used for defective and wasted concrete
    c) Concrete placed outside of the concrete pay-lines (e.g. for filling the overbreak other than approved overbreak due to geological conditions) or required as a result of

careless excavation

d) Any additional cement required due to usage of greater proportion of crushed aggregate than established at trial mix stage for a specified concrete class

8.21.1 ADMIXTURES

1) Measurement for payment for air-entraining, water-reducing, water-reducing-retarding and super plasticizer admixtures will be of the weight or volume of the agreed dosages established at trial mix stages or the approved modifications thereof, for different classes of concrete, and computed on the basis of the number of cubic meters of concrete measured and approved for payment.
2) Payment will be made at the applicable Unit Price per kilogram entered in the Bill of Quantities, which shall include the entire cost of supply, handling, storage, dispersing and tests for complying with all requirements specified.
3) No extra measurement for payment or payment will be made for concrete admixtures used for Contractor's convenience such as accelerators and non-shrink agents.
4) No payment will be made for admixtures used for Contractor's convenience only.

8.21.2 STEEL REINFORCEMENT

1. Measurement for payment for reinforcing bars will be of the weight of reinforcing steel, including splices, as stated in the bar lists approved by the Engineer in the course of the work. The weight entered in the bar lists will be computed using the nominal weight per lineal meter of different bar diameters based on the specific weight of 7,850 kg/m3.
2. Payment will be made at the Unit Price per metric ton entered in the Bill of Quantities, which shall include the entire cost of supply, storage, cutting, bending, placing, wire clips, ties, separators, and any other fastening devices.
3. No extra measurement for payment or payment will be made for the following:
    a. Wire for tying reinforcement
    b. Any additional reinforcement or splices required when Contractor's casting sequences differ from construction joints shown on the Final Design and /or Construction Drawings
    c. Any reinforcing steel placed by the Contractor for his own convenience in addition to those shown on the Final Design and /or Construction Drawings and entered in the bar lists
    d. Any reinforcing steel delivered for testing

8.21.3 FORMWORK

No Payment will be made towards form work. The cost thereof shall be included in the applicable Unit Price for concrete in the structure with which it is associated.

8.21.4 MOVEMENT JOINTS

1) Measurement for payment will be made for the following items in the units stated:
    e) Waterstops: per linear meter placed
    f) Joint Sealing Compound (including primer and plastic tape): per dm3 placed
    g) Joint Filler Panels: per square meter
2) Payment will be made at the appropriate Unit Price entered in the Bill of Quantities, which shall include the entire cost of all materials, plant and labour for furnishing and constructing movement joints as specified, and all temporary protection of the joints from damage.
3) Payment will only be made for the movement joints shown on the Final Design and /or Construction Drawings or directed by the Engineer. Additional joints for Contractor's convenience may be approved by the Engineer, but no payment will be made for materials used in such joints.

8.21.5 TESTS

1) All cost associated with testing as described in this Section shall be borne by the Contractor, who shall make allowance for such expense in the Unit Prices for the concrete work. These shall include, but not be limited to, the following:

a) The costs for all tests to be carried out prior to the start of concrete work, whether carried out at Site or elsewhere
b) Routine tests for quality control during the execution of the concrete work carried out by the Contractor as specified herein and as directed
c) Other tests required during execution of the work to be carried out by an approved test laboratory(ies)
d) Preparation, storage, handling, curing and delivery of additional samples to the site laboratory, if so required for additional testing.

2) Should the Contractor fail to adhere to his testing program, all test deemed necessary by the Engineer to check concrete work will be performed by the Engineer at the site laboratory or at an independent laboratory assigned by him, at Contractor's expense.

9 DRILLING AND WATER PRESSURE TESTING

9.1 SCOPE OF WORK

1) The work under this Section includes all labour, materials, equipment and services required for the execution of drillholes and water-pressure tests from surface construction sites, at locations shown on the Construction Drawings or where the Engineer may direct. This Section shall be read in conjunction with the Section "Grouting".
2) Drilling shall include the following:
    a) Drilling of exploratory holes;
    b) Drilling of boreholes;
    c) Drilling for grout curtain below the cut of trench
    d) Drilling of control holes to determine the effectiveness of grouting
    e) Drilling of drainage holes
    f) Drilling for installation of instrumentation, with or without core recovery
3) The general extent and the approximate location of the drill holes are tentatively indicated on the Drawings for the purpose of Bid preparation. The final number, length and location of the drill holes shall be determined by the Engineer, based upon the actual conditions encountered at the site.
4) The direction of the drill holes may be vertical or inclined.
5) Selected holes shall be water tested in stages as the drilling progresses or after completion of the drill hole, as directed by the Engineer.

9.2 SUBMITTAL

1) Within 24 hours of completion of any drilling with core recovery, the Contractor shall submit, in duplicate, a technical log of the drillhole in a form approved by the Engineer. The log shall include the following data:
    a) Date of beginning and end of drilling
    b) Drillhole number
    c) Location, ground surface elevation, coordinates, inclination, direction, and length of drillhole
    d) Type and diameter of drilling bit and core barrel used, make of drilling rig and length and diameter of casing, if used
    e) Elevation of ground water levels encountered, including dates and times of measurement
    f) Results of leakage tests and other drillhole tests, if any
    g) A record of the drillers observations on progress of drilling, rate of penetration, speed and uniformity of rotation of bit, action of the drill rig such as jerky, smooth, rough, steady, etc.
    h) Length of each core run and the length, or percentage, or both of the core recovered and location and cause of core losses
    i) Any changes in the character of the drilling water or mud, and in case the drilling water was lost (partly or totally), the elevation or depth when this happened
    j) A simple drillers interpretation and description of the nature of the formation encountered as the drilling progress
    k) Location and nature of cavities, seams, cracks, soft or broken rock, whether filled or open, and any other observation which could give information in connection with the purpose of exploratory drilling
    l) Names of drillers and inspectors
2) Geological logging shall be performed by the Contractor and submitted to the Engineer.
3) Colour photographs of the core boxes from each drillhole shall be taken by the Contractor

and submitted to the Engineer in a digital copy within 10 days from the completion of the drillhole.

4) The Contractor shall submit reports in duplicate giving the results of each water-pressure test performed, within 24 hours of the end of the shift in which the tests were carried out. The reports shall contain the following:
    a) Location and number of drillhole
    b) Date and time of test performance
    c) Type of test
    d) Pressure readings and water levels before and after testing
    e) Packer rod characteristics and depth of packer(s)
    f) Total injected water volume and rate per minute and per linear meter of hole for various pressures
    g) Description of all surface water leaks indicating the distance and approximate quantity.
5) Should the Contractor intend to use a water-soluble additive to drilling water, he shall submit a notification and a sample of the additive to the Engineer for approval at least 15 days prior to being used.

9.3 EQUIPMENT

9.3.1 GENERAL

1) The Contractor shall have sufficient drilling rigs at the Site for the timely completion of the Works. The drilling rigs shall be in good operating condition and adequate for the satisfactory progress of the work.
2) Drilling equipment and methods shall be such as to minimize oversizing or caving of the holes. Drill casing, where required, shall be of high-quality steel, plain or perforated as directed or approved by the Engineer. The casing necessary for driving through soils shall be of a diameter to take the largest size core barrel or bit to be employed. Auxiliary casing shall be provided where it is necessary to case through formations already penetrated and where no casing has been installed. This shall have a diameter to fit inside the hole and permit the use of the next smaller core bit and barrel. When casing is installed to keep the grout hole open for grouting, equipment and casing shall facilitate the casing removal immediately prior to, or simultaneously with, the grouting process.
3) The Contractor shall have available at the Site drilling equipment for both rotary and percussion type drills. The minimum diameter of drilling hole shall be 38 mm. Other required diameters shall be 48 mm, 63 mm, 76 mm, 98 mm, and 101 mm according to the purpose of the drilling as determined by the Engineer.
4) Drilling equipment shall be capable of drilling at any angle and shall have the following capacity:
    a) Exploratory holes up to 100 m
    b) Boreholes up to 100 m
    c) Dam grouting curtain up to 30 m
5) The Contractor shall keep at the Site an ample supply of different types and sizes of drilling bits to allow optimal drilling in the different materials to be encountered in the course of work, and sufficient rods and casings of various diameters to allow proper telescoping and to ensure the stability of drillholes.

9.3.2 DRILLING WITH CORE RECOVERY

1) Drills for exploratory drilling shall have the following features:
    a) Automatic adjustment for drill pressure and rate of advance
    b) Proper working indicator of drilling pressure
    c) Transmission gear to adjust spindle speed (e.g. 60 to 300 rpm for rock)

2) The Contractor shall use swivel-type double, or triple tube core barrels.
3) Drill rods shall be of sufficient diameter to permit adequate flow of the drilling fluid and to provide sufficient upward velocity of the fluid to remove effectively the sediments.

9.3.3 WATER PRESSURE TESTING

1) The Contractor shall provide a sufficient number of complete sets of pressure testing equipment (with spares) to allow simultaneous testing at the various drilling and/or grouting locations.
2) Unless otherwise directed by the Engineer, the pumps shall have a capacity of 200-250 liters per minute at a pressure of 10 bar and shall be capable of exerting a pressure of at least 25 bar. The pumping system shall be capable of maintaining any desired pressure without fluctuation and the pressure and discharge must be continuously adjustable.
3) Water pressure shall be measured by means of a pressure gauge with an accuracy of 0.5 bar and a range of 50 bar. Discharge shall be measured with an accuracy of 2%. The water meter shall measure the discharge from 0.5 l/min. Water meters as well as all pipes, hoses and couplings shall be designed to resist a pressure of 60 bar.
4) Water-meters and pressure gauges shall be calibrated and certified by an independent laboratory prior to installation at the Site and shall be subject to weekly verification. One pressure gauge and one water-meter shall, after independent checking, remain at the disposal of the Engineer for further checking purposes. The Contractor may be requested to establish, by way of tests, correction graphs for pressure losses occurring in the pipes. Pressure gauges shall either be installed directly at the collar of the drillhole or preferably at the depth of the stage.
5) Packers shall consist of mechanically expanded rings or pneumatically expanded sleeves of rubber or other suitable material, which can be set tightly in a drillhole at any depth required. Packers shall be capable of withstanding pressures of up to 50 bar without leakage. The Contractor shall keep at the Site an adequate supply of single packers, as well as double packers spaced 3 and 6 m apart to allow to isolate a section of a hole, and of diameters to suit the various hole diameters. Each packer shall have a minimum length of 50 cm.
6) For water level measurements, electrical probes with an accuracy of 10 mm shall be used. They shall be provided with measuring tapes marked with centimeter gradations.

9.4 EXECUTION

9.4.1 GENERAL

1) Holes shall be drilled to an accuracy of within 3 degrees of the angle of inclination specified. Holes shall be drilled within 25 cm of the positions shown on the Construction Drawings or directed by the Engineer.
2) The diameter specified for any drillhole shall be the minimum diameter. The diameter of the hole as drilled shall equal or exceed the specified diameter over the entire length of the hole.
3) Sufficient circulation water shall be used to flush out all sediments. The use of lubricants such as metallic salts or mineral soaps in the circulating water to help the drilling process or to reduce the wear on the drill bits shall require the consent of the Engineer. These products shall not impair the quality of the grouting or the setting of the grout. The use of grease, oil, or other lubricants shall not be permitted for grout holes. The injection of cement grout to stabilize the drillholes is subject to approval by the Engineer.
4) Unless otherwise directed by the Engineer, all holes shall be thoroughly washed out from the bottom with water under pressure immediately after drilling. Water flushing shall continue until the waste water runs clear.
5) All surface holes (with drilling completed to any stage) shall be temporarily capped or otherwise protected.
6) If the drilling plan is altered to require additional drillholes in any section of the works, the Contractor shall reinstall the equipment and carry out new drilling in the pattern and lengths as ordered by the Engineer. All such additional drilling shall conform to these Specifications.

9.4.2 DRILLING FOR CURTAIN GROUTING

1) The Contractor shall drill from the surface at locations, lengths, and directions indicated on the Construction Drawings or as directed by the Engineer. Tentative systems of drillholes are indicated on the Tender Drawings.
2) Holes for curtain grouting shall have the following minimum diameters, measured at the deepest point of the hole:
    a) AX (48 mm) for rotary drilling with length up to 75 m
    b) 38 mm (1 ½") for percussion drilling with length up to 10 m
    c) 63 mm (2 ½") for percussion drilling with length up to 25 m
    d) 89 mm (3 ½") for percussion drilling with length up to 75 m
3) The length of holes is tentatively indicated in the Drawings. The drill holes shall be vertical or inclined as indicated on the Construction Drawings or instructed by the Engineer.
4) The holes in moderately permeable to tight foundations shall be drilled with rotary equipment, while percussion or rotary-percussion drills may be used in very permeable and open foundations. The choice between rotary and percussion and rotary percussion shall depend more upon the mechanical characteristics and/or the weathering of the rock than its permeability.
5) For curtain grouting, primary holes with core recovery will be drilled with 6m spacing. They will be used to determine the depth of the grout curtain. The remaining holes will be drilled without core recovery and grouted with the split-spacing method. The efficiency of the grouting will be then verified by the drilling of control holes with core recovery. Depending on the results, the Engineer may require additional grout holes.
6) When the grouting is to be done in a descending arrangement, the drilling shall be interrupted to grout the previous section. After the time specified by the Engineer the hole shall be washed and/or re-drilled and the drilling resumed.
7) Holes drilled in soft rock or fractured formations shall, with the approval of the Engineer, be cased with a perforated steel pipe. Where practicable, such casing shall be later removed. Casings shall only be allowed to remain permanently in place with the approval of the Engineer.

9.4.3 EXPLORATORY HOLES, DRILLING

9.4.3.1 Drilling and Core Recovery

1) The Contractor shall carry out exploratory drilling work as directed by the Engineer at any time throughout the duration of the Contract. The exploratory drilling shall comprise:
    a) Drilling from the surface for geological exploration, testing and sampling
    b) Exploratory and control holes for the grout curtains
    c) Drilling for installation of instrumentation
2) Exploratory drillholes shall be of minimum diameter 76 mm (NX). However, the Engineer may order exploratory drilling of 98 mm diameter. Drilling shall be performed with rotary drilling equipment using coring type bits. Unless otherwise directed or approved by the Engineer, the Contractor shall use a standard ball bearing, swivel-type, double tube core barrel equipped with core bits set with diamonds, tungsten carbide, or similar hard materials and standard core lifters. Core diameter shall be 54 mm minimum for 76 mm diameter drillhole and 68 mm for 98 mm diameter drillhole.
3) Coring runs shall be limited to a maximum length of 3 m. The cores shall be removed from the holes immediately if blocking of the bit or grinding of the core is indicated by the drill behavior regardless of the length of the run which has been made. When less than 80% percent of core is recovered from a 3 m run, the length of the following run shall be shortened by 50%, unless otherwise approved by the Engineer.
4) Only samples not altered or damaged by the drilling process will be considered as "core". Core must correspond to the depth of origin with an accuracy of 50 mm. The Engineer may at any time check the accuracy of the core runs during drilling operations. Core recovery not representative of the drillhole depth will lead to partial or total redrilling of the hole by the Contractor.

5) A core recovery of at least 95% is required in sound rock and 80% in weathered and fractured rock and in soils of any nature. Drilling shall be stopped and the cores removed from the barrel as often as is necessary to secure the required core recovery. Where a higher core recovery is required, the Engineer may order the use of triple tube core barrels such as Mazier samplers or similar approved.
6) Each hole drilled shall be protected from becoming blocked by means of a cap or other suitable device on the collar. Any hole that becomes blocked before completion of operations shall be cleaned out in a manner satisfactory to the Engineer or replaced by another hole drilled by the Contractor.
7) Where indicated on the Construction Drawings or directed by the Engineer, the cored holes shall be fill-grouted in accordance with the provisions of the Section "Grouting".

9.4.3.2 Handling and Storage of Cores

1) The Contractor shall provide strong core boxes, 1 m inside length, of wood, metal or other durable material subject to approval by the Engineer. The boxes shall be provided with hinged covers and with longitudinal spacers that will form separate compartments so that each box shall hold cores from e.g. 5 m of the hole. The number of the compartments will however depend on the core diameter.
2) The core boxes shall be stored in weatherproof sheds of sound construction in the vicinity of the Works, at locations approved by the Engineer.
3) The core shall be carefully extracted from the core barrel and stored in core boxes in the correct orientation and sequence. All cores shall be marked with an arrow in the direction of drilling. Wooden blocks which fit between the longitudinal spacers with a clear and durable inscription of the depth shall be placed between each core run. Where core is not recovered, or where samples have been removed by the Engineer, timber blocks of square cross-section shall be placed in the box. These timber blocks shall be cut to the same length as the missing cores and placed in the corresponding positions. If these positions cannot be determined, the blocks shall be placed at the top of the run.
4) No box shall contain cores from more than one hole. Clear designating marks, hole numbers, data of start and completion, and elevations shall be marked on the boxes and along the lines of cores.

9.4.4 EXPLONATERY HOLE, SAMPLING AND TESTING

9.4.4.1 Introduction

In the course of drilling in overburden, at any time throughout the duration of the Contract, the Engineer may direct the Contractor to perform:

1. Collection of Undisturbed Samples;
2. Standard Penetration Tests;
3. Cone Penetration Test (CPT) and Cone Penetration Test with pore pressure measurement (CPTU);
4. Lugeon Tests;
5. Lefranc Test

The Engineer may perform special tests in exploratory holes.

9.4.4.2 Undisturbed Sample

All the equipment and the execution of the test shall be in accordance with ASTM Method D 1587-00. Undisturbed samples as well as split-barrel samples shall be delivered by the Contractor to the site laboratory, or to a specialized laboratory designed by the Engineer.

9.4.4.3 SPT tests

All the equipment and the execution of the test shall be in accordance with ASTM Method D 1586.

9.4.4.4 CPT and CPTU tests

All the equipment and the execution of the test shall be in accordance with ASTM Method D5778-95

9.4.4.5 Lugeon Test

All the equipment and the execution of the test shall be in accordance with BS 5730-ENGL.

a). Allowable Water Pressure

All primary and check holes of the grout curtains shall be water pressure tested. Stage length for testing shall be the same as for grouting, if not otherwise directed. The Engineer may direct the performance of water pressure tests in other holes, as he may consider necessary. Double or single packer shall be applied as necessary to isolate and test zones of high water take.

Water pressure shall be at the following maximum pressures, unless otherwise directed by the Engineer:

Depth into rock (m)	Water Pressure (kg/cm2)
0 - 5	2
5 - 10	4
10 – 20	6
> 20	8

b).Lugeon Test execution

i. The Contractor shall perform water-pressure tests by the Lugeon Test Method in grout and exploratory holes or section of holes, as the drilling proceeds or after completion of a drillhole, as and where directed by the Engineer.

ii. The permeability as measured in the drillholes shall be expressed in Lugeon units, 1 Lugeon unit being equal to a water take of 1 liter per minute per linear meter of hole at a pressure of 10 bar.

iii. The hole or section of a hole to be subject to testing shall be sealed with single packer placed 3 m above the bottom of the hole (descending stages), or with double packers 3 m apart (ascending steps). The groundwater table, if any, shall be measured and registered before and after each test.

iv. After the packer is installed, the drillhole shall be thoroughly flushed and the Contractor shall check that the flow through the packer is not obstructed.

v. Water shall be pumped into the hole through a header and pressure shall be applied in stages up to the maximum pressure. The maximum pressure shall be determined by the Engineer, but shall in general not exceed 10 bar. Where water-pressure tests are carried out in grout holes, the maximum pressure shall not exceed the maximum grouting pressure to be used. Unless otherwise directed by the Engineer, the pressure at the various stages shall be as follows:

Stage	Pressure (Bar)
1	1.0
2	2.0
3	4.0
4	2.0
5	1.0

vi. Discharge measurements shall be started only after a stable pressure has been established. For each stage of pressure, water absorption shall be measured 3 times for periods of 3 minutes each. The time for each stage of pressure shall therefore be at least 9 minutes and the total time for a complete Lugeon test comprising 5 stages of pressure will be at least 45 minutes.

vii. If during discharge measurements the rate of absorption or pressure changes, the test shall be extended until discharge and pressure remain constant over a period of 5 consecutive minutes.

viii. If, due to high absorption, it is not possible to maintain the required pressure, the pump shall be operated at its maximum discharge rate for 10 minutes and the pressure shall be measured at 2 minute intervals.

9.4.4.6 Lefranc Test

In case the permeability is so high that water under pressure is seeping at rates exceeding the capacity of normal pumps, or in case of the presence of soil, the Contractor shall carry out permeability tests by the Lefranc's method. The Engineer may direct the performance of water tests which could be constant head type or falling head type, as he may consider necessary.
All the equipment and the execution of the test shall be in accordance with BS 5730-ENGL.

9.4.4.7 Laboratory Test

Test Description	**Procedures**
Grain Size Distibution	ASTM 421/D422/D1140
Atterberg Limits	ASTM D4318
Unit Weight	D7263 - 09
Moisture Content	ASTM D2216
Triaxial Tests	ASTM D2166
	ASTM D2850
	ASTM D4767
Direct shear	ASTM D3080
Consolidation	ASTM D2435

The type of tests and the standard procedure to be adopted are shown in the following tables:
The methodology of the testing operations shall be the ISMR (International Society of Rock Mechanics) standard procedures.

Test Description	Procedures
Unit Weight	ASTM D1556
UCS + determination of Young Modulus	ISRM suggested method for determining deformability of rock materials in uniaxial compression
Triaxial	ASTM D 2664

9.5 MEASUREMENT AND PAYMENT

9.5.1 GENERAL

1) The estimates of the quantities for drilling, water pressure testing and sampling given in the Bill of Quantities are to be considered as merely a guide on which the Contractor is to prepare his Bid and not as an accurate indication of the quantity of the work.
2) The quantities for each of the pay items will be varied to suit the conditions disclosed in the course of the work, and the Contractor shall not be entitled to any extra payment over and

above the Unit Prices entered in the Bill of Quantities by reason of changes of the amount and length of drillholes, by reason of the location of the drilling required by the Engineer, or by reason of the timing of the drilling in relation to excavation, concrete and other works.

3) The unit prices stipulated hereinafter shall include for all labour, equipment and materials required for the execution of the work. If for any particular item no separate pay item is foreseen, the cost shall be included in one of the unit prices entered in the Bill of Quantities.

9.5.2 SETTING UP OF DRILL RIGS

1) Measurement for payment will be made separately for setting up, on the surface, of:
   a) Drill rigs to be used for roto-percussion drilling, without core recovery
   b) Drill rigs to be used for rotary drilling, without core recovery
   c) Drill rigs to be used for rotary drilling, with core recovery.
2) The unit prices shall apply irrespective of the diameter or length of the hole to be drilled.
3) Measurement for payment for setting-up the drilling equipment will only be made once for each drillhole, irrespective of the number of times the equipment is actually set up, e.g. for stage grouting. Only in case the drilling method is changed at the requested of the Engineer, the corresponding new set up will be paid in addition. Payment will be made at the Unit Price per set-up entered in the Bill of Quantities, which shall include the entire cost of labour, equipment, and materials for setting-up the drilling equipment.

9.5.3 DRILLING

1) Measurement for payment and payment will be made separately for drilling holes:
   a) By different drilling methods:
      - Without core recovery by roto-percussion
      - Without core recovery by rotary drilling
      - With core recovery
   b) For drillholes of the following total lengths:
      - Not exceeding 10 m
      - Exceeding 10 m but not exceeding 25 m
      - Exceeding 25 m but not exceeding 60 m
      - Exceeding 60 m
   c) For drillholes of the following final diameters:
      - 38 mm
      - 48 mm
      - 63 mm
      - 89 mm or more.
2) The total length of the drillhole will be paid at the unit price per meter which corresponds to the location, drilling method, total length and final diameter. No distinction will be made between holes drilled for different purposes.
3) The Unit Prices for drilling from the surface shall apply for vertical drilling downward to an inclination of 30° from the vertical. Additional payment will be made for inclined drilling with a range of 30° to 90° from the vertical and for overhead drilling at the unit prices per linear meter of hole so drilled entered in the Bill of Quantities.
4) The unit price per meter entered in the Bill of Quantities shall include the entire cost of labour, equipment and materials for drilling and washing out the holes and for temporary casing, if required.
5) When drilling of a hole is carried out successively for multiple-stage grouting, the measurement for payment will only be of the total length of the hole actually drilled in the rock or concrete. Any redrilling required because of the Contractors failure to clean the grout out of the hole before it has set shall be at the Contractor's expense.
6) Measurement for payment for any required re-drilling where the grout has been allowed to set at the direction of the Engineer will be of the actual length of redrilled hole. Payment for

this length in linear meter will be made at a rate of 50% of the corresponding unit price.

7) Where redrilling of previously drilled drain holes is required after an additional grouting, measurement for payment will be by the actual length of redrilled hole. Payment for this length in linear meter will be made at a rate of 50% of the corresponding unit price.
8) Measurement for payment for perforated steel pipe casing left permanently in place with the approval of Engineer will be made at the unit price per linear meter entered in the Bill of Quantities, which shall include the entire cost of supply and installation of the casing.
9) The unit price per linear meter of drillholes with core recovery shall include the provision of core boxes, preservation and storage of cores, preparation of drill logs, provision of colour photographs of the boxed cores, and any assistance provided by the Contractor to the Engineer during the geological logging and handling of core boxes.
10) Additional payment will be made for drilling with triple tube core barrels, where directed by the Engineer, at the unit price per linear meter of hole so drilled entered in the Bill of Quantities.
11) Measurement for payment and payment for the installation of instruments in exploratory holes will be made in accordance with the provisions of the relevant section of these Specifications.

9.5.4 SAMPLING AND TESTING

9.5.4.1 UNDISTRURBED SAMPLE

1) Measurement for payment for undisturbed sampling will be of the number of samples.
2) Payment will be at the Unit Price per piece entered in the Bill of Quantities, which shall include transporting of samples to the site laboratory. No deduction will be made for drilling of that stage where the sampling was performed.

9.5.4.2 SPT TESTS

1) Measurement for payment for Standard Penetration Tests will be of the number of tests satisfactorily performed.
2) Payment will be at the Unit Price per piece entered in the Bill of Quantities which shall include the entire cost of labour, equipment, and materials used for carrying out the test, the provision of test records and reports to the Engineer and all costs associated with interruptions to the drilling in case of the test is performed in association with a borehole.

9.5.4.3 CPT AND CPTU TESTS

1) Measurement for payment for CPT and CPTU will be of the length of tests satisfactorily performed.
2) Payment will be at the Unit Price per meter entered in the Bill of Quantities which shall include the entire cost of labour, equipment, and materials used for carrying out the test, the provision of test records and reports to the Engineer, and all costs associated with interruptions to the drilling in case of the test is performed in association with a borehole.

9.5.4.4 LUGEON TEST

1) Measurement for payment for water-pressure tests will be of the number of tests satisfactorily performed, irrespective of size, length, or inclination of hole.
2) Payment will be made at the Unit Price per test entered in the Bill of Quantities, which shall include the entire cost of labour, equipment, and materials used for carrying out the water-pressure test, the provision of test records and reports to the Engineer, and all costs associated with interruptions to the drilling caused by the intermittent nature of the testing work.

9.5.4.5 LEFRANC TEST

1) Measurement for payment for Lefranc will be of the number of test performed tests satisfactorily performed.
2) Payment will be at the Unit Price per piece entered in the Bill of Quantities which shall include the entire cost of labour, equipment, and materials used for carrying out the test, the provision of test records and reports to the Engineer and all costs associated with interruptions to the drilling caused by the intermittent nature of the testing work.

9.5.4.6 Laboratory Test

1) Measurement for payment for laboratory tests will be of the number of tests satisfactorily performed.
2) Payment will be made at the Unit Price per test entered in the Bill of Quantities, which shall include the entire cost of labour, equipment, and materials used for carrying out the test, the provision of test records and reports to the Engineer.

9.5.5 INSTALLATION IN DRAIN HOLES

1) Measurement for payment of PVC pipe installed in the drainage holes as directed by the Engineer will be the length of pipe so installed. Payment will be made at the unit price entered in the Bill of Quantities which shall include the entire cost of supply and installation of perforated pipes, as well as all necessary coupling.
2) Measurement for payment for the supply and installation of drain holes outlet devices will be by the number of outlets. Payment will be made at the unit price per piece entered in the Bill of Quantities which shall include the supply and installation of all required accessories, and sealing with mortar.
3) Measurement for payment for the supply and installation of pressure gauges will be by the number of gauges installed. Payment will be made at the unit price per piece entered in the Bill of Quantities, which shall include the supply, installation and removal of the pressure gauge, including pressure relief valve and all necessary pipes and fittings, rubber collar etc., grouting work around the drain pipe, and eventual redrilling through the concrete and placement of dry pack mortar when pressure measurements are no longer required.

9.5.6 EXCLUSIONS

1) All costs for provision of embedded steel pipes and fittings for grouting will be measured and paid for in accordance with provisions of the Section “Grouting”.
2) No extra measurement for payment or payment will be made for the following:
    a) Drilling through steel ribs, steel lagging, reinforcing steel or steel lining
    b) Installation and removal of grout stub pipes
    c) Reaming or redrilling any holes through the concrete lining for the purpose of placing, and for supplying and placing, the dry-pack mortar
    d) Holes which have been blocked and cannot be used because of cave-ins, lost drill rods or packers, or striking other obstructions (e.g. reinforcement bars), and drilling the new holes to replace them.

10 GROUTING

10.1 SCOPE OF WORK

1) The work under this Section includes all labour, materials, equipment, and operations required for the performance of grouting in the holes from the surface at locations shown on the Final Design and/or Construction Drawings or where the Engineer may direct.
2) Grouting operations shall include the following:
    a) Curtain grouting below the cut-off trench the dam and below other structures (if necessary), in order to create a high density zone with a low permeability.
    b) Fill grouting of drainage trench, around conduits and sump pits, and of exploratory drillholes and drain holes.
3) The general extent and approximate location of the drillholes are tentatively indicated on the Final Design Drawings for the purpose of Bid preparation. The final number, length, location and inclination of the drillholes, as well as the composition and consistency of the grout mixes, grouting pressures, pumping rates and sequence in which the holes are to be drilled and grouted shall be governed by actual conditions encountered on Site and shall be at all times subject to approval by the Engineer.

10.2 DEFINITIONS

10.2.1 CEMENT GROUT

1) Cement grout is defined as a mixture of cement and water with the addition of admixtures, sand and bentonite, if required, which is forced under pressure into prepared holes or pipes in order to fill voids or consolidate the rock mass as a whole.
2) Cement grouts are subdivided into stable and unstable mixtures:
    a) Unstable mixtures are simple suspensions of cement in water. These suspensions are only homogeneous as long as they are in movement and the sedimentation starts as soon as the movement is stopped.
    b) Stable mixtures are colloidal suspension dissolved in water which grain size is so small that no appreciable sedimentation occurs during the grouting operation. These suspensions are obtained by high speed mixing of cement with addition of bentonite and/or admixtures and shall be used for all grouting works.

10.2.2 SINGLE-STAGE GROUTING

1) The single-stage grouting (nipple grouting) is carried out by introducing the grout at either the collar of the hole through a nipple or by means of a grout supply pipe at the bottom of the hole. The entire length of the hole is grouted in one operation.
2) This grouting method will in general apply for contact grouting and for consolidation grouting of short holes in stable ground.

10.2.3 MULTIPLE-STAGE GROUTING

1) This grouting method will in general apply for consolidation grouting in holes crossing unstable ground.
2) Multiple-stage grouting is carried out by introducing the grout into a predetermined section of the hole which is blocked off by a packer. The grouting of the entire length of hole is performed in successive stages either in ascending or descending arrangement.
3) The terms ascending or descending arrangement mean only the sequence of the grouting stages, either from bottom to the collar of the hole or in reverse, irrespective of the effective direction or inclination of the hole.
4) When grouting is done in ascending arrangement, the hole is drilled to its full depth, washed out, and the packer is set at the top of the deepest section to be grouted. The section is then water-pressure tested and grouted at the required pressure through the grout supply pipe. The packer is allowed to remain in place until there is no back pressure and then withdrawn to the

top of the next section to be grouted. The water-pressure testing and grouting is repeated successively section by section until the entire length of the hole is filled with grout.

5) When grouting is done in descending arrangement, the work is accomplished in sections from the collar of the hole. The hole is drilled to a limited depth, washed out and the packer is set just above the section to be grouted. The section is then water-pressure tested and grouted at the required pressure. The grout within the hole is washed out before it hardens while the grout surrounding the hole is allowed to obtain its initial set, before the hole is drilled to an additional depth. Repeating thus successively drilling, water-pressure testing, and grouting at various depths until the entire length of hole is completely drilled and grouted.

10.2.4 WATER-CEMENT RATIO

The water-cement ratio (W/C) is the proportion by weight of water to cement in a water-cement mixture.

10.3 SUBMITTAL

1) At least 60 days prior to the start of grouting works the Contractor shall submit for approval fully detailed proposals and a detailed layout of his proposed arrangements for grouting, including specifications of all equipment, tools and all grouting materials to be used, and qualification and experience of the proposed personnel.
2) An overall grouting program shall be drawn up jointly between the Contractor and the Engineer. Grouting mixes, pressures, pumping rates, and sequencing will be selected, subject to modifications, to meet local conditions encountered during the performance of the work. Grouting works shall be planned in such a manner that they can be carried out according to the approved plan concurrently with other activities. Modifications to the grouting program shall be implemented as directed by the Engineer.
3) Prior to each phase of grouting, the Contractor shall submit for approval a detailed program for the particular grouting works along with information relating to the methods he proposes to use and details of grout mixes. No grouting work shall be executed without prior written approval by the Engineer.
4) During the performance of the grouting works, the Contractor shall keep complete daily records of all grouting operations which shall include the following:
    a) Number and location of the drillholes
    b) Results of water-pressure tests
    c) Grouting method
    d) Date and time of commencement and of each change in grouting operations
    e) Rate of pumping
    f) Grouting pressures and gauge reference number
    g) Water-cement ratio and its variations
    h) Separate quantities of cement, sand, bentonite, admixtures and chemicals used
    i) Connections, if any, with other holes and cracks, as well as any surface leakage of water or grout
    j) Number of holes and depth of holes left for redrilling
    k) Time of completion
    l) Name of the foreman in charge

    Grouting reports in an approved form shall be compiled from these records and submitted weekly to the Engineer. Results of water pressure tests and grout takes shall be submitted graphically.
5) The Engineer reserves the right to require any additional information deemed necessary to be included in the submitted documents.

10.4 SAMPLING AND TESTING

1) The Contractor shall prepare and test the trial mixes as directed by the Engineer at least 30

days before commencement of any grouting. Materials for use in grout mixes shall be tested for compliance with the applicable requirements stipulated in "Materials" of this Section.

2) Following tests shall be required:
   a) Laboratory tests:
      - Grain size distribution and moisture content of sand
      - Atterberg limits
      - Chemical analysis of water and solids
      - Compressive strength
      - Viscosity (by fan-viscosimeter and Marsh cone)
      - Density
      - Decantation and setting time (by Vicat needle)
      - Shrinkage of the grout
   b) Field tests:
      - Density by hydrometer or mud balance
      - Viscosity by Marsh cone

   Sampling and testing will be supervised by the Engineer
3) All chemical grouts shall be tested in the laboratory at the Site under conditions identical to those to which they will be subjected in the field, in order to determine the suitability of various chemicals and proportion of the ingredients to satisfactorily complete the work.
4) During the actual grouting operations the Contractor shall carry out tests on grout mixes at the same time as grouting, and shall plot values of viscosity, sedimentation limits, compressive strength, and maximum viscosity possible for the grouting on a diagram. The frequency of testing will be once for each grouting jobsite or until acceptance criteria have been met. However, if a significant change in the cement source occurs, sampling and testing must be repeated. Acceptance criteria will be determined by the Engineer.

10.5 GROUTING MATERIALS

10.5.1 GENERAL

1) The following kinds of grout mixes may be used:
   a) Neat cement grout, possibility with admixture
   b) Cement-sand grout, possibility with admixture
   c) Chemical grout such as polyurethane, one or two component type
   d) Cement-bentonite grout with or without sand

   The quantities of sand, bentonite, fly and admixtures will depend on the permeability of the rock and the size of the voids to be grouted.
2) Cement, sand, water, admixtures and flyash for use in grout mixes shall conform to the requirements of Section "Concrete", except as specifically amended hereafter.

10.5.2 CEMENT

1) Cement shall have a minimum specific surface of 3,500 cm2 per gram as determined by the Blaine air-permeability method (ASTM C204). No cement particle shall be retained on US Standard Sieve No. 200 (0.075 mm).
2) Cement Type I shall be used, pending confirmation that the ground water is not aggressive.

10.5.3 SAND

1) Sand in grout might be required for small portions of the work in highly fissured or fractured rock zones. Sand shall have the following grading:

US Standard Sieve	Square Mesh Sieve Opening	Percentage Passing (by weight)
No. 8	2.360 mm	100
No. 16	1.800 mm	95-100

No. 30	0.600 mm	60-85
No. 50	0.300 mm	20-50
No. 100	0.150 mm	10-30
No. 200	0.075 mm	0-5

2) Sand shall not contain more than 3% of flat or elongated particles having a maximum dimension in excess of four times the minimum dimension.

10.5.4 WATER

1) Water shall not contain more than 2,000 ppm of suspended colloidal solids and no particles larger in size than the cement particles. It shall not be aggressive. The chloride content shall be less than 50 mg/l and the sulfate content less than 100 mg/l.
2) The temperature of water used for the preparation of grout shall not exceed 25°C.

10.5.5 ADMIXTURES

1) Admixtures shall be added to grout mixes to optimize the strength, viscosity, density, decantation, setting time and shrinkage.
2) Only admixtures proved by testing prior to the start may be used for grouting. Manufacturer's certificates or guarantees will not be accepted as relieving the Contractor of his responsibility for the suitability of any admixture. Admixtures shall be Sikament 100 with expansion effect, supplied by SIKA, or approved equal.

10.5.6 BENTONITE

Bentonite shall be as specified by the American Petroleum Institute as follows:

Type	Sodium Montmorillonite
Wet screen analysis residue on US Standard Sieve No. 200 (0.075 mm)	max. 2.5%
Moisture	max. 13%
Fan Reading	min. 30 at 600 rpm
Yield Point	max. 3 x plastic viscosity
Filtrate	maximum 13.5 cc
Liquid limit	not less than 350
Plastic limit	not less than 28

10.5.7 FLY ASH OR POZZOLANA

1) For improving the fluidity, stability and sulphate resistance of the grout, finely ground fly ash or pozzolan may be added to the standard grouting materials and to replace up to 20% of the cement. Alternatively, Portland Pozzolan cement may be used.
2) Fly ash shall be used only if proved to be compatible with other grouting materials by testing prior to the start of grouting and approved by the Engineer.

10.5.8 CHEMICALS

1) When chemicals are required or proposed, they shall be accompanied by the manufacturer's certificates that they have been commercially used with satisfactory service in similar type of work. The storage, handling and usage shall be strictly with the manufacturers printed instructions.
2) The use of toxic chemicals such as acrylamide shall not be permitted for use in the Works.
3) When Sodium Silicate is required or proposed it shall meet the following requirements:

Specific Gravity at 15°C	More than 40°Be (Baume gravity meter)
SiO	28% to 30% by weight
Na2O	9% to 10% by weight
Fe	Less than 0.02% by weight
Matter insoluble in water	Less than 0.2% by weight

10.6 GROUT MIXTURES

10.6.1 GENERAL

1) The type of grout and products for each mixture will be determined by the Engineer according to design requirements and the purpose of the work.
2) The proportions of various constituents in the grout mixtures shall be selected by the Engineer in collaboration with the Contractor and shall be constantly adopted to the conditions at the Site as the Engineer may direct.
3) Any grout mixture not used within one hour after mixing shall be wasted.

10.6.2 UNSTABLE CEMENT MIXTURES

1) Neat cement grouts with a water-cement ratio (W/C) varying from 1 to 0.5 will normally be used. Admixture may be added to obtain better penetration.
2) Where sand is added to the mix, the weight of sand added shall not exceed twice the weight of cement.
3) The materials for unstable mixtures may be mixed in the same mixer under condition that there shall be no appreciable segregation of the grout before setting.

10.6.3 STABLE CEMENT MIXTURES

1) Stable mixtures shall consist of cement, with addition of bentonite as required and as the Engineer may direct. The water-cement ratio (W/C) may vary from 2:1 to 0.5:1.
2) The preparation of cement-bentonite grout mixture shall be as follows:
    a) Phase 1: Mix bentonite and water in a high-speed colloidal mixer and transfer to a storage reservoir where the mixture is continuously agitated.
    b) Phase 2: Transfer the bentonite slurry to a second high speed colloidal mixer and add cement and additional water. The final mixing shall last for at least 2 minutes.
3) Water used for the preparation of the bentonite slurry shall not contain any suspended cement particles.
4) Under no circumstances shall the same mixer be used for both phases.

10.6.4 GROUT MIXES FOR DAM/SPILLWAY GROUT CURTAIN

1) The proposed grout mix will start with one part cement/pozzolan to one part water (by weight) with 1 to 2% super plasticizer (e.g. Sikament). If the grout pressure develops with this consistency, the hole shall be grouted to refusal point. If there is a pressure drop or take beyond 200 l/m, the grout mixture shall be thickened with 1:0.7 mixture, to obtain the development of the desired grout pressure.
2) If after thickening of the mix, the grout take is greater than 200 l/m, intermediate holes shall be drilled and grouted (secondary, tertiary, etc.).
3) In areas of known high permeability, as interpreted by the Engineer, or where detectable water loss during drilling occurs, the starting grout mix shall be 0.8 water to 1 cement/pozzolan and 1 to 2% plasticizer.
4) If the take exceeds 0.5 m3/m the mix shall be switched in order to fill the open seams with mortar composed of one part sand, cement/pozzolan and water (i.e. 1:1:1) with plasticizer as required. Mortar shall be pumped to refusal.

10.7 EQUIPMENT

10.7.1 GENERAL

1) Only modern, properly operating grouting equipment approved by the Engineer and operated by trained and experienced crew shall be used for the performance of the work.
2) Grouting equipment shall consist of grout pumps, weighing scale for additives and cement, grout mixers, water meters, agitator sumps, pressure gauges, packers, pipe lines and fittings, and miscellaneous tools specifically designated for grouting purposes.
3) Grouting equipment shall be capable of effectively mixing and stirring the grout and forcing it into the grout holes or grout connections in a continuous, uninterrupted flow at any specified pressure up to a maximum of 25 bar, and of accurately measuring the grout take. It shall maintain the specified pressure for at least 5 minutes after the hole refuses to accept further grout. The equipment shall be capable of accurately controlling grout flows and pressures and shall be suitable for neat cement and cement-sand grouts.
4) Spare gauges, valves and fittings shall be kept available at the Site, and a two-way communication system between the mixing plant and place of grouting shall be provided if the distance exceeds 60 m.
5) Stand-by equipment which can be activated immediately shall be furnished to ensure continuity of work in the event of main equipment breakdown. The standby equipment shall be able to operate at pressures up to 10 bar.
6) Graduated water discharge meters shall be accurate to ±5%.
7) Equipment for proportioning grout mixes based on number of cement bags or weighing of cement from bulk silo, and dosing of bentonite and water shall maintain dosing accuracy of 2 and 5%, respectively.
8) Prior to commencement of work, during the work as specified or as requested by the Engineer, and at the end of the work, all pressure gauges, recorders and discharge meters shall be checked and calibrated.
9) The grouting equipment shall always be maintained to Engineer's satisfaction in order to guarantee continued and efficient performance during grouting work.

10.7.2 GROUT MIXERS AND AGITATOR SUMPS

1) Grout mixers for mixing the stable mixtures shall be of the mechanically operated, high speed colloidal type of sufficient size, and operating at 1,500 to 2,000 rpm to ensure complete dispersion and activation of the mix, with electric or pneumatic drive.
2) For mixing the unstable mixtures the paddle mixers may be used.
3) Hand-powered mixers or concrete mixers shall not be permitted for preparation of grout mixtures.
4) Mixers shall be provided with equipment for measuring weight and volume of mix components with an accuracy of 2% and a water meter calibrated in liters with a reset switch for zeroing after each delivery.
5) After mixing, the grout shall be discharged through a 5 mm mesh screen into an agitator sump equipped with stirring paddle to prevent settling and to remove any air bubbles from the mix. The stirring paddle shall be of such arrangement to guarantee a complete circulation of the entire sump content. The agitator sump shall have at least the same capacity as the mixer so that one batch of grout can be pumped while the next batch is being mixed.

10.7.3 GROUT PUMPS

1) Grout pumps shall be capable of delivering a flow of 50 l/min of thick grout (W/C = 1) at specified pressure and shall be able to achieve and hold a pressure of up to 25 bar. They shall deliver grout at constant pressure and flow, without pressure surges.
2) Pumps shall be of the duplex double acting piston-type or a single acting plunger type. The pump body shall be of high wear and shock resistant material. The plunger unit shall be of stainless steel, highly resistant to abrasion.

3) The pump shall have either pneumatic drive or electro-hydraulic drive.
4) The pumps shall be equipped with precise pressure and capacity control valves which allow the setting of both, the maximum pressure and the flow, independently. The pump shall automatically stop whenever the preset pressure is reached, and shall maintain that pressure without fluctuation.
5) For works requiring a small volume of grout, the Contractor may use hand operated grout pumps approved by the Engineer. These pumps shall be able to achieve a pressure of up to 10 bars.

10.7.4 PRESSURE GAUGES

1) The Contractor shall provide pressure gauges for both low and high pressure ranges (0-15 bar and 0-30 bar). Two gauges for the appropriate range shall be provided in each grout line, one at the pump for the use of the pump operator, the other at the hook-up connection directly at the collar of the hole. The required pressure for each particular hole shall be measured on the hook-up pressure gauge, not at the pump.
2) Pressure gauges shall have an accuracy of 3%. A minimum of two standardized pressure gauges for each range shall be calibrated and certified by an independent laboratory prior to the commencement of grouting works. One gauge for each range shall remain at the disposal of the Engineer, and the other shall be used by the Contractor for checking and calibration of working gauges. Working gauges shall be used for no longer than 2 shifts before being cleaned and recalibrated. All working gauges shall have reference numbers for identification, which shall be quoted in the grouting reports to be submitted to the Engineer.

10.7.5 CONNECTIONS TO GROUT HOLES AND PACKERS

1) Supply and return lines equipped with quick release couplings shall be able to withstand an internal pressure greater than the maximum produced by the pump. The internal diameter of the lines shall be such that no appreciable settlement of grout will take place when pumping at the minimum discharge capacity of the pump.
2) Valves shall be provided at the pump, in the supply line and at the collar of the hole being grouted. Suitable screens shall be incorporated in the supply line for removing oversize particles and foreign matter before injection into the grout hole.
3) Packers shall be the same as used for water-pressure testing as specified in the Section "Drilling and Water-Pressure Testing".

10.7.6 EMBEDDED PIPES AND FITTINGS FOR GROUTING

1) Standard mild steel pipes and fittings for grouting shall be set in the concrete as the Engineer may direct, or where shown on the Final and Construction Drawings. The pipes and fittings embedded in concrete shall be cleaned thoroughly of all dirt, grease, grout and mortar immediately before embedment and shall be firmly held in position and protected from damage or displacement while the concrete is being placed. A standard coupling and nipple wrapped to facilitate eventual removal shall be attached to the grout pipe where embedded in concrete. No portion of the pipe shall be allowed to remain within 50 mm of the concrete surface and the resulting recess, after removal of the pipe or fitting, shall be filled with dry-pack mortar.
2) “Tube-à-manchette" type pipe shall be provided by the Contractor for chemical grouting operations or where closing the gap between two different concrete stages caused by the shrinkage is required and as shown on the Construction Drawings. The pipe shall have an internal diameter of not less than 50 mm and shall be perforated every 30 to 40 cm. Each series of holes shall be covered by the rubber sleeve, called “manchette”, to allow the grout under pressure to flow out but not re-enter. In the drillhole the pipe shall be embedded by means of a cement-bentonite mixture which shall be injected into the space between the "Tube-à-manchette” and the temporary hole casing while this is being withdrawn. The grout supply pipe shall have a double packer to allow the grout to following out only from one series

of holes covered by the "manchette".

3) Care shall be taken to avoid premature blockage of pipes. Any pipe that becomes blocked before completion of operations shall be cleaned out in a satisfactory manner or replaced by the Contractor.

10.8 GROUTING OPERATIONS

10.8.1 GENERAL

1) All pressure grouting operations shall be carried out in the presence of the Engineer.
2) Should the Engineer deem necessary to carry out an additional grouting in any section of the Works, the Contractor shall reinstall the necessary equipment and perform the grouting to the satisfaction of the Engineer.

10.8.2 CURTAIN GROUTING

1) Curtain grouting shall be performed below the cut of trench of the dam, and as indicated on the Final and Construction Drawings and/or as directed by the Engineer. Hole depths, inclinations, sequence of grouting, method of grouting, whether single or multi stage, in ascending or descending arrangement will be adapted by the Engineer based on information from exploratory drilling or current operations. The holes shall be drilled and grouted by split spacing method.
2) The depth of the grout curtain shall be defined according to the results of the water pressure tests obtained in the primary holes.
3) All primary holes shall be pressure tested before grouting. Based on the results the Engineer determines the grout mix to be used at the beginning of grouting and the maximum pressure.
4) Normal sequence of grouting shall be ascending from bottom to top of hole in stages determined from water-pressure tests. Where the permeability exceeds 15-20 Lugeons, grouting shall generally be performed in descending arrangement.
5) When performing the multiple stage grouting in descending arrangement, the grout that is within the hole shall be removed from each stage except the deepest one, by washing, or by the use of a chopping or a “fishtail” bit before it takes a hard set.
6) Stage length shall be a maximum of 5 m.
7) Unless otherwise directed, air, wash water and grout pressures shall not exceed 2 bar plus 0.25 bar per linear meter of the depth measured from the collar of the hole to the bottom of the packer. Grout pressure shall not be released nor packers moved until the grout in each successive stage has achieved an initial set.
8) The curtain grouting shall be performed from one or several grout stations. If several such stations are used, each shall be equipped complete, with mixers, agitator sumps, pumps, gauges and measuring devices, and shall have a sufficient supply of grouting materials.
9) In case when the required pressure is not reached even when injecting maximum volume, the Engineer will decide whether the grouting will be interrupted, or the grout mixture is to be changed, or accelerator added.Where grout is found to be flowing from adjacent holes or cracks of any kind, such openings shall be capped temporarily by plugging or caulking. If this does not bring satisfactory results, further grouting shall be interrupted and the injected material let to harden.
10) Grouting injection will be deemed to be completed when the take has become 0.03 m3/m or less per stage of hole being grouted during 10 minutes at the specified grouting pressure and mixture.
11) After the conclusion of the grouting program, the Contractor shall drill control holes as stipulated in the Section "Drilling and Water Pressure Testing”. Unless otherwise directed, these control holes shall be drilled generally at a distance of 36 m. These holes shall be fill grouted. Based on the results obtained in the control holes, the Engineer may order additional grout holes or a new line of grout holes to be executed.

12) The general target of permeability of the grouted foundation is 5 Lugeons.

10.8.3 CLOSURE OF HOLES AND CLEAN-UP

Upon completion of grouting work each hole shall be filled with thick grout and connections not embedded in the concrete shall be removed.

10.8.4 CONTACT GROUTING BETWEEN CONCRETE AND EMBEDDED COMPONENTS

1) Grouting between concrete and embedded components shall not commence until the backfill concrete has been in place for at least 30 days.
2) Low pressure contact grouting shall be carried out until all voids are thoroughly filled. The maximum grouting pressure shall be 5 bar or as directed by the Engineer, and the Contractor shall ensure that the specified pressure is not exceeded.
3) Pre-tapped holes for grouting, complete with threaded steel plugs, will be provided by others in the steel components. The Contractor shall provide threaded pipes to protect the thread of the grouting holes during the drilling and grouting operation.
4) After completion of grouting, a knocking test shall be performed jointly by the Contractor and the Engineer to establish if contact grouting between the steel component and the concrete has been completely successful. If a "hollow" sound indicates the grouting to be incomplete, the Contractor shall re-grout, which may include the drilling, tapping and subsequent sealing of additional holes. All costs associated with regrouting, including those associated with the drilling, tapping and subsequent sealing of additional holes, shall be borne by the Contractor.
5) After successful completion of the grouting, the Contractor shall clean the threaded holes and screw the plugs back in position.

10.8.5 GROUTING OF CONTRACTION AND CONSTRUCTION JOINTS

1) All grout shall consist of neat cement/water mix. Cool water not exceeding 30°C shall be used in the mix to prevent quick setting of the grout.
2) Grouting of the joints shall be completed before the grout takes its set in the grout pipe system, but the joints shall not be grouted so rapidly that the grout will not settle in the joint. The time consumed for filling a joint shall be at least 30 minutes.
3) The grout shall be pumped into the bottom headers of the pipe system and the vent or highest headers shall be left open until the joint is filled with grout of proper consistency for retention in the joint. Thereupon the system shall be closed and the required pressure applied and held until the grout has set sufficiently to be retained in place.
4) Nipples in the exposed faces shall be removed and the holes filled with dry pack mortar.
5) Grouting of contraction and vertical construction joints may be specified by the Engineer at other concrete structures.

10.9 MEASUREMENT AND PAYMENT

10.9.1 GENERAL

1) The estimates of the quantities for grouting given in the Bill of Quantities are to be considered merely as a guide serving the Contractor to prepare his Bid and not as an accurate indication of the quantity of the work.
2) The quantities for each of the pay items will be varied to suit the conditions disclosed in the course of the work, and the Contractor shall not be entitled to any extra payment over and above the Unit Prices entered in the Bill of Quantities by reason of changes of the amount and length of holes to be grouted, amount of material absorbed, by reason of the location of the grouting required by the Engineer, or by reason of the timing of the grouting in relation to excavation, concrete or other works.
3) The unit prices stipulated herein shall include, but not be limited to, all labour, equipment, processing, mixing, hooking-up to the hole, injecting grout, hole closures and clearing up, and shall be independent of the volume or weight of materials injected. Where the multiple-stage grouting is employed, this item shall also include cleaning grout from the holes at the

completion of a grouting stage. If for a particular item no separate payment is made, it is intended that the relevant cost is included in one of the unit prices entered in the Bill of Quantities.

10.9.2 CONTACT GROUTING BETWEEN CONCRETE AND EMBEDDED COMPONENTS

1) Measurement for payment and payment will be of the number of holes (connections) injected with grout.
2) Payment will be made at the unit price entered in the Schedule in square meter, which shall include all labour, materials and equipment required for:
    a) Grouting valves where required
    b) Grouting materials, irrespective of the quantity actually taken
    c) Hook-ups to the grout holes and grouting operation
    d) Knocking test after completion of the grouting
    e) All repairs and finishing works to the surface after grouting.
3) Should re-grouting be necessary, all relevant costs, including those associated with the drilling, tapping and subsequent sealing of additional holes, shall be borne by the Contractor.

10.9.3 GROUTING OF CONTRACTION AND CONSTRUCTION JOINTS IN CONCRETE STRUCTURES

1) Measurement for payment and payment for grouting of contraction and construction joints in concrete structures will be based on the projected area of the joint obtained from the Construction Drawings.
2) Payment will be made at the unit price per square cubic meter entered in the Bill of Quantities, which shall include full compensation for furnishing all labour, materials, tools, equipment and incidentals for mix proportioning, injection, caulking of leaks, clean up, records and any other costs necessary for doing the work as specified in this Section, shown in the Final and Construction Drawings and/or directed by the Engineer.
3) Embedded pipes and fitting for the grouting of contracting and construction joints will be paid for separately, as detailed here below.

10.9.4 EMBEDDED STEEL PIPES AND FITTINGS

1) Measurement for payment for embedded steel pipes and fittings left permanently in place will be of the weight, regardless of pipe diameter. Payment will only be made for pipes which installation has been expressly ordered or approved by the Engineer or when shown on the Detailed Site Execution Drawings.
2) Payment will be made at the Unit Price per kilogram entered in the Bill of Quantities, which shall include the entire cost of supply, installation, and protection against blockage of pipes and fittings.

10.9.5 EXCLUSIONS

1) No extra measurement for payment or payment will be made for following:
    a) Preparation and testing of trial mixes
    b) Grouting materials used in mixture which has been prepared more than one hour prior to injecting or which have been lost due to improper handling or rejected due to improper mixing
    c) Supply and injection of water
    d) Plugging and caulking leaks during grouting
    e) Protection of drainage systems, if any, during grouting
    f) Communication facilities required during grouting
    g) Closure of the holes as specified and clean-up
    h) Preparation and submission of records and reports on grouting operations.

11 DAM EMBANKMENT CONSTRUCTION

11.1 SCOPE OF WORK

1) This section covers all labour, materials, equipment and services required in the construction of the DAM EMBANKMENT.
2) It does not refer to work on roads or other minor embankment works.
3) The embankment works shall be executed generally in accordance with the Drawings and this Technical Specification or as the Engineer may direct.
4) Particular attention is drawn to the PREAMBLE of this Technical Specification in respect to the selection of methods of construction and the modification to these following site testing and experiments.
5) In addition to any limitations on the gradings of the fill material or any compaction requirements which may be determined by site testing and experiments, the Engineer reserves the RIGHT TO MODIFY, during the progress of the work, any other features which he considers necessary for the proper performance of the completed works.
6) The approval given by the Engineer to the Contractor's plants and equipment or their operation, or of any construction methods shall not relieve the Contractor of his full responsibility for the proper and safe execution of Dam embankment works or any obligations under this Contract.

11.2 SUBMITTAL

11.2.1 SUBMITTALS BEFORE CONSTRUCTION

1) At least 60 days prior to the commencement of the embankment construction the Contractor shall submit to the Engineer for approval of the proposed quarry working method and results of trials and tests carried out at the quarry site.
2) During the progress of trial embankments and tests, the Contractor shall submit to the Engineer copies of all records and results of tests.
3) At least 30 days before starting the construction of dam embankment the Contractor shall submit for the Engineer's approval, a detailed CONSTRUCTION PROGRAMME and METHOD STATEMENT for the main dam embankment works.
4) Within 30 days from the date of issue of Notice to Commence and prior to the delivery of the compaction plant to the Site, the Contractor shall provide the Engineer with all the manufacturer's data, drawings, and computations to verify compliance with the specified compaction requirements. The characteristics and efficiency of this equipment shall be subject to the approval of the Engineer.

11.2.2 SUBMITTALS DURING CONSTRUCTION

1) To enable the Engineer to verify the condition of the prepared foundation surface, the Contractor shall notify the Engineer in writing, giving at least 7 days notice before the commencement of placing any embankment fill.
2) At least 7 days prior the commencement of placing of any filter layer the Contractor shall submit for Engineer's approval details of proposed materials source and methods of placing and compacting,

11.3 MATERIALS

11.3.1 GENERAL

The construction materials shall be taken from the quarries shown on the Detailed Design, from the excavation of the other structures or from other approved sources as directed by the Engineer.

Materials originating from excavation for Permanent or Temporary Works may also be used as fill materials, but only when such materials have been approved for such use and only within specified zones.

11.3.2 DAM BODY (CL/SC)

The principal material to be used in the construction of the dam shall comprise CL/SC material available from the plain of the dam site area.

Rejection by the Engineer may be made at the source, on the transporting vehicle, or in place.

Final acceptance of earth material will be made only after the materials have been dumped, spread and compacted in place.

The Contractor shall co-operate with the Engineer to ensure that only acceptable earth materials be hauled from the source to the work site.

The type of material and grading requirements for the embankment are described in the Tender Drawings and are separately described below.

The main body of the Dam shall comprise CL/SC material available from the plain of the dam site area or from other sources as directed and/or approved by the Engineer.

The selected material must be the following gradation:

Percentage passing	size (mm)
100	3 – 25
85	0.6 – 3.8
50	0.2 – 1.3
15	0.001 – 0.025

The material shall be compacted with not less than four full (4) passes of crawler-type tractor having a min. weight of 18 ton.

The minimum thickness of each layer will be not more of 0.3 m.

11.3.3 UPSTREAM DAM SURFACE (LARGE_STONE)

Upstream dam surface will be protected with stones. This material will be collected from the borrow areas, resulting from the crushing of the sound material.

The selected material must be the following gradation:

Percentage passing	size (mm)
100	460 – 950
85	340 – 700
50	260 - 530
15	170 - 370

The material shall be placed by excavator in order to obtain max interlocking.

11.3.4 COARSE FILTER (GW/GP)

Between upstream facing large stone and fine filter a transition material is present.

This material consists of GW/GP and will be collected from the quarry areas, resulting from the crushing of the sound material.

The selected material must be the following gradation:

Percentage passing	size (mm)
100	165 – 380

85	100 – 240
50	32 – 85
15	7 – 22

The material shall be compacted with not less than four full (4) passes of vibratory roller min. weight of 15 ton.

The minimum thickness of each layer will be not more of 0.4 m.

The design of coarse filter layer shall satisfy the following criteria and shall be subject to the Engineer's approval; calling with the apex B and F respectively the filter material and the base material, the criteria are:

a) PERMEABILITY CRITERION:

$$\frac{D^F_{15}\,\min}{D^B_{15}\,\max} \geq 5$$

b) RETENTION CRITERION:

$$\frac{D^F_{15}\,\max}{D^B_{85}\,\max} \leq 5$$

c) UNIFORMITY CRITERION OF THE FILTER:

$$1.5 \leq \frac{D^F_{60}}{D^F_{10}} \leq 8$$

d) The grain size curves of the filter and base material shall be roughly parallel;

e) Filter does not contain more than 5% of material finer than 0.074 mm after compaction.

The filter material shall be handled and placed in such a manner as to avoid segregation and mixing with foundation or backfill material.

11.3.5 FINE FILTER (SM/SC)

Between upstream dam body and coarse filter a transition material is present.

This material consists of SM/SC and will be collected from the quarry areas, resulting from the crushing of the sound material.

The selected material must be the following gradation:

Percentage passing	**size (mm)**
100	10 – 30
85	6 – 18
50	1.2 – 4.5
15	0.02 – 0.13

The material shall be compacted with not less than four full (4) passes of vibratory roller min. weight of 15 ton.

The minimum thickness of each layer will be not more of 0.4 m.

The design of coarse filter layer shall satisfy the following criteria and shall be subject to the Engineer's approval; calling with the apex B and F respectively the filter material and the base material, the criteria are:

a) PERMEABILITY CRITERION:

$$\frac{D^F_{15}\,\min}{D^B_{15}\,\max} \geq 5$$

b) RETENTION CRITERION:

$$\frac{D^F_{15}\text{max}}{D^B_{85}\text{max}} \leq 5$$

c) UNIFORMITY CRITERION OF THE FILTER:

$$1.5 \leq \frac{D^F_{60}}{D^F_{10}} \leq 8$$

d) The grain size curves of the filter and base material shall be roughly parallel;

e) Filter does not contain more than 5% of material finer than 0.074 mm after compaction.

The filter material shall be handled and placed in such a manner as to avoid segregation and mixing with foundation or backfill material.

11.3.6 BORROW / QUARRY OPERATIONS

The dam embankment materials shall be obtained by operating the borrows / quarries.

The operation of borrows / quarries shall generally be in accordance with requirements of Section 6, "Excavation and Filling" and particularly the specification in respect of blasting in that Section.

Before commencement of embankment construction, the Contractor shall carry out trials as specified at the designated quarry sites to ascertain the optimum methods for production of the earth fill materials.

The aim of the trials and tests shall be to establish an efficient system by which to produce fill material within the specification requirements with the minimum of additional treatment or screening and to minimize wastage.

As a result of such tests and trials the Contractor shall propose for the Engineer's approval a quarry working method. If approved, subject to any modifications required by the Engineer, this method shall become the standard operating procedure for the quarry and shall only be varied or changed by agreement with the Engineer.

The Contractor shall provide and maintain facilities at the quarry to enable the selection of any special grading of fill material for particular zones of the dam as specified herein and on the Drawings or as subsequently instructed by the Engineer. On completion of the Works the Contractor shall ensure that the quarry is left in a safe and tidy condition to the satisfaction of the Engineer.

11.3.7 ORGANIC MATTER

No organic matter shall be included in the dam construction and the Engineer reserves the right to reject complete loads of fill where the organic content is high or mixed with the fill so as to preclude satisfactory removal.

11.3.8 STOCKPILING OF EMBANKMENT MATERIALS

The Contractor shall stockpile embankment materials, graded or not, in such a manner as to fulfil the construction programme without delay.

The period, volume, location, etc. of the stockpiling, shall be in accordance with the requirements of Subsection 6.9 "Disposal of Excavated Material" of the Technical Specification and shall be entirely the Contractor's responsibility.

11.4 FOUNDATION PREPARATION

11.4.1 GENERAL

1) The foundation for the dam embankments shall be excavated generally in accordance with the requirements of the Section "Excavation and Filling"
2) All overhanging rock shall be detached by barring or wedging and all loose or semi detached blocks shall be removed from the foundation surfaces.
3) The exposed rock surface in the foundations shall be cleaned by means of water and/or air jetting and shall then be inspected by the Engineer. To assess the quality of foundations the

Engineer may require sampling and testing to be carried out on the material exposed in the foundations and the Contractor shall provide all facilities to assist the execution of such sampling and testing (see Section 14.8).

4) Where erodible material is exposed in the foundations, the surface will be compacted according to the Engineer's instructions and/or specially selected and graded material shall be placed over the area as directed by the Engineer to provide the filters as shown on the Detailed Design and/or Construction Drawings, specified herein (see subsection 14.3.2.5) and as directed by the Engineer.
5) In particular cases, e.g. faults, the removal of soft or decomposed material and surface protection by shotcrete may be directed by the Engineer.
6) Preparation of foundations shall include the provision of adequate drainage and dewatering to ensure sufficiently dry working conditions for the operations in progress.
7) The placing of fill to form the embankments may proceed only with the approval of the Engineer, which will be based on the condition of the foundation determined by inspection after the completion of all foundation preparation works. The Contractor shall be responsible for maintaining the foundation surfaces in the approved condition until they have been covered by fill material.

11.4.2 FOUNDATION FOR OTHER STRUCTURES

For the foundations for all structures and drainage pipelines within the dam embankment areas, the following special provisions shall apply:

- For the final stages of excavation within 1 m of the foundation levels and slopes, blasting will not be permitted.
- All abrupt irregularities to line and level shall be removed and graded out.
- Any cracks and joints in the exposed rock surface shall be cleared out to a depth of not less than three times their width at the surface. The cracks and joints shall then be filled with cement mortar grout pumped or thoroughly brushed to completely fill the voids.
- Depressions and holes or similar irregularities shall be filled with concrete or selected fill material as directed by the Engineer. The concrete or fill material shall be thoroughly compacted by vibration.
- Where such surface treatment occurs on steep slopes or areas of difficult access, gunite or shotcrete shall be used as the fill material after the cleaning of the surface asspecified.

11.5 PLACING

11.5.1 GENERAL

Placing of embankment materials shall be carried out according to the lines, slopes and level as shown on the Detailed Design and/or Construction Drawings or as directed by the Engineer. The setting out of the zone limits shall be performed by the Contractor and these limits shall be strictly observed. The Engineer reserves the right to modify these limits as well as make any other changes in the dam section as he may decide upon to optimise and/or expedite construction. The optimum thickness of layers to provide the required degree of compaction and the specified density of compacted fill shall be determined by the site tests and trials.

The placing methods shall be continuously reviewed by discussion between the Engineer and Contractor, with the Engineer reserving the right to subsequently modify any arrangements where this is considered necessary to optimise and/or expedite construction.

The two quality control tests which shall be carried out in situ during construction of the embankment are the following:

- density tests;
- Sieve Analysis.

The materials shall be placed in such a manner that the top surface of any section under construction shall remain approximately level.

The embankments shall be generally raised uniformly in horizontal layers, with variations in level within and between zones permitted only where essential for the progress of the work and approved by the Engineer.

11.5.2 WATER CONTENT

The optimal amount of water to be added will be decided on the basis of the site tests and trials.

11.5.3 INSTRUMENTATION

The requirements for instrumentation within the dam embankment are given in Section 15 of the Technical Specification and the location of the instrumentation is shown on the Detailed Design.

The Contractor shall make allowance, in his spreading and compacting operations, for the works of positioning of the instrumentation and any connecting cables and for avoiding any damage to this equipment during subsequent works.

11.6 TESTS AND QUALITY CONTROL

During the construction of the trial embankments and the main dam embankment, tests shall be carried out to measure the achievement of the specified requirements for all zones of the embankments.

All tests will be specified by the Engineer in advance with sufficient time for the Contractor to organise the appropriate equipment and personnel.

The standard tests to be performed shall be as follows:

Specific weight: measurement of the density of the material in the laboratory. 5 Samples per test.

Grading: the grading of soil material samples in the laboratory and production of grading curves.

Settlement: Measurement of settlement of layers in situ by topographic levels over a defined grid for each pass of compaction plant. Each test comprises a set of measurements for each layer and a report on results.

Field Density: excavation to the complete depth of the in situ layers of soil material, the measurement of the void volume by water contained by plastic sheet lining and the measurement of the weight of the removed soil material.

The frequency of the tests for each embankment shall be as follows:

TYPE OF TEST	NUMBER OF TESTS	
	Trial Embankments	Dam
Specific Weight	5	25
Grading	5	25
Settlement	5	every layer of zone 1 and zone 2
Density	5	75

11.7 TOLERANCE

The following tolerances to dimensions of the embankment shall be observed in respect of the finished works:

- Slope of upstream face, Zone 1: H:V ± 0.05:1
- Crest level (including camber): ±5 cm
- Maximum penetration of Zone 1 into Zone 2: 0.5 m in horizontal width

11.8 MEASUREMENT AND PAYMENT

11.8.1 TRIAL EMBANKMENT AND TESTS

No separate measurement or payment will be made for the trial embankments and standard tests.

The unit rates for the embankment fill materials shall include for all works on the trial embankments as specified, together with the regular measurement recording and standard testing as specified and the reinstatement of embankments after testing.

11.8.2 FOUNDATIONS

The preparation of foundations to the embankments shall be measured as the net area of surface prepared as specified and the payment under this item will be made at the Unit Price per square meter entered in the Bill of Quantities which shall include all the works necessary.

For the foundations at the cut off, walls and other structure, conduits, etc., the preparation as specified shall be measured by the net area of finished surface.

Any additional concrete or shotcrete shall be measured and paid for as similar work covered in Section “Concrete Work” and Section “Sprayed Concrete” respectively.

11.8.3 EXCAVATED MATERIALS

Where suitable material is obtained from excavations on the Works its use as fill will be measured separately by volume of such material placed and compacted in the embankment.

The payment for this item will be made at the Unit Price per cubic meter entered in the Bill of Quantities which shall include costs of excavations (where necessary) loading and transporting the material from the relevant excavation or disposal area and for its placing, spreading and compaction in the embankment as specified.

Any work of stockpiling of this material shall also be included for in the unit rates of the placed material.

11.8.4 EMBANKMENTS

The measurement of quantities of fill in the embankments shall be based on the agreed survey of the foundation area after its preparation to receive fill. The measurement of the embankments will be made to the specified lines.

The payment for embankment material shall be made on the basis of the net volume of compacted material in the embankments, placed in layers of thickness as specified, spread, water added when necessary and compacted to the required performance criteria, according to the Unit Prices per cubic meter entered in the Bill of Quantities for the following category of fill embankment.

The rates shall be deemed to include the entire cost of, but not limited to, the following:

a) the excavation at the specified borrows / quarries including blasting and any selection at the quarry face, stockpiling, crushing, screening, washing in order to obtain the required grading, together with all loading and transporting of the material to the embankments, and the disposal of waste, placing, spreading and compacting the material as specified herein and directed by the Engineer;
b) any disturbance to the placing and compaction works occasioned by the placing of the instrumentation system (see Section “Dam Instrumentation”);
c) all delays during embankment works resulting from placing of instrumentation system and carrying out of standard or special tests;
d) surveying, setting out, checking of embankment profile and alignment, and any subsequent rectification works resulting from undue or incorrect survey; provision of suitable equipment for, and delays due to carrying out this work.

11.8.5 EXCLUSIONS

No extra measurement for payment or payment will be made for the following:

a) extra work caused by Contractor's negligence;
b) all costs of dewatering and keeping the foundation surface dry;

c) surveys to verify the foundation area;
d) extra work or material required to repair damages to the final embankment surface caused by erosion or travel of the construction equipment;

Any additional work in areas where surface embankment has already been completed, which the Contractor may be directed by the Engineer to carry out, will be measured and paid for at the same Unit price entered in the Bill of Quantities as for the original item. No increase in Unit Price for such additional work will be allowed.

Any alteration or adjustment to the construction methods to be adopted following the results of site tests or trials, will not allow increasing the unit rates and price for the works unless it has been demonstrated that the relevant materials or conditions are significantly different from those that could have been foreseen at tender stage by an experienced Contractor (as defined in Conditions of Contract).

12 DAM INSTRUMENTATION

12.1 SCOPE OF WORK

The work to be done under this Section shall comprise the supply of all labour, materials and plant, except as provided herein, and the performance of all work necessary for supplying and installing instruments, as shown on the Detailed Design, as required by the Engineer and as specified herein.

The location of all instruments shall be as shown on the Detailed Design or as otherwise required by the Engineer.

12.2 SUPPLY

1) The instruments and equipment shall be assured to be of high quality, realized according to the best practice and according to international standards prescriptions. It shall be manufactured by well known reputable international company, with experience in large dam instrumentation.
2) All the instruments and equipment shall be subject to Engineer's acceptance procedure of inspection and testing at their arrival at dam site. The verification of the material shall be in accordance with the manufacturer's specifications.
3) Acceptance of the instrumentation devices (sensors, cabling and communication facilities) after installation, is to be subject of special procedures to be defined by the manufacturer/supplier and agreed with the Engineer. The proper functioning of every instrument, and satisfactory cabling and all connections to junction boxes, data loggers, computers and relevant identifications, is to be checked carefully. In case of malfunction the faulty instrument or connection shall be replaced.
4) Activities of supplying, testing, calibrating, installing and commissioning of the monitoring system shall be provided with by supplier's skilled and qualified personnel, under the Contractor's coordination.
5) All instruments and equipment shall be accompanied by documents providing the following information:
    a) Technical documentation (purpose of instrument, principle of measurement general characteristics and performances in terms of accuracy, sensitivity, range, etc., in compliance with these Technical Specifications).
    b) Proceeding for installation and use (list of materials and tools needed for installation, detailed procedure of installation, calibration, use and results interpretation of the instrument, measurement forms and files, etc.).
    c) Calculations and interpretation results (calibration curve, calculation formula and form, example of calculation).
    d) Acceptance and maintenance instructions (detailed proceedings of the instrument's acceptance, calibration and tests procedures, frequency of calibration where necessary, list of recommended spare, identification and description of possible failures, breakdown indicators, etc.).

12.3 INSTALLATION

1) All work in connection with the installation of instrumentation shall be done under the direct supervision of the Engineer. Every precaution shall be taken to ensure that installations are true and plumb and that the various instrumentation components are in no way damaged.
2) The Contractor shall protect all instruments and connections from damage and displacement during the progress of the work, and markers and barricades shall be provided as required by the Engineer. Any damage to, or displacement of, the instruments and connections shall be repaired immediately to the satisfaction of the Engineer, at no additional cost to the Employer.
3) Tubes shall be installed without joints in the maximum lengths practicable as determined by the Engineer and where necessary, splicing and coupling shall be performed in accordance with the

manufacturer's requirements. Open ends of all incomplete lines of tubing and casing shall be kept capped and the Contractor shall, at all times during installation, keep the insides of casing and tubes free from foreign matter. All tubing shall be flushed and pressure tested after installation of each section or joint, and prior to backfilling.

4) The methods and procedures for installation of instruments shall be in accordance with the various manufacturer's instructions and under the supervision of the supplier's representative.
5) Cabling installation shall be done where prescribed according to the manufacturer's requirements, disposing the cables in pits and galleries (where necessary encased in sleeve pipes) in safe and stable location.
6) Such works shall be carried out as and when required by the Engineer and in any stages as may be necessitated by the progress of the construction of the Dam embankment.
7) Instruments shall be provided, where necessary, with protective device against lightning and associated over voltage.

12.4 TYPE OF INSTRUMENTS

The instrumentation systems to monitor the behaviour of the Dam embankment and the reservoir levels will be as follows and the approximate quantity and probable locations are shown on the Detailed Design. This specification covers the supply, installation and/or construction of the dam safety instrumentation systems for the, dam embankment and their foundations, survey and water level recorder instrumentation.

For the purpose of this Contract, the following instrumentation shall be installed:

I. Weather station
II. Radar Level Meter
III. Reservoir water level staff
IV. Seepage flow weir.
V. Open standpipe piezometer
VI. Vibrating wire piezometer
VII. USBR settlement gauge
VIII. Inclinometer
IX. Target (Levels)
X. Automatic total station
XI. Meteorological Station
XII. River gauge and discharge station
XIII. Data acquisition units

I. WHETHER STATION

1) The Contractor shall be responsible for providing a fully equipped automatic weather station to be located within the drainage area subject to approval by the Engineer. The weather station shall be able to measure the following climate parameters:

(a) Rainfall and duration of storm
(b) Real time evaporation
(c) Real time ambient temperatures
(d) Maximum temperature
(e) Minimum temperature
(f) Real time wind speed and wind direction
(g) Real time humidity
(h) Real time pressure
(i) Cloud height.

2) Apart from the instrumentation requirements, the weather station will have to be provided

with the following:

(a) The weather station will receive power from a solar panel connected in parallel with rechargeable batteries. Solar output should be at its optimum for minimum 5 hours a day
(b) A mast minimum 10m high
(c) The weather station instruments will be provided with data loggers and will have the facility to be upgraded to send real time data to a central operations station
(d) The weather station instruments will be protected against lightning strikes
(e) The weather station will be fenced in by a 2 m high vandalized-free hot-dipped galvanized steel security palisade fence with a 1.0 m wide gate of similar height that can be locked with Chubb security lock. The fence will be constructed on a 300 mm wide x 400 mm deep Grade of reinforced concrete foundation. The foundation shall protrude 100 mm above the surrounding ground level. The palisade fence poles shall be of robust design and no member of the fence will have a thickness of less than 3.0 mm. The bottom of the palisades shall not be more than 50 mm above the concrete foundation. The plan dimensions of the fenced area and height will not negatively impact on the automatic weather station manufacturer's clear distance requirements for safe operation.
(f) All instrument read-out points will be housed in a properly designed structure of which the floor, roof and walls are all constructed with suitable Grade of concrete. The Contractor will be responsible for the design of the structures which shall be submitted to the Engineer for approval. These structures will all be provided with lockable Grade 304 stainless steel plate doors and frames.
(g) All enclosures to be the highest grade of stainless steel provided by the manufacturer.

3) The Contractor is required to submit a method statement to the Engineer, prior to commencement of this part of the works for the supply and installation of the automatic weather station in accordance with the above specification. This should include manufacturer's details, technical specifications a priced bill of quantities and drawings. The Engineer shall assess the method statement in conjunction with the Employer. The Contractor shall only proceed with construction upon approval by the Engineer.

II.RADAR LEVEL METER

Use:

A radar water level measurement device shall be installed in proximity of the spillway in the position shown in the Detailed Design and as directed by the Engineer.

Technical description:

The instrument must be connected to the Control Room for automatic data acquisition and transmission and must respect the following specifications:

- Measurement field : 20 m
- Feeding : 9,6-36 V
- Accuracy : $\pm$ 2 mm
- Sensitivity : 1 mm
- Temperature Range : -40° to 80°C
- Pressure Range : -1 to +2 bar

This instrument will be installed to measure the water level in the reservoir until the elevation +1359 msl. Below this elevation the water level in the reservoir will be measured by one piezometric water level measurement device.

PIEZOMETRIC WATER LEVEL MEASUREMENT DEVICE

Use:

One vibrating wire piezometer will be installed on the u/s dam face to measure the water level in the reservoir in the positions indicated in the Detailed Design and according to the Engineer's instructions on site. This device is able to measure the level when reservoir water level is below +1359 msl.

The instruments must be positioned in a suitable pit at a level lower than the minimum reservoir level so that they are always submerged and must be linked via cable to the data acquisition instrumentation situated on the dam crest for transmission and recording of data.

Technical description:

The vibrating wire piezometer shall have the following basic characteristics:

- Accuracy: ±0.5% Full Scale
- Resolution: 0.025% Full Scale
- Temperature Range: -20° to 80°C

III. RESERVOIR WATER LEVEL STAFFS

Use:

This instrument is aimed at indicating the reservoir levels by means of elevation direct reading on a sign.

The water level staffs must be installed as shown on the Detailed Design for optical reading of the water level in the reservoir.

The position of the water level staffs must allow the maximum visibility from several observation points and will be agreed together with the Engineer.

The Contractor shall ensure that the water level staffs are fixed in a solid manner to the Engineer's satisfaction.

Technical description:

Reservoir level measuring staff will be enameled iron plates 180 x 1000 mm (combined to obtain the total depth of the reservoir and suitably disposed to record the river tail water level) the elevation character will be 400 x 800 mm. with 100 mm resolution in height, and elevation marking each 2 m of elevation.

Staff Gauges shall be rust resistant, corrosion or discoloration from the water and any other environmental agent.

Staff Gauges shall be marked in metric units, with graduation marks every centimeter and showing every decimeter with alternate black and white 10 cm high bands. The staffs shall be located in places where water movement does not affect the level and where they can be easy read.

IV. V-NOTCH FLOW MEASUREMENT WEIR

Use:

The purpose of the weirs is to measure seepage water through the dam and from the foundations of the dam. Two (2) V-notch weirs shall be installed at downstream toe drain as indicated in the Drawings or as directed by the Engineer.

The flow measurement devices must be installed in respect of the following specifications and according to the Engineer's instructions on site.

Technical description:

It is composed by a movable sharp-edged stainless steel plate (about 450 x 600 mm) provided with a 30° or 90° triangular opening for low and medium flows, or with an upper rectangular opening for large flows, installed in the existing reinforced concrete manholes.

It is composed by a movable sharp-edged stainless steel plate (about 450 x 600 mm) provided

with a 30° or 90° triangular opening for low and medium flows, or with an upper rectangular opening for large flows, installed in the existing reinforced concrete manholes.
The plate slides into a milled guide, which is anchored by bolts to the drain gutter walls with the interposition of a rubber gasket to make the coupling water tight.
Otherwise, a steel frame is bolted to the drain gutter walls. On its upstream side, the frame is coupled with a rubber gasket: the plate is juxtaposed to the frame and water tightly anchored by clamps.
The V notch shall be removable, being equipped with a steel handle. According to the measurement volume it shall be possible to change the V-notch type (30° triangular shape, 90° triangular shape, rectangular shape) inserting it in the milled guide.
Graduated gauge staff are installed at each V-notch for water level measurements, as described at above.
The graduated gauge staff instrument shall allow the reading of the water level with ±1 millimeter accuracy.
The flow shall be then calculated from the u/s level readings.
The range of flow for which the instrument can work shall be provided by the supplier in the flow- level curve characteristic of the v-notch, and shall be at least:

- Min. Range: from 0 to 15 l/s (30° triangular shape)
- Min. Range: from 0 to 43 l/s. (90° triangular shape)
- Min. Range: from 0 to 120 l/s. (rectangular shape)

V. OPEN STANDPIPE PIEZOMETER

Use:

Twelve (12) standpipe piezometers shall be installed along the downstream the dam axis and in the downstream berms as shown in the drawings to measure and monitor the uplift pressures, seepage and the water table level.

Technical description:

The standpipe piezometer consist of a 100 mm diameter hole drilled by rotary drilling (with or without core recovery as instructed by the Engineer) until a depth of 15 m beneath the foundation level as instructed by the Engineer. The hole shall host a 54 mm diameter PVC pipe. The last 4 m of the PVC pipe shall be slotted and a layer of geotextile shall be applied around the slotted bottom pipe over a length of 4 m.
The space between the pipe and the hole shall be filled with a water cement grout with an expanding agent over the entire length except for the bottom 4 m where it shall be filled with sand. The Contractor should verify is the bottom of the hole is stable.
The pipe must be straightened and fitted inside the hole with extreme care so that the pipe is not bent, broken or damaged any way.
The depth of the sand should be measured and confirmed prior applying the grout.
After verifying that the pipe is installed properly and the sand has been applied to the correct depth, all to the Engineer's approval, a small quantity of the grout material should be applied. This amount of the grout must be allowed to initially set so that a proper seal is formed before applying the rest of the grout over the reminder of the hole's length. This will ensure that the grout will not penetrate the sand at the bottom of the hole.
To complete the installation a small concrete slab and a protective cap with a 3 way connector with 2 valves one of which is fitted with a manometer shall be foreseen.
In the case of any deviation from the process described above, the Contractor should, at his expanse, repeat the installation and construction process accordingly as specified herein subject to the Engineer's approval.
The Contractor shall execute extreme care during construction process so that the pipe or other apparatus are not damaged in any way.

The water level should be read by portable acoustic water level meter and automatically with a vibrating wire piezometer inserted in the standpipe. In case of the water is pressurized in the piezometer, the pressure will be measured by a manometer device.

VI. VIBRATING WIRE PIEZOMETER

Use:

For the observation of pore water pressures within the dam foundation, twelve (12) vibrating wire piezometer shall be installed in boreholes as shown in the Drawings or directed by the Engineer.

The requirements of this Specification include the supply of pore pressure meters with cables and ancillaries, the installation of the meters and cables during construction of the dam, the connection of the cables to the monitoring terminal and monitoring of the pore water pressures.

Vibrating wire piezometers shall be installed within the raised portion of the main embankment, within the foundation. Locations will be indicated on the drawings.

Technical description:

The VW piezometer consists of a vibrating wire sensing element enclosed in a protected stainless steel housing.

The sensing element shall be hermetically sealed.

The pressure cell shall be protected from surrounding material with a specific porous filter with openings of 0.02 mm.

All the parts of the sensing element, other than the wire, shall be made of stainless steel.

The VW shall be fitted with a surge protector and resistant to electrical and radio frequency interferences.

It shall be designed to withstand a max pressure of 10 bar (100 m water pressure) with an accuracy of ± 0.1 % F.S and resolution 0.025% F.S. Temperature Range -20° to 80°C.

The vibrating wire piezometers shall be installed in a slotted PVC pipe 60∅ 80 borehole at∅protected by a REPS type net in an appropriate/specified locations according to the drawings, and, where multiple installation is required, preferably in close but separated boreholes/places.

VII. USBR SETTLEMENT GAUGE

Use

Three (3) USBR settlement systems shall be installed in the dam embankment as shown in the drawings to measure and monitor settlement and deformation in the dam embankment.

The USBR settlement gauge must be installed in respect of the following specifications and according to the Engineer's instructions on site.

Measurement is performed using a special probe and its stainless steel tape graduated in centimetres, with precision vernier; measurement is facilitated by a suitable device with a winch.

The USBR settlement system is the most robust and reliable system for monitoring settlement during the construction phases of embankments.

Technical description:

The system is constituted by a column of tubes of two different diameters, partially inserted one into the other and able to slide like a telescope (it is constituted by an access pipe with telescopic sections). On the smaller diameter tube, steel profiles are anchored and fixed to the ground, these form the measuring point for each layer.

The system will consist of:

- Bottom element: tubular element in galvanized steel, blind, with bottom device for the recovery of the probe (standard Length =1.5m):;

- One head Element: Tubular element in stainless steel, complete with special head for the application of different measuring devices (standard Length = 1m)
- Intermediate Element: Two tubular elements in galvanized steel to form a column element with a length of 1.5 ÷ 1.7 m; other dimensions available on request
- USBR Probe: in stainless steel
- Dimensions:
  - Diameter = 35mm;
  - Length = 225mm
- Tape holder support: in steel and varnished and galvanized brass, complete with locking bush to the settlement column
- Measuring Tape: Stainless steel, L=50m or L=100m

VIII. INCLINOMETER

Use:

A total number of 3 inclinometers shall be installed in the embankment at each cross section as shown in drawings in order to monitor movements in the embankment.

The Inclinometer must be installed in respect of the following specifications and according to the Engineer's instructions on site.

The control system is generally composed of multiple IPI sensors, connected to each other via a single cable for the version with output signal, or with independent cables for the version with analogue output, inserted into an inclinometer column which forms the reference element and guide for the entire system.

Thanks to the pairs of guide wheels on the body of each instrument, the chain is lowered into the column, bringing the various sensors in the chain to the pre-established level.

The inclinometer column follows the ground's movements, consequently causing a change in inclination of the individual IPI sensors which automatically provide data revealing the deformation of the column.

Technical description:

The inclinometer shall have the following basic characteristics:

- Range:
  - X=Y=±15° (digital)
  - X=Y =± 5° or ±20 ° (analogue)
- No linearity : (digital) ±0.0125% f.s. (±0.002°) (0.03 mm/m)
- Diameter of the probe
  - 25.4 mm (digital)
  - 30 mm (analogue)
- Length of the probe
  - 710mm (digital)
  - 1400 mm (analogue)
- Weight of the probe : 1,2 Kg
- Material of the probe : Stainless steel
- Resolution of data : 0.001
- Accuracy : +/- 2mm for 25m
- Temperature : -40 up to 70 °C
- Type of the sensor : MEMS Accelerometer, biaxial type

IX. AUTOMATIC TOTAL STATION

Use:

One automatic totals station shall be foreseen to monitor the dam displacements with respect

to reference point located outside the dam. The system will be composed by:

- No. 1 automatic total station;
- About 28 targets installed on the dam crest and on the downstream face of the dam;
- No 1 concrete pillar downstream the dam.

All targets shall be installed on a concrete footing according to the Engineer instructions. An identification number and other details of the beacon will be inscribed on each concrete footing.

Bi reflex targets: A convergence bolt made of 12mm x 170 mm galvanized steel rebar with SS threaded stud shall be securely attached to the exposed rock or shortcrete surface. The bolt shall be provided with a plastic cap with a breaking point serving as an adopter for the mounting a reflector with a marked centre point. This device shall be designed for high precision measurements with two axis of rotation and to be observed from both sides. The manufacture accuracy must be better than +0.1mm to achieve an overall accuracy +/- 1mm within the measuring section.

Technical description:

- Angle measurement:
  - Accuracy: 0.5";
- Distance measurement:
  - Range 1.5 m to 3500m
  - Accuracy 0.6 mm + 1ppm
- Long Range Automatic Aiming (ATR):
  - Range ATR mode 1500/3000m
  - Accuracy 0.5";

X.DATA ACQUISITION UNITS

1) All instruments or sensors shall maintain the ability to be read manually or by portable Data Acquisition Units before entering the network.
2) Where necessary, according to design drawings and manufacturer's instructions, the automated instruments shall be provided with:
   - data base management computers and software
   - power supply
   - measurements records communication and transmission systems
3) The instrumentation supply shall include, where necessary, the whole set of cabling (individual cables to de-centralized data loggers, communication cables, power supply cables), that shall be provided in order to assure a proper, durable and safe connection and functioning according to the manufacturer's requirements and to the international standards prescriptions.
4) The connection, where required, shall be extended up to the control panel dedicated to the visualization and acquisition of all records.
5) The layout and disposition of the control panels and relevant connection systems (supply, communication and transmission) shall be fixed by the Contractor according to the type of the measurements and to the manufacturer's instructions, taking into account the need of reliable and easy control and elaboration of the acquired data, to monitor in good time the dam stability.
6) A specific automated data acquisition system (ADAS) shall be installed before the impounding of the dam for the following measurements:
   - Piezometers
   - Water level indicator and data loggers
   - Reservoir level recorder
   - Meteo Station

7) This automated system will have a central network monitoring station to manage the field system, collect and store the data in electronic format, print the data and relevant graphs, and provide an external communication interface.
8) Cabling for this system will be installed through dam galleries and shafts up to reaching the location where the acquisition units will be installed.

12.5 USE OF INSTRUMENTS

1) The Contractor shall take records of the data to be obtained from all the instruments to monitor the behaviour of the Works during the construction, impounding and commissioning periods.
2) During the construction period it shall be possible to monitor the data recorded by the instruments already installed, collecting and gathering the data directly at instrument's location by means of portable PC and/or portable devices.
3) Type of records, duration (continuous or spot measurements), filing and elaboration of all the measurements shall be defined by the Contractor in the Operation and Maintenance Manual of the Plant, in compliance with the manufacturer's instructions.

12.6 MEASUREMENT AND PAYMENT

1) Measurement for payment of the Dam Instrumentation shall be made by number of the particular instrument installed as shown on the Drawings and as directed by the Engineer.
2) Payment for the Dam Instrumentation shall cover purchase, delivery to Site, installation in accordance with suppliers instruction and protection until completion of the maintenance period, and payment will be made at the Unit Price for the following items entered in the Bill of Quantities.
3) Any services by the Contractor, on the instructions of the Engineer, for using the instrumentation systems and recording results shall be deemed to be included in the payments for operation of the Site Testing Laboratory.

13 ROAD WORKS

13.1 GENERAL

1) The dam site area is accessible from Mbarara by a road of 90 km approximately length. The first 65 Km stretch is the road Mbarara-Kikagati, which is paved and in fair conditions and seems indicated for heavy vehicle traffic. The remaining 25 Km, from the branch out from the main road Mbarara-Kikagati, must be rehabilitated. The road shall be enlarged and stabilized in order to transport heavy construction materials and machineries.
2) The Contractor must build a permanent road approximately 2 km long, including the access to the dam site, to the management's camp, to the raw pumping stations and the road running from the dam site to North on the left side of the river, about 190 m, and inundated by the reservoir.
3) The Contractor must also build the additional temporary roads that he deems necessary, and maintain the road system for the entire duration of the works.

13.2 PERMANENT ROADS

13.2.1 GENERAL

1) Permanent roads relevant to this Contract are shown on the Detailed Design and include:
    a) the access Road to the dam, coming from the junction with the Mbarara-Kikagati road in proximity of the Kikagati;
    b) the access road to the management's camp and to the raw pumping stations.
2) The Contractor shall:
    a) build the permanent road which connects the dam, the management's camp and the raw pumping stations
    b) rehabilitate to the road reaching the dam and appurtenances structures from Mbarara- Kikagati road;
    c) build the temporary roads deemed necessary for the execution of the works;
    d) maintain these roads for the entire duration of the work.
3) The detailed design of the additional permanent roads shall be prepared by the Contractor, on the basis of general arrangement drawings shown on the Detailed Design and submitted to the Engineer for approval.

13.2.2 SCOPE OF WORK

1) This section covers all labour, materials, equipment and services required for the construction of the permanent roads.
2) Work related to the roads, such as excavation, culverts, drain ditches, retaining walls, slope protection etc. is covered by the respective sections of these Specifications.
3) Work for the pavement construction shall include the following elements:
    a) Excavations and construction of the road embankment
    b) Construction of sub-base
    c) Construction of base course

13.2.3 CONSTRUCTION MATERIAL SOURCES

1) The materials for sub-base and base course shall be obtained from the excavation of the works and from the approved borrow and quarry areas. Materials shall be composed of hard, dense, durable particles in conformity with the quality specified for concrete aggregates.
2) All sub-base and base materials shall be approved by the Engineer.

13.2.4 SUB-BASE MATERIAL

1) The material shall meet the following grade requirements:

US Standard Sieve	Percentage by Weight Passing
3"	100

2½	90-100
No.4	35-70
No.200	0-20

2) If the material does not contain a sufficient quantity of natural cementitious material to bond readily under the action of traffic, there shall be added to, and incorporated in it, a binder consisting of rock screening or other cementitious materials. The sources from where the binder will be obtained, together with the method to be used for adding it to the sub-base material, will be approved by the Engineer.

13.2.5 BASE COURSE MATERIAL

1) The material shall meet the following grade requirements:

US Standard Sieve	Percentage by Weight Passing
1½	100
3/4	50-75
No.4	25-50
No.200	0-12

2) If the material does not contain a sufficient quantity of natural cementitious material the Contractor shall add a binder as previously specified for the sub-base.

13.2.6 SUB-GRADE PREPARATION AND COMPACTION

1) The areas to be covered with aggregate shall be carefully cleaned so that no objectionable material shall be incorporated in the future aggregate course.
2) If necessary, the surface which will be in contact with the aggregate course shall be so treated as to fill the fissures, cavities, pockets, hollows and depressions.
3) The sub-grade shall be made to conform to prescribed lines and grades, and the loose material for a thickness of 30 cm shall be compacted to 95% of the maximum dry density, or as directed by the Engineer.

13.2.7 PLACING

1) The surfacing materials shall be spread on the prepared sub-grade to such depth that, when thoroughly compacted, it will conform to the prescribed grades and dimensions. Segregation of coarse and fine particles shall be avoided, and any segregation material shall be remixed by harrowing and blading.
2) The depositing and spreading of the material shall start at the point nearest to the point of loading and the Contractor shall route the hauling equipment over the surfacing material already in place and shall distribute the travel evenly over the entire width of the surfacing so as to distribute the compacting effect of the equipment.
3) The hauling and spreading shall be accompanied by blading and/or dragging, and the surfacing shall be free from corrugations and waves. If necessary, to produce proper compaction, water shall be incorporated with the surfacing material, either at the source or after it is spread on the roadway, at the option of the Contractor.
4) The method of incorporating water in the surfacing material shall be subject to the approval of the Engineer.
5) Immediately following final spreading and grading, each layer shall be compacted to full width by means of smooth wheel power rollers or pneumatic tired rollers.
6) The compaction corresponding to each layer of compacted sub-base and base material shall not be less than obtained with 5 complete passes of a smooth-wheel vibrating roller of 8 tons minimum weight.

7) Rolling shall progress gradually from the sides to the center, and shall continue until the whole surface has been rolled. Any irregularities or depressions that develop shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform. Along curbs, header and walls and at all places not accessible to the roller the base material shall be tamped thoroughly with mechanical tampers.

13.3 MAINTENANCE

1) The Contractor shall be responsible for the maintenance of all permanent and temporary roads on the Site that he will construct or improve until the completion of the Works.
2) The Contractor shall maintain the roads in such a way that the surface never has undulations, hollows ruts or other damages which limit the speed of the vehicles.
3) Unpaved roads shall be frequently sprayed with water during the dry weather season to prevent the formation of dust clouds.

13.4 TEMPORARY ROADS

1) The Contractor shall design, construct and maintain all temporary roads, bridges, parking areas and other access facilities within the site that he deems necessary for the construction of the Works, including all borrow, quarry and stockpile areas. Where necessary, the roads shall be wide enough to allow heavyweight traffic in both directions. To prevent excessive erosion, no steeper longitudinal slopes than 10% shall be designed, except when specifically approved by the Engineer.
2) Except where rock is encountered, the back slopes of cut banks shall be stable and compatible with existing topography, and shall be flattened and rounded as far as practicable into natural ground surface.
3) The Contractor shall construct suitable drainage structures in sufficient numbers to prevent accumulation of excessive water and erosions along the roadways.
4) Roads shall be frequently sprayed with water during the dry weather season to prevent the formation of dust clouds. Site roads shall be graded as necessary to ensure a firm and even surface.
5) Upon Completion of Works the temporary construction roads shall be turned over to the Employer. Those roads which the Employer does not choose to keep shall be made impassable to vehicular traffic and the surfaces shall be scarified and left in a condition which will facilitate growth of natural vegetation, removing the granular material, if any.

13.5 MEASUREMENT AND PAYMENT

13.5.1 PERMANENT ROADS CONSTRUCTION

13.5.1.1 Earthmoving and Structures

1) Measurement and payment for the clearing, grubbing, excavation, fills, backfill, concrete works, culverts, supports and slope protections will be made in accordance with the corresponding sections of these Specifications.
2) All costs of de-watering and keeping the sub-grade surface dry during construction will be included in the unit price for excavation.
3) No extra payment will be made for the preparation of the sub-grade and protection or maintaining excavated surfaces in satisfactory conditions until the sub-base is placed, and the cost thereof shall be deemed to be included in the unit prices for the materials to be placed upon it.

13.5.1.2 Sub-base and Base Course

1) Measurement for payment of sub-base and base granular material, including that for shoulders, will be of the in-situ volume of the material placed and compacted.
2) Payment will be made at the appropriate unit prices per cubic meter entered in the Bill of Quantities, which shall include the entire cost of, but not limited to, the following:

a) Excavation in the borrow and quarry areas including all clearing, grubbing and stripping in, and trimming, levelling and draining thereof, as stipulated in the Section "Excavation and Filling"
b) Provision of all labour, equipment and materials required for the preparation, segregating, grading, blending and mixing, wetting or drying of the materials in order to obtain the required gradation, moisture content and other properties
c) Loading the materials in the borrow and quarry areas, processing plants, or in stockpiles including any rehandling of suitable materials from the required excavations
d) Transport of materials from the source to the final location
e) Provision of all labour, equipment and materials required for the placing, spreading, compacting watering or reduction of the water content as needed of the materials
f) Quality control and performance of tests as required
g) Surveying, setting-out, checking of profile and alignment, and any subsequent rectification works resulting from undue or incorrect surveys, provision of suitable equipment for, and delays due to carrying out this work.

13.5.1.3 Exclusions

No extra payment will be made for the following:

a) Extra work caused by the Contractor's negligence in setting out the structures and slopes
b) Rectification, removal and replacement of the materials which during the placement or afterwards have been contaminated with foreign matters, mixed with unsuitable materials, or lost due to erosion
c) Extra work or material required to repair damages to the temporary or final surfaces caused by erosion or travel of the construction equipment
d) Stockpiling, rehandling, reloading and transport of materials which cannot be directly placed in the final locations after being excavated
e) Damages to concrete structures caused by Contractor's operations
f) Additional passes of the compacting equipment ordered by the Engineer if he determines that a higher degree of compaction than specified is required.

13.5.2 PERMANENT ROADS MAINTENANCE

Payment for permanent road maintenance will be made at the unit price entered in the Bill of Quantities per month, which shall cover all labour, construction equipment and materials for satisfactorily maintain all roads.

13.5.3 TEMPORARY ROADS CONSTRUCTION

1) Payment for construction of the temporary roads will be made as Lump Sum entered in the Bill of Quantities, which shall cover all labour, construction equipment and materials for carrying out all necessary works.
2) Payment of the Lump Sum will be made according to the actual construction progress obtained dividing the total amount by the total length shown on the Contractors approved drawings and multiplying for the works done in the month corresponding to the statement of account.

13.5.4 TEMPORARY ROADS MAINTENANCE

1) Payment for maintenance of the Temporary Roads will be made at the Lump Sum entered in the Bill of Quantities, which shall cover all labour, construction equipment and materials.
2) Payment of the Lump Sum for maintenance will be made in equal monthly installments for each of the month during which the facility is maintained by the Contractor according to the Contractor's approved detailed construction schedule. Each monthly installment will be calculated as the total Lump Sum divided by the number of months of maintenance according to the Contractor's approved construction schedule.
3) In the event that the Contractor is entitled to an extension of time for the Completion of Works, the payment will continue at the same rate per month as stipulated above.

14 MISCELLANEOUS and ANCILLARY WORKS

14.1 SCOPE OF WORK

This section covers all labour, materials, equipment and services required for the following Miscellaneous items necessary for minor construction works and finishing:

- Roofing
- Plastering
- Painting
- Flooring and Tiling
- Windows and Doors
- Ceilings
- Plumbing
- Electrical System
- Water Treatment Plant
- Demolitions of structures
- Non-shrink grout for the installation of permanent equipment where shown on the Drawings

14.2 ROOFING

The works covered by this sub section shall include the complete delivery of materials, their temporary storage and protection on Site and the execution of all roofing together with ancillary works.

The climatic conditions on Site shall be taken into account with regard to wind force, impermeability and corrosion protection.

Roofing work by means of corrugated steel sheets shall be carried out as shown on the Drawing or as directed by the Engineer.

Supports to steel sheet roofing shall be in steel, either in the form of trusses or beams.

14.3 PLASTERING

The work covered by this sub section shall include the supply and storage of all materials and the execution of the plastering work, its protection and final cleaning up as indicated on the Construction Drawings, or as directed by the Engineer.

The completed work shall be covered and kept damp until final setting has taken place.

The required mortar shall be mixed from clean aggregates, free of organic matter, and first quality building lime with an admixture of cement, or shall consist of pure cement mortar, as required.

Mixed mortar shall be stiff and shall not flow from the trowel. Prepared mortar which is not immediately applied cannot be used again and shall be rejected.

The materials of mortars shall be measured out in their correct proportions and shall first be thoroughly mixed together in a dry state until they are of a homogeneous appearance in consistency and colour.

Clean water shall then be added while the mixture is being turned over until it attains a suitable consistency.

Mixing by hand will be allowed only if the Engineer gives specific approval. Mixing by machine, using the same sequence of operations described above shall be carried out whenever possible.

Surfaces to receive plaster shall be properly cleaned and the surfaces shall be moderately wetted shortly before applying plaster.

All internal plastering shall be finished to an even and polished surface with a float, trowel or other suitable tool, special care being taken to obtain perfectly smooth and glazed faces.

Finished plaster work with cracks, blisters, discolouration or similar defects will not be accepted and shall be removed and replaced to the Engineer's satisfaction.

Patching of defective surfaces shall only be carried out with prior approval of the Engineer.

Windows, doors, their frames and glazing, floors, fittings, and all other building components shall be protected against soiling and damage before starting plastering.

14.4 PAINTING

14.4.1 GENERAL

The works covered by this sub section shall include the supply and storage of all material and the application of all paint work as shown on the Construction Drawings or as directed by the Engineer, including protection and finish painting of metal surfaces, except those metal surface specified under the Technical Specifications for Permanent Equipment supplied by others.

All interior surfaces of ceilings and interior and exterior surfaces of walls shall be painted as shown on the Detailed Drawings or as directed by the Engineer.

The Contractor shall provide all labour, materials, supplies, equipment and scaffolding to perform all operations necessary to complete the work.

All painting work shall be applied strictly in accordance with the Manufacturer’s instructions and only under favourable atmospheric conditions.

Paint shall be delivered in undamaged original containers bearing the Manufacturer's trademark, colour, instructions for storage, handling and application. Paint shall be kept in closed original containers until used.

The Contractor may choose the method for paint applying (manual or spraying) but a skillful performance shall be guaranteed, excluding soiling of adjacent parts. Where damage due to spraying may occur, paint shall be hand applied.

The Engineer may direct the method to be used to achieve the required results to his satisfaction. Surfaces to be painted shall be thoroughly cleaned and be dry before applying any paint. Metal parts shall be cleaned of rust by sandblasting where directed by the Engineer. Previously primed surfaces, soiled with oil or grease shall be cleaned without affecting the quality of the primer.

14.4.2 MATERIALS

1) The painting materials shall be of quality as available from CARBOLINE COMPANY (USA), or KELLER (Switzerland), or SIKKENS (Holland) or an equally qualified supplier.
2) Colour of paints shall be in accordance with the colour schemes selected by the Engineer. Exact tones of the colour selected shall be in accordance with the samples supplied and applied on test areas in the Works approved by the Engineer.
3) All paint materials shall be delivered to the Site in their original containers, with labels intact and seals unbroken. All paints shall be of well known registered brands.
4) All tinting colours and thinning materials shall be of the same brand as the oil paint specified for the particular area. Tinting colours for oil paint shall be colours-in ground in pure linseed oil for the best grade.
5) With the exception of ready mixed materials in original containers, all mixing shall be done at the Site.
6) The Contractor is responsible to ensure that the storage and handling of paint material complies with the requirements of pertinent codes and fire regulations. Proper containers placed outside of the building shall be provided and used for painting wastes, which shall be properly disposed of or removed from the premises at the close of each days work. No plumbing fixture shall be used for this purpose.

14.4.3 PREPARATION OF SURFACES

1) Concrete and masonry work shall be left to cure for one month and any surface defects repaired before painting.

2) Cracks, holes and other defects in plaster shall be filled or patched with an approved filling compound. The filling shall finish flush with and in the same plane as the adjoining surface. Where patches in cement plaster are required, the surfaces shall be coated with an approved bonding agent, the defects filled with an approved mortar mix for patching, and the patched areas finished to match the texture of the cement plaster. Plaster surfaces that will be painted for the first time shall be uniformly coated with a solution composed of 1 kg of zinc sulphate to 41 of water, to which shall be added 28 g of dry sienna to each 41 of zinc sulphate solutions, 24 hours after application of the zinc sulphate solution, the surfaces shall be thoroughly washed with clear water and allowed to dry thoroughly.
3) Metal welds and blisters shall be ground and sanded smooth, pits and dents filled and imperfections corrected so as to leave a smooth surface.
4) Metal surfaces to be painted shall be clean and thoroughly dry before painting. Prior to painting, black steel surfaces shall be sand-blasted down to rust degree SA 2-112 according to SIS-standard 055 900, to remove all mill scale, weld splatter, rust and any other deleterious material. Oil and grease shall be removed by an approved solvent. The surface shall be wiped clean of any dust prior to priming.
5) The Contractor shall be responsible for and shall rectify any surface finish which in the opinion of the Engineer is unsatisfactory to receive paint.

14.4.4 WORKMANSHIP

1) All paint shall be applied by brush unless spray painting or other method is specifically approved by the Engineer.
2) Material shall be applied in accordance with the manufacturers printed directions. Any thinning that may be required shall be added only with the approval of the Engineer and then with an approved type of thinner and in the amount recommended by the paint manufacturer.
3) One liter of paint as originally supplied by the manufacturer shall not cover a greater area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of additional coat(s). Application on masonry surfaces may vary according to surface texture but in no case shall the manufacturers coverage rate be exceeded. On porous surfaces, it shall be the Contractor's responsibility to achieve a finish comparable to the manufacturers coverage rate by decreasing the coverage or applying additional coats of paint.
4) Painting shall be equal in quality to the samples as submitted to and approved by the Engineer.
5) The Contractor shall remove all lighting fixtures, including canopies, surface hardware and similar items before painting, safely store them and replace them when painting is complete. Dripped, spilled or splattered paint shall be cleaned up promptly. Drop cloths shall be laid to completely cover flooring and all other work items during painting, and shall remain in position until the paint work is dry, finished and inspected.
6) The premises shall at the times be kept free from an accumulation of waste material and rubbish. On completion of the painting, all tools, scaffolding and surplus materials shall be removed from and about the building, ready for inspection by the Engineer.
7) Any primer or finish applied on steel surfaces that shows signs of rusting, flaking, powdering or peeling, shall be sand-blasted to remove the paint bare to the metal and repainted.

14.4.5 PAINTING SCHEDULE

1) Prime shall consist of one coat unless otherwise specified. Finish shall consist of two coats unless otherwise specified.
2) The following paints shall be applied, unless otherwise shown on the Drawings or directed by the Engineer.
    a) Steel works (not galvanized):
    Primer: inorganic zinc based on zinc silicates with good resistance to acid and alkalis TDFT (*) >=60 microns

Finish: epoxy-polyamide with good resistance to acid and alkalis TDFT >=250 microns

b) Steelworks (galvanized):
Solvent: modified neoprene adhesive or equivalent solvent TDFT>=20 microns
Primer: inorganic zinc based on zine silicates with good resistance to acid and alkalis TDFT >= 60 microns.
Finish: epoxy-polyamide with good resistance to acid and alkalis TDFT >= 250 microns

c) Interior doors:
Primer: alkyd based resin TDFT >=80 microns Finish: alkyd based enamel TDFT>= 200 microns

d) Acid Resistant Paint:
Primer: epoxy-polyamide with very good resistance to acid TDFT >=125 microns

e) Indoor Concrete and Plaster:
Primer: impregnation compatible with finish
Finish: water resistant acrylic resin. Consumption=approx. 220 g/m2

f) Outdoor Concrete and Plaster:
Primer: impregnation compatible with finish
Finish: water resistant acrylic resin specific for outdoor. Consumption = approx. 250 g/m2.

(*) Total Dry Film Thickness

14.5 FLOORING AND TILING

The works in this sub section shall include the supply of all materials for, and all finishing and covering works to floors and walls, together with incidental preparatory work and ancillary items asdescribed.

Before applying cement finish to already hardened or cured concrete slabs, the surfaces shall be thoroughly cleaned of all rubbish, concrete and mortar droppings. Oil and grease soiled parts shall be cleaned with oil removing agents.

For a good bond, surfaces shall be rough and where necessary they shall be roughened either by sandblasting or by chipping, followed by a complete removal of all detached particles of concrete and dust. The surface shall be washed thoroughly with water under pressure and be kept wet for 24 hours prior to placing the concrete finish, but no free water shall remain on the surface during placing of surfacing.

Cement finishes shall be carried out perfectly level or sloped towards drains, in accordance with the Construction Drawings.

A bonding course of pasty, rich cement mortar scrubbing shall be applied with a stiff brush prior to placing the cement surfacing on the cleaned, roughened and wetted concrete surfaces.

Before the applied mortar has thickened appreciably, the top course shall be added, tamped or rolled and levelled to the required thickness and slope. The surface shall be tested for high or low spots, which shall be levelled.

Surfaces shall be smooth, have a dense finish and be free from defects and blemishes.

All cement floor finishes shall be protected from damage, especially that due to quick drying. Floors shall be covered completely with clean, airtight, impermeable coverings such as plastic sheets to prevent against a quick loss of moisture. During curing time (minimum 2 weeks), no use shall be made of the floor.

Surfaces to receive P.V.C. tile work shall have a floated finish, perfectly smooth and level.

Where cement finishes are to be carried out with a tile like pattern, the Engineer will indicate the exact layout of lines in situ.

Ceramic tiles or single fired tiles shall be laid on walls and floors in the bathrooms and

kitchens.
P.V.C. tiles shall be laid in other rooms, corridors etc.
Tiles shall be of first class quality, perfect in shape and colour.
Samples of all tiles must be submitted to the Engineer for approval, whereafter no changes shall be introduced.
The surface on which the single fired, ceramic and "gres'' tiles are to be laid shall be thoroughly cleaned and all traces of building materials removed and the surface shall then be thoroughly wetted with water before the screed is laid.
Joints of single fired tiles on floors shall be pointed with lean grey Portland cement, unless otherwise specified by the Engineer.
Ceramic tiles for walls shall be glazed and shall by supplied with the necessary corners, channels and ends together with all matched special units, such as soap dishes, brackets for towel bars and glass shelves, toilet paper holders, etc.
Joints shall be pointed with white lean Portland cement.
Wall tiles shall fit perfectly around all pipes. Connections to all sanitary appliances must be well arranged and be neatly carried out.
P.V.C. tiles shall be laid strictly in accordance with the Manufacturer's recommendations for the specific material and be glued only with the appropriate recommended glues.
Finished floor covering shall not contract or expand nor warp, or become detached. Completed floor coverings shall be thoroughly protected against soiling and damage.
Samples of proposed materials shall be submitted to the Engineer for approval in advance of any ordering of material.

14.6 WINDOWS AND DOORS

The works covered in this sub section shall include the supply and erection of the windows and doors as described and in the locations shown on the Final and/or Construction Drawings, together with their relevant hardware and glazing.
The Contractor shall verify the exact dimensions of each item before ordering and shall supply for the Engineer's approval full details including, where necessary, drawings of each item, components and fixing arrangements.
Durable packing and protection shall be provided to prevent damage during transportation and handling up to delivery to the Site of all the materials.
The windows and doors shall be in accordance with their description on the Detailed Drawings.
All windows and doors and their fixtures and fittings shall be carefully handled and stored on Site prior to erection. They shall be stored within an enclosed storage building and covered to protect them from all weather conditions. They shall be supported to prevent bending or twisting stresses.
Holes in structures for embedding the anchors of frames shall be carried out by the Contractor, and care shall be taken not to damage any finished surroundings.
All door frames shall have a minimum of two anchor fixings on each side of the door opening, but the distance between fixing points shall not exceed 400 mm.
Windows and doors shall open as indicated on the Detailed Drawings and/or schedules.
Joints between walls and window and door frames and between the frames and windows and doors shall be perfectly airtight.
All surfaces shall be smooth and crack free.
All windows and doors shall be rigid and safe against warping. When closed, all windows and doors shall fit perfectly.
All glazing shall be performed by skilled workmen. The Contractor shall strictly follow the details indicated on the Drawings, or, if none exist, shall prepare his own working details and have them approved by the Engineer.
Glass panes shall nowhere be rigidly fixed. They shall be set on supports in such a way that their

weight will be well distributed and no warping can occur which would impair the operation of windows and doors.

Glass pane edges shall nowhere touch the framework.

Exterior glazing shall resist wind pressure and weathering and be set rainproof and airtight.

Only heavy-duty standard-type hardware, well resistant to humidity (rustproof), shall be used for windows and doors.

A sample of each type shall previously be approved by the Engineer. Ready-installed hardware shall be well protected against damage.

All windows and door frames shall be fitted with mosquito netting.

14.7 CEILINGS

The works covered by this subsection include the supply and erection of suspended ceilings as shown on the Construction Drawings, including all ancillary works.

The required detailed drawings shall be provided by the Contractor, following his check of all measurements on site. Any discrepancies shall be referred to the Engineer for confirmation before commencing with the work.

Hangers, fasteners and other assembling means shall be chosen according to type and weight of the material to be suspended or fixed.

14.8 PLUMBING

The Works covered by this sub section include the supply and installation of pipes, appliances and ancillary fittings and equipment for the complete water supply from the elevated water tank, and sanitary drainage systems to septic tanks.

Prior to acceptance, the systems shall be tested to above normal working pressures and conditions, and any defects or leakages shall be rectified.

Local rules and regulations for the installation of plumbing and the quality of materials shall be observed.

The hot and cold water systems shall be constructed in accordance with the shown on the Construction Drawings or as directed by the Engineer.

Hot and cold water pipes shall be of adequate size to serve the sanitary units concerned.

Pipes shall be fitted with clips, plugged and screwed to walls or built into plaster or other surfacing as specified by the Engineer.

The sanitary drainage system shall be constructed in accordance with the layout, shown on the Construction Drawings or as directed by the Engineer.

Pipes for the conveyance of sewage and wastes shall be obtained from an approved manufacturer. The pipes and fittings shall be fixed to walls using correctly sized brackets and clips of a type designed for the purpose, and all fixings shall be at sufficiently close centres as to prevent any deflection of the pipe resulting in a back-fall in the pipe.

Connections to water closets and floor mounted soil fittings shall be made using the correct sized socket for the outlet of the fitting.

All pipework for water supply and drainage shall be firmly fixed and supported to resist movement under internal pressure.

Pipes passing through walls and floor slabs shall be protected with sleeve pipes and proper insulation. There shall be no direct contact between wall or floor and the pipe. The insulation wrapping shall allow for free movement of the pipeline.

Plumbing installations shall be complete, with hand basins, sinks, W.C. units, water heaters and showers, as shown on the Drawings or as directed by the Engineer.

A sewerage system shall be provided to collect all foul drainage in septic tanks and soak-aways in accordance with the Drawings prepared by the Contractor and approved by the Engineer.

14.9 ELECTRICAL SYSTEMS

The works covered by this sub section shall include the supply and installation of all materials and equipment necessary for the proper and efficient operation of the electrical systems specified herein, as indicated in the Bill of Quantities, as shown on the Contractor's Construction Drawings or as directed by the Engineer on Site.

The works shall be executed in accordance with local regulations.

14.10 WATER SUPPLY PLANT

The water supply plant will provide drinking water and service water to the Sites of Installations. The Contractor shall submit for the Engineer's approval the detailed drawings for the entire plant and details of the proposed treatment plant for drinking water.

The water supply plant will generally comprise:

- one submersible pump to be installed upstream of the diversion works at a lower than the minimum river level, with a discharge greater than 1 litre/sec, head greater than 45 m and power about 1 HP (0.75 kW);
- elevated water tank, in concrete, steel or glass-fibre, divided into two sections for service water and drinking water and comprising all necessary pipelines and valves;
- a steel pipeline, of at least 2" diam., complete with bends, valves, vents, etc. necessary for the supply of water to the elevated water tank situated near the Installations;
- system allowing automatic or manual operation of the pump;
- water treatment plant with a capacity of 20 to 40 m3/day. The treatment process shall be principally electrical. Any chemicals shall be commercially available in Uganda and of a type with a shelf life of at least 5 years.
- the plant shall be complete with all accessories necessary to guarantee state-of-the-art automatic operation.

14.11 REQUIRED DEMOLITIONS

14.11.1 GENERAL

1) Demolition works refer to plain concrete and reinforced concrete.
2) The works under this paragraph shall concern the structures to be demolished by written instruction of the Engineer due to changes of the original design.

14.11.2 EXECUTION METHOD

3) Demolitions shall be carried out with hammers and/or hand held type paving breakers unless different approval by the Engineer.
4) Demolition works shall be performed in an orderly manner and the Contractor shall take any necessary precaution and measure to avoid damage to adjacent structures as well as to prevent dust, labour accidents and minimize interference with the activities of others contractors.
5) Materials resulting from demolition works shall be disposed of as specified for the unloading of excavated materials in these Specifications.

14.12 NON-SHRINK GROUT

14.12.1 GENERAL

1) The non-shrink grout shall consist of a special compound formulated with catalyzed metallic fine-elements, water reducing agents and other components which, by producing a void-filling action, completely overcomes any shrinkage which may be caused by water evaporating from the grout.
2) The grout shall be used for bearing plate beds, blockouts, filling of recesses and the like, second stage fillings and similar works shown in the Drawings or directed by the Engineer in connection with the installation of the Permanent Equipment.

14.12.2 MATERIAL AND PLACING

1) The mixture shall be composed of one (1) part of non-shrink compound, one (1) part of Portland cement, one (1) part of sand or fine gravel (8 mm max size) and sufficient water for obtaining a self-leveling mortar.
2) The non-shrink compound shall be the Kemox-B produced by Sika, or equivalent material approved by the Engineer.
3) Mixing and placing of the grout shall be in accordance with the instructions supplied by the manufacturer of the compound and/or by the Engineer.

14.13 MEASUREMENT AND PAYMENT

14.13.1 ROOFING

Measurement for payment for roofing will be of the horizontal projected area of finished roof. Payment will be made at the Unit Price per square meter entered in the Bill of Quantities which will include the supply and placing of all materials.

Gutters and corner pieces will be measured by length including gutter ends and slip joints. Downpipes, elbows and bends will be measured by length along the centre line of finished pipe.

The rates for payment shall include all cutting and jointing and wasted materials.

These rates shall also include the extra cost of bends and fittings together with all brackets and fixings.

14.13.2 PLASTERING

Measurement for payment for plastering will be of the area of finished work regardless of the kind of surface, height and extension to which coatings are applied.

Payment will be made at the Unit Price per square metre entered in the Bill of Quantities, which will include for all materials and activities necessary for the work. No additional payment will be granted for scaffolding.

Openings of an area less than 1 m2 will not be deducted from measured areas. No separate measurement will be made for joints, returns, rounded-off corners, forming of square corners and similar kinds of finishing to plastering.

14.13.3 PAINTING

Payment for paintwork will be made at the Unit Price per square meter entered in the Bill of Quantities, according to the following provisions:

1. No direct payment will be made for furnishing and applying paint for steel works and wooden elements, the entire cost of this work being include in the Unit Prices entered for the various items in the Schedule.
2. Measurement for payment for painting works on plaster and concrete will be based on the area covered with the paint of the required type.
3. Payment of painting works on plaster and concrete will be made at the appropriate Unit Price per square meter entered in the Schedule, which shall also include material supply, surface preparation, scaffoldings, application and protections and completion of the finishes
4. The rates shall also include for the supply to the Employer's store on Site of 1% of eachtype and colour of paint, supplied in un-opened containers.

14.13.4 FLOORING AND TILING

Measurement for payment for all floor finishes, tiling and floor coverings will be of the net area of completed work for each material.

Payment will be made at the Unit Price per square metre entered in the Bill of Quantities. Openings of less than 0.10 m2 will not be deducted.

The rates for payment of the items for floor finishes, tiling and floor coverings shall include for all materials and fixings, fitting to corners and edges, cutting and jointing and for all wasted materials. 0.5% of each flooring material, but a minimum of 1 m2 shall be supplied as spare material and the rates for measured items shall include for such.

14.13.5 WINDOWS AND DOORS

Measurement for payment of windows and doors will be by Unit Price per square meter entered in the Bill of Quantities.

Unit prices shall include all glazing, required fittings and miscellaneous material. 10% of each particular type and size of glass pane, but minimum one full pane, shall be supplied as spare material and the rates for the measured items shall include for such.

14.13.6 CEILINGS

Measurement for payment of ceiling work will be of the net surface area of the finished work. Payment will be made at the Unit Price entered in the Bill of Quantities which shall include all material for suspending and fixing of ceilings, as well as all wall connections and material for setting-in of electrical appliances, joint covers, cutting and adapting the material to shapes and dimensions and for any wasted materials.

As spare parts, 2% of each type of ceiling material, but minimum one full panel, shall be supplied and the rates for measured items shall include for such.

14.13.7 PLUMBING

Pipelines supply and installation, including appliances and ancillary fittings, bends, valves, all fixing and connection material, labels, etc., will be paid in relation to the net installed pipeline length.

Items such as W.C., Wash Basins, Showers etc., will be paid per supplied and installed unit. Payment will be made at the Unit Price entered in the Bill of Quantities.

The rates of payment for pipework and appliances and equipment shall include for all pipe fittings (bends, valves, etc.) and fixings and the insulation and protection as specified.

The rates shall also include for testing of the pipework and appliances to the appropriate pressure and conditions.

14.13.8 ELECTRICAL SYSTEM

Payment for the supply and installation of the electrical system as indicated on the Construction Drawings, performed by the Contractor and approved by the Engineer, will be made at the lump sum amount entered in the Bill of Quantities.

14.13.9 WATER SUPPLY PLANT

Payment for the supply and installation of the Water Supply Plant as indicated on the Drawings will be made at the lump sum amount entered in the Bill of Quantities.

14.13.10 REQUIRED DEMOLITIONS

1. Measurement for payment for required demolitions will be based on the in-place volume obtained from the Engineer's instructions.
2. Payment will be made at the appropriate Unit Price per cubic meter entered in the Bill of Quantities, which shall also include re-steel cutting and transport of resulting material to spoil areas.

14.13.11 NON-SHRINK GROUT

1. Measurement for payment for non-shrink grout will be based on the volume obtained from the Drawings.
2. Payment will be made at the appropriate Unit Price per cubic meter entered in the Bill of Quantities, which shall also include material supply, mixing, surface preparation, placing and formworks.