3-2-D-2-8 *Wet Weather Concreting*

Concreting during periods of constant rain shall not be permitted unless aggregate stockpiles, mixers and transporting equipment, and the areas to be concreted are adequately covered.

During showery weather, the Contractor shall ensure that work can be concluded at short notice by the provision of stop ends. On no account shall work be terminated before each section, between one stop end and another is complete. Adequate covering shall be provided to protect newly placed concrete from the rain.

3-2-D-2-9 *Cold Weather and Night Concreting*

No concrete shall be mixed, placed or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated and such night work is approved by the Engineer.

Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches five (5) degrees C. When directed by the Engineer, the Contractor shall enclose the structure in such a way that the concrete and air within the enclosures can be kept above fifteen (15) degrees C for a period of seven (7) days after placing the concrete. The Contractor shall supply such heating apparatus as stoves, salamanders or steam equipment and the necessary fuel. When dry heat is used, means of maintaining atmospheric moisture shall be provided.

When directed by the Engineer, all aggregates or mixing water or both, shall be heated to a temperature of at least ten (10) degrees C, but nor more than twenty-one (21) degrees C the aggregates may be heated by steam or dry heat.

The temperature of the concrete shall be not less than fifteen (15) degrees C at the time of placing in the forms. In case of extremely low temperature, the Engineer may, at his discretion, raise the minimum limiting temperature for work, aggregates and mixed concrete. Salt, chemicals or other material shall not be used to prevent freezing.

3-2-D-2-10 *Joints*

3-2-D-2-10-1 *Construction Joints*

Wherever the work of placing concrete is delayed until the concrete shall have taken its initial set, the point of stopping shall be deemed a construction joint. So far, the location of construction joints shall be as shown on the plans, but if not shown on the plans, they shall be planned in advance and the placing of concrete carried continuously from joint to joint. The joints shall be perpendicular to the principal lines of stress and in general be located at points of minimum shear.

Where dowels, reinforcing bars or other adequate ties are not required by the plans, keys shall be made by embedding water-soaked beveled timbers in soft concrete. The key shall be sized as shown on the details, or as directed by the Engineer, which shall be removed when the concrete has set. In resuming the Work the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance or other soft material with stiff wire brushes and if deemed necessary by the Engineer, shall be roughened with a steel tool. The surface shall then be thoroughly washed with clean water and painted with a thick coat of neat cement mortar, after which the concreting may proceed.

3-2-D-2-10-2 Expansion Joints

Expansion joints shall be constructed at the locations of the materials and to the dimensions shown on the plans.

Preformed expansion joint filler for concrete, bituminous type conforming to AASHTO M33 shall be placed in the joint. The joint filler shall cover the full depth minus the thickness required to place the bituminous putty at each joint. One face of the filler shall be held rigidly in place against the face of the concrete previously cast, while fresh concrete is placed against other face of the filler.

3-2-D-2-10-3 Contraction Joints

Contraction joints shall be constructed at the locations, of the materials and to the dimensions shown on the Plans or as directed by the Engineer.

3-2-D-2-10-4 Cold Joints

When the continuous placement of concrete in any structural member is interrupted or delayed, for any reason, for a period long enough for the previously partially placed concrete to take its initial set, the Engineer shall declare such joint a cold joint and the Contractor shall immediately remove the previously partially placed concrete from the forms. No extra payment will be made for the initial placement or the removal of concrete which is wasted because of a cold joint. The Engineer may suspend all or any part of subsequent concrete Work until he deems the Contractor has corrected the cause of the cold joint occurrence.

3-2-D-2-11 Holes, Cavities and Fixing

Holes shall be accurately marked and boxed-out for before concreting operations commence. No holes shall be formed after the concrete has set. Where bars, if placed to specified spacing would foul holes of size less than 250 mm x 250 mm. The full length of the bar shall be moved to one side unless otherwise indicated on the Drawings. For holes exceeding 250 mm x 250 mm, the bars shall be cut on site and lapped with additional equivalent bars.

Wherever possible, the Contractor shall build in all pipe work, Ironwork, and steelwork which passes through walls and floors. The pipe work, ironwork, and steelwork shall first be thoroughly cleaned and freed from any deleterious matter. Every care shall be taken to ensure that it is thoroughly encased in concrete.

Bolts, hooks and other fixings shall be embedded in concrete, or holes shall be drilled and fitted with threaded expanding anchors to receive the bolts. The Contractor shall ensure that bolts, hooks and fixings are accurately positioned Holding down bolts for machinery shall be set to template.

Where brick or stonework is to form a facing to the concrete or where the end of a brick or stone wall butts against a concrete face, galvanized metal ties of approved manufacture to BS 1243 shall be incorporated.

3-2-D-2-12 *Finishing*

All top surfaces, such as the top of retaining walls, curbs, abutments, rails, etc., shall be treated by tamping and floating with a wooden float in such a manner as to flush the mortar to the surface and provide a uniform surface, free from pits or porous places. The surface thus obtained shall be troweled to produce a smooth surface and brushed lightly with a damp brush to remove the glazed surface.

Unless otherwise shown on the Drawings, all exposed concrete surfaces shall be smooth finish with epoxy paint and shall be free from honey-combing, fins, projections and air-holes. After removal of the forms, the Contractor, at his own expense, shall make good faulty surfaces by filling them with cement and sand (1/2 by vol.) mortar and rubbing them with a fine carborundum stone.

Immediately after the curing period, the Contractor shall repair all minor shrinkage cracks identified by the Engineer. Repairs shall be made as directed by the Engineer using an approved water resistant, high modulus low viscosity epoxy.

Unless otherwise provided on the plans, all true and even surfaces, obtained by use of a form lining, which are of a uniform color, free from stone pockets, honeycomb, excessive depressions or projections beyond the surface shall be considered as acceptable surfaces and a rubbed surface finish will not be required, except as follows:

The above provisions for surface finish shall not preclude requiring the use of a dry carborundum brick for straightening molding lines, removing fins, etc., or requiring a rubbed surface finish on all portions of the structure which do not present an acceptable surface even though a form lining is used.

3-2-D-2-13 *Curing and Protection*

All concrete shall be cured for a period of time required to obtain the full specified strength, but not less than seven (7) consecutive days beginning immediately after placement. Curing shall be done according to one of the following pertaining methods:

3-2-D-2-13-1 *Water Curing*

All surfaces, unless sealed by metal forms or submerged, shall be water cured including those surfaces which have previously had liquid curing membrane applied. For construction joints or other surfaces where no liquid membrane is specified, water curing shall begin within one (1) hour of placement. Where liquid membrane is placed, water curing shall begin within four (4) hours of placement.

For structure decks and slabs, the Contractor shall provide sufficient water and equipment to keep the surface of the concrete continually damp until the membrane curing is applied. The water shall be applied with a nozzle that so atomizes the flow that a mist and not a spray is formed. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

Surfaces to be water cured shall be covered with wet sand, cotton mats, double thickness burlap or other equivalent absorbent material. The absorbent material shall cover the concrete surface completely. The material shall be completely saturated with water and kept continuously saturated throughout the curing period. After initial saturation, all surfaces shall be covered with polyethylene sheeting meeting requirements of ASTM C-171 or other approved impervious material. The sheeting shall be weighted or secured to prevent moisture loss. However, the

surfaces of the concrete shall be readily available for inspection of the Engineer. The sheeting shall be in good repair. Sheeting that contains holes or is otherwise damaged shall be rejected by the Engineer. The Contractor shall be responsible for thoroughly inspecting and monitoring the concrete surfaces throughout the curing period. Additional water shall be added to any areas which are not still saturated. Inspections by the Contractor shall be conducted at least twice per day for the duration of the curing period and more often if ordered by the Engineer. The Engineer shall be advised of the inspection schedule and may accompany the workman to verify the acceptability of curing.

3-2-D-2-13-2 Membrane Curing

Except for construction joints and surfaces sealed by metal forms, liquid membrane shall be used as follows:

On wood formed vertical surfaces, forms shall be stripped as soon as practical and liquid curing membrane applied immediately except that those areas being rubbed or finished during the curing period shall be kept wet until finishing is complete when clear liquid curing membrane shall be uniformly applied.

On metal formed surfaces, with or without wood lining, liquid curing membrane shall be applied if the Contractor elects to strip the forms within the curing period.

The curing membrane used shall be in accordance with the requirements specified for curing membrane material, AASHTO M 148 Type 1-D. The curing membrane shall be applied in two (2) applications. The rate of each application of curing compound will be -as prescribed by the Engineer with a spreading rate per application of one (1) liter of liquid per five (5) square meters of concrete surface. If the concrete is dry or becomes dry, it shall be thoroughly wet with water and the curing compound applied just as the surface film of water disappears. During curing operations, any unsprayed surfaces shall be kept wet with water. Any curing membrane material on construction joints and/or reinforcing steel shall be completely removed before the following concrete pour.

Hand operated spraying equipment shall be capable of supplying a constant and uniform pressure to provide uniform and adequate distribution of the curing membrane at the rates required. The curing compound shall be thoroughly mixed at all times during usage.

No traffic of any kind will be permitted on the curing membrane until the curing period is completed, unless the Engineer permits the placement of concrete in adjacent sections in which case the damaged areas shall be immediately repaired as directed.

3-2-D-2-13-3 Cold Weather-Curing

When concrete is being placed in cold weather, it shall be placed in accordance with the requirements provided in section "Cold weather and night concreting".

When concrete is being placed and the air temperature may be expected to drop below five (5) degrees C, during the curing period, the Contractor shall provide suitable measures such as straw, additional burlap, or other suitable blanketing materials and/or housing and artificial heat curing to maintain the concrete temperature between ten (10) degrees C and thirty-two (32) degrees C as measured on the surface of the concrete. The surface of the concrete shall be kept moist by the use of an approved moisture barrier such as wet burlap or polyethylene sheeting. The moisture barrier shall be maintained in intimate contact with the concrete during the entire curing period. After the completion of the required curing period, the Contractor shall remove the curing and protection in such a manner that rapid cooling of the concrete will be prevented.

When concrete is placed in cofferdams and subsequently flooded with ground water, the above curing conditions may be waived providing the surface of the water is not permitted to freeze.

3-2-D-2-13-4 Steam Curing

Precast concrete members shall be cured for not less than seven (7) days by water or by steam curing, at the option of the Contractor. Steam curing for precast members shall conform to the following provisions:

After placement of the concrete, members shall be held for a minimum four (4) hours presteaming period. If the ambient air temperature is below ten (10) degrees Celsius, steam shall be applied during the presteaming period to hold the air surrounding the member at a temperature between ten (10) degrees and thirty-two (32) degrees Celsius.

To prevent moisture loss on exposed surfaces during the presteaming period, members shall be covered as soon as possible after casting or the exposed surfaces shall be kept wet by fog spray or wet blankets.

Enclosures for steam curing shall allow free circulation of steam about the member and shall be constructed to contain the live steam with a minimum moisture loss. The use of tarpaulins or similar flexible covers will be permitted, provided they are kept in good repair and secured in such a manner to prevent the loss of steam and moisture.

Steam at the jets shall be low pressure and in a saturated condition. Steam jets shall not impinge directly on the concrete, test cylinders, or forms. During application of the steam, the temperature rise within the enclosure shall not exceed five (5) degrees C per hour. The curing temperature throughout the enclosure shall not exceed sixty-five (65) degrees C and shall be maintained at a constant level for a sufficient time necessary to develop the required transfer strength. Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where temperature is representative of the average temperature of the enclosure.

Temperature recording devices that will provide an accurate continuous permanent record of the curing temperature shall be provided. A minimum of one temperature recording device per sixty (60) meters of continuous bed length will be required for checking temperature.

Members in pretension beds shall be detensioned immediately after the termination of steam curing while the concrete and forms are still warm or the temperature under the enclosure shall be maintained over fifteen (15) degrees C until the stress is transferred to the concrete.

Curing of precast concrete will be considered complete after termination of the steam curing cycle.

All newly placed concrete for precast concrete piles, both conventionally reinforced and prestressed, shall be cured by steam as provided above except that piles with a designation of "Corrosion Resistant" shall be kept continuously wet for their entire length for a period of not less than seven (7) days including the holding and steam curing periods.

3-2-D-2-14 Making Good

The cement mortar used in filling recesses in the concrete formed by hobbins in connection with formwork shall contain an approved expanding admixture.

3-2-E PRECAST CONCRETE

3-2-E-1 PRECAST CONCRETE

This section includes the work for furnishing and installing precast concrete structures. Reinforcement shall be in accordance with detail shown on plans.

Precast concrete units shall be manufactured with air-entrained concrete. The maximum size of aggregate shall be 1.9 cm. The minimum cement content shall be 350 kilograms of cement per cubic meter of concrete. The final finish surface shall be smooth. Precast units shall be true to line, plane and dimensions in accordance with the following special requirements:

3-2-E-1-1 Plant Requirements

The units shall be manufactured in an approved area or enclosed building under the Engineer's control and inspection with guaranteed provision to meet the requirements for curing and protecting the concrete as specified.

3-2-E-1-2 Forms

Metal of tight rigid construction, true to shape, and with smooth finish shall be used.

The forms shall be oiled in any approved manner. Re-use of old, worn, or misshapen forms, will not be allowed.

3-2-E-1-3 Vibration

Vibrators shall be provided and used as directed by the Engineer. Prolonged vibration shall be avoided in order to prevent surface finish susceptible to crazing. Units showing surface checking or crazing will be rejected.

3-2-E-1-4 Protection and Curing

The units shall be cured either by steam or water for a sufficient length of time for the concrete to obtain the minimum compressive strength.

3-2-E-1-4-1 Steam Curing

Two to four hours after the concrete has been placed and attained the initial set, the first application of steam shall be made. Forms shall be removed after the units have been steam cured for 24 hours.

The steam shall be at 100% relative humidity to provide moisture for proper hydration of cement. The steam shall be directly applied onto the concrete. During application of steam the ambient temperature shall increase at the rate not to exceed 4.4° C per hour until a minimum temperature of 54° C is reached.

When discontinuing the steam application, the ambient temperature shall be decreased at the rate of 4.4° C per hour until a temperature of -6.7° C above the atmospheric temperature has been attained. The concrete shall not be exposed to temperature below freezing for a minimum of 6 days after casting.

3-2-E-1-4-2 Water Curing

The units may be water cured with water, saturated material or other acceptable or approved methods that will keep the units moist for a period of 5 days. Under no condition will the use of curing compounds be permitted.

Concrete delivered in outside temperature lower than 4.4° C shall arrive at work having a temperature not less than 15.6° C nor greater than 32.2° C. Water and aggregates shall be heated if necessary but the water shall not be heated above 60° C. The use of direct heating torch in mixer shall not be approved.

3-2-E-1-4-2-1 Testing and Sampling

Representative test specimens of the concrete shall be taken by the Engineer. No precast units will be shipped to the project until the test specimen cured show a compressive strength equal or superior to the concrete type required strength.

3-2-E-1-4-2-2 Inspection

All precast units shall be subject to inspection at the point of manufacture and any units showing defects or damage before the completion of the project shall be removed and replaced at the expense of the Contractor.

3-2-F SAMPLING & TESTING

3-2-F-1 GENERAL REQUIREMENTS

3-2-F-1-1 Sampling & Testing

All concrete, aggregate, cement and water shall be sampled and tested during construction as frequently as deemed necessary by the Engineer. All test samples shall be supplied by the Contractor at his expense. Samples shall be obtained in accordance with AASHTO T 23, T 141, T 2, T 127 and T 26. All costs connected with manufacturer's Certificates of Guarantee, laboratory analysis and all subsequent testing for material acceptance shall be borne by the Contractor

The Contractor shall provide on the Site equipment, staff and labor for carrying out the sampling and testing and he shall carry out any or all of these tests at such times and with such frequency as may be requested by the Engineer.

All equipment shall be calibrated and checked from time to time as the Engineer may require. The

Contractor shall provide all samples required by the Engineer. Those samples to be tested in an off site laboratory shall be carefully forwarded by the Contractor to an approved laboratory. Results of laboratory and site tests shall be kept on site and copies of all test reports shall be forwarded in duplicate to the Engineer.

Frequency of tests and the number of samples required will be governed by the results of the previous tests the quality of the materials revealed during the tests and the uniformity of that quality. Should it become evident that the quality of concrete is deteriorating the Engineer may require additional samples to be taken and test cylinders to be made and tested to determine the cause.

3-2-F-1-2 *Quality Control*

Compliance with the specified characteristic strength shall be based on tests on cylinders at an age of 28 days. For major structures the frequency of sampling shall be initially three samples taken each day for five days of concreting and thereafter at a frequency of one sample per 10m³ of concrete but not less than one sample for each day concreting.

For minor structures the frequency of sampling shall be one sample per 20 m³ but not less than one sample for each day concreting. For mass concrete works and concrete works at pipeline appurtenances sampling shall be at on average of one sample per 50 m³.

A minimum of 3 test cylindres shall be made from each sample.

Where materials are of an unfamiliar grading or type, or where directed by the Engineer compression tests shall be carried out at 7 days and adjustments made in advance of the main control methods outlined above.

Cylinders test results will be examined individually in 10 consecutive sets of four and the standard deviation and mean strength of each set calculated. The concrete mix proportions will only be acceptable if all of the following requirements are complied with:

i. Not more than two results in 40 are less than the characteristic crushing strength.
ii. No value of the average for any set of four results is less than the characteristic strength plus one-half of the design margin.
iii. When 40 results have been obtained and the mean strength and standard deviation are calculated, the mean strength minus 1.64 times the standard deviation shall be greater than the characteristic strength.

Where the results do not conform to the above requirements the following action shall be taken:

Adjustments to the mix shall be made to obtain the strength required.

In the case where any result is less than 80° of the characteristic strength, the structural implications shall be considered and action taken as ordered by the Engineer.

For those Prescribed Mixes required to be tested, requirements (i) and (ii) only still be applicable.

3-2-F-1-3 *Concrete Compression Tests*

The Engineer will make and cure the cylinders from concrete as mixed for the work, which will be tested in accordance with AASHTO T 22 after seven (7) and twenty-eight (28) days. Test specimens shall be made and cured in accordance with AASHTO T 23. These specimens will be the basis for acceptance of the concrete in the structure.

They also provide means for checking the adequacy for laboratory mixture proportions for strength. If the average of the strength tests of the specimens falls below the minimum allowable compressive strength at seven (7) or twenty-eight (28) days, the concrete mix shall be redesigned. In the determination of the average compressive strength of the specimens, no cylinder specimen shall have a strength less than eighty-five (85) percent of the allowable strength.

The Engineer will take a total of four (4) cylinders from each day's run of concrete at each structure site. Two (2) cylinders will be for the seven (7) day test and two (2) cylinders for the twenty-eight (28) day test. All four (4) specimens are to be taken from the same batch. The Contractor shall give the Engineer full cooperation and, when requested by the Engineer, labor assistance in preparing the cylinders. When directed by the Engineer, the Contractor shall transport the cylinders from the structure site to the laboratory.

The Engineer may make additional test cylinders to ascertain the effectiveness of the methods by which the structure is being cured and also to determine when the structure may be placed in service.

These cylinders shall be cured in the field in the same manner as the concrete placed in the structure, and the Contractor shall protect the cylinders from all damage.

The Contractor shall take every precaution to prevent injury to the test cylinders during handling, transporting and storing. He will be held solely responsible for any test failures caused by improper handling and transportation, or any other cause which may be detrimental to the test cylinder.

In order that the test cylinders may be transported from field to laboratory undamaged, the Contractor shall provide a minimum of two (2) approved metal boxes. [One (1) for the Contractor's use and one (1) for the Engineer's use.] Boxes shall be of such size to receive a minimum of six *(6)* test cylinders and leave space for sawdust packing around all surfaces of the cylinders. Boxes shall be approved by the Engineer. The Contractor shall, when directed by the Engineer, provide as many additional boxes as may be required by the remoteness and/or magnitude of the concrete work.

When test cylinders fail to meet minimum strength requirements, the Engineer may require core samples to be taken to determine the acceptability of such structures. The contractor shall, at his own expense, furnish all equipment required for such core samples.

3-2-F-1-4 Loading Tests

The Engineer may permit that a loading test be made on the works or any part thereof for one or more of the following reasons:

Failure of "Site Cylinders" to attain the strength requirements. Premature

removal of formwork.

Overloading of structure during construction.

Improper compaction and/or curing of concrete.

Any other circumstances attributable to alleged negligence on the part of the Contractor, which, in the opinion of the Engineer, may result in a structure being of less than the required strength.

If the results of the test are not satisfactory, the Engineer will direct that the part of the work concerned be taken down or removed and reconstructed to comply with the Specification, or that such other remedial measures as he may think fit be taken to make the work acceptable.

The Engineer may instruct the Contractor to take out cylindrical core specimens from the structures concerned and have them tested. The cutting equipment and the method of doing the work shall be to the Engineer's approval. The specimens shall be dealt with in accordance with BS 1881. Prior to testing, the specimens shall be available for examination by the Engineer.

3-2-G WATER RETAINING STRUCTURES-SPECIAL CLAUSES

The design, detailing materials and workmanship shall comply with the requirements of BS 8007.

3-2-G-1 MAKING GOOD

The cement mortar used in filling recesses in the concrete formed by bobbins in connection with formwork shall contain an approved expanding admixture.

3-2-G-2 CONSTRUCTION JOINTS IN WATER RETAINING STRUCTURES

Waterstop not less than 150 mm wide shall be built into all construction joints in external walls and construction. Construction joints shall only be formed at positions approved by the Engineer.

3-2-G-3 WATERTIGHTNESS OF STRUCTURES

The Contractor shall be responsible for the watertightness of structures and any remedial measures necessary. Where detailed on the Drawings the surfaces of concrete shall be coated with a waterproof coating.

In the event that a structure designed and specified to be water retaining fails to satisfy the watertightness tests, the Contractor shall undertake such remedial works as are necessary and are approved by the Engineer. In certain situations the Engineer may permit the provision of an internal waterproofing coating in compliance with the specification. Where such a coating is permitted it shall be applied to the whole of the internal water retaining face.

3-2-G-4 WATERPROOF COATINGS

Waterproof coatings shall be applied only where shown in the drawings or where instructed by the Engineer.

Coating shall be chloride free and suitable for contact with potable water (in case of potable water retaining structure) and sulfate resistant in case of wastewater retaining structure.

The system shall be applied in accordance with the manufacturer's recommendations. Prior to application, the surfaces shall be prepared and all cracks, porous patches and generally defective areas shall be cut-out and made good.

The system shall provide a waterproof coating without impeding the breathing of the structure.

Expansion joints shall be formed in the waterproofing system by the use of compatible sealants as recommended by the manufacturer.

The system shall be cured for a period of not less than 7 days.

3-2-G-5 HYDROPHILLIC RUBBER SEALER

Hydrophillic rubber sealer shall be co-extruded from chloroprene and hydrophillic rubbers into a cellular strip approximately 25 mm x 7 mm thick which expands as it absorbs water. The strip shall incorporate an expansion delay coating to prevent activation during setting of the surrounding concrete.

Hydrophillic rubber sealer could be applied to the perimeter of all pipes to be built into concrete structures to existing concrete walls and slabs at or below water levels which have been demolished and require extension, and to other locations as indicated on the Drawings.

The strip sealer shall be bonded to the pipe diameter or on to the face of demolished structures on to which new concrete is to be placed so as to be at least l00 mm from the wall surface. Where dowel bars are incorporated in bonding new concrete to old, the sealer shall be placed above the dowel bars on the "wet" side of the structure. Bonding shall be accomplished using proprietary neoprene or epoxy adhesives to ensure the sealer is not disturbed during placement of the concrete.

The application shall be in accordance with the manufacturer's recommendations.

3-2-H DEMOLITION & REMOVAL

3-2-H-1 DESCRIPTION

This work shall consist of the complete demolition and removal of a whole, not partial, structural concrete and miscellaneous concrete structures as indicated on the plans or as ordered by the Engineer. All demolition material shall be removed from the work site to approved dumping site.

3-2-H-2 DEMOLITION DETAILS

Care shall be exercised in the demolition so as not to damage neighboring structures designated to remain in place.

3-2-H-3 STRUCTURAL CONCRETE REMOVAL

3-2-H-3-1 Description

This work shall consist of the removal of a section or segment from a structural concrete elements and other concrete removal indicated on the Plans or ordered by the Engineer. All removed material shall be removed from the work site to approved dumping sites.

3-2-H-3-1-1 Removal Of Structural Concrete

All concrete shall be removed to a pay line shown on the Plans or to sound surface as determined by the Engineer. Reinforcing bars and miscellaneous material shall be removed as part of this work unless the Plans or the Engineer specifically direct otherwise. Surfaces from which structural concrete has been removed shall be cleaned, except that surfaces not designated to come in contact with new concrete placements need not be cleaned.

Chipping hammers shall weigh no more than 20 kg with the bit and muffler removed. The hammer shall deliver no more than 1600 blows per minute. The Contractor shall provide the Engineer information from the hammer manufacturer that these requirements are not exceeded. The air pressure used to power the hammer shall not exceed 759 KPa measured at the air compressor. An air pressure gauge in proper working condition shall be provided. Only sharp chisel point bits shall be used. All bits determined by the Engineer to be dull shall be sharpened or replaced. If the Engineer determines that the Contractor's operations are resulting in damage to concrete that is to remain, the Contractor shall make immediate corrections. These corrections shall include the use of a lighter chipping hammer if so ordered by the Engineer.

3-2-H-3-1-2 Materials

Materials used in this work shall conform to the following requirements:

Sandblasting Sand: No. 40 Boiler Slag Grit or

No. 2 Sandblast Sand

3-2-H-3-1-3 Construction Details

General care shall be exercised in removing concrete so as not to damage material designated to remain in place. Reinforcement designated to remain in place shall be cleaned in a manner satisfactory to the Engineer. Saw cutting of concrete shall be performed only where indicated on the Plans or where ordered by the Engineer.

All concrete surfaces which require cleaning, after the concrete removal has been performed, shall be thoroughly sandblast cleaned, or abraded by other mechanical means satisfactory to the Engineer. After blast cleaning, the surface shall be air blown or vacuum cleaned. Air-blowing may be used on vertical or overhead surfaces. Vacuum cleaning will be required for all other surfaces.

For any structural concrete removal item, where a hammer size limitation is specified on the Plans or in the Specifications, the Engineer may order the Contractor to use a lighter hammer than that specified, if, in his opinion, the hammer being used is destroying concrete that should remain.

3-2-I CONCRETE GROUTING MATERIAL

3-2-I-1 SCOPE

This specification covers a grouting material for use in grouting anchor bolts, dowels and other miscellaneous items in concrete.

3-2-I-2 GENERAL

The material shall be a non-metallic, non-shrink grout which, when mixed with water, will harden rapidly to produce a permanent anchoring bond. It shall contain no metals nor rust or corrosion promoting agents. The color shall be light gray matching approximately the color of hardened concrete.

3-2-I-3 MATERIAL REQUIREMENTS

The material when prepared in accordance with the manufacturer's instructions shall be of a tolerable consistency. It shall also have the following properties:

The material shall exhibit no shrinkage on setting but may exhibit slight expansion of no more than 0.40%.

Compressive strength - Two-inch cubes of this material when cured as shown shall have the following minimum compressive strengths:

Cure	Strength
24 hour air cure @ 23° C	27.6 MPa Min.
7 day air cure @ 23° C	41.4 MPa Min.
7 day air, 10 day water submersion	41.4 MPa Min.
7 day air, 24 hour, 10% NaCl solution submersion, 25 cycles freeze-thaw	41.4 MPa Min.

The material shall have a minimum initial set of 30 minutes.

Pull-out strength - T15 concrete reinforcement bar grouted 15 cm deep in 2.2 cm hole in saturated surface dried concrete shall have a pull-out strength of 4500 kg.

The material shall contain not more than 0.05% chlorides or 5% sulfates. The material shall withstand 25 cycles of freeze-thaw (10% NaCl) with a maximum loss of 4%.

3-2-J REHABILITATION OF RESERVOIRS

3-2-J-1 DESCRIPTION

The following specifications include procedures, materials and workmanship for the rehabilitation of existing reservoirs. Rehabilitation works will include, but will not be limited to structural repairs and general building rehabilitation. Repair works may include the following:

- Repairs to cracked concrete.
- Sealing joints and cracks to prevent leakage.
- Sealing of pipe penetrations including replacement of some pipes.
- Repairs to damaged concrete.
- Repairs and replacement of corroded reinforcement.
- Removal and replacement of plaster and rendering.
- Major structural demolition and reconstruction.
- Internal and external tanking and waterproofing.
- Earthworks.
- Replacement of miscellaneous metalwork, access ladder covers and the like.
- Painting.
- Cleaning and general restoration.

The procedure for the rehabilitation of reservoirs shall be for the Contractor to first undertake an initial Site Survey. This survey will determine the general nature and condition of the site, the structure, pipework and ancillaries. Based upon the results of this survey, the Engineer together with the Contractor shall plan and undertake a detailed structural inspection/survey. This detailed survey will identify the extent and nature of any defects which in the opinion of the Engineer needs to be rehabilitated or repaired. The Engineer will instruct the Contractor as to the extent and method of rehabilitation or repair to be implemented. In the case of major defects, the Engineer may instruct the demolition and reconstruction of the structure either in whole or in part.

Only structural repairs are defined beneath for reservoirs.

3-2-J-2 SITE SURVEY

The Contractor shall record the existing conditions of the site, the structure and its associated equipment and shall produce dimensioned drawings of the structure comprising plans and sections at a scale of not less than 1:100 and dimensioned plans and layouts of any existing mechanical and ancillaries.

The drawings and condition survey shall be supported by photographs and shall be submitted to the Engineer for approval within 10 days of the survey. The cost of this work is considered to be included in the unit rates of the bill of quantities.

3-2-J-3 STRUCTURAL SURVEY

The Engineer together with the Contractor's engineer accompanied by adequate support staff shall inspect the structure to assess its condition and determine the scope of the rehabilitation work. The survey shall include a cover meter survey and rebound hammer survey of concrete surfaces.

Structural surveys may need to be undertaken in stages involving a number of visits by the Engineer and Contractor. The scope of work may be amended by the Engineer, as necessary, to incorporate the findings of the surveys.

To facilitate the structural surveys it may be necessary to remove existing plastering and rendering, clean the structure, excavate to expose buried surfaces, provide temporary accesses and scaffolding, and carry out water tightness testing or other preparatory work. The preparatory work to be undertaken will be instructed by the Engineer after receipt from the site survey. Further instructions may be issued by the Engineer during the course of the detailed survey and the rehabilitation works. The cost of this work is considered to be included in the unit rates of the bill of quantities.

3-2-J-3-1 Cover Meter Survey

Cover meter surveys shall be carried out using normal methods and equipment. On plane members the direction of reinforcement with least cover shall be determined. The cover meter head shall he moved across the surface of the concrete along a line in a direction perpendicular to the direction of reinforcement with least cover and with the head oriented in the direction which enables the cover to that reinforcement to be measured. The lines along which the cover meter head is moved shall be approximately 500 mm apart. The cost of this work is considered to be included in the unit rates of the bill of quantities.

3-2-J-3-2 Rebound Hammer Survey

Rebound hammer for testing the hardness of concrete shall be carried out in accordance with International codes and standards as instructed by the Engineer. The cost of this work is considered to be included in the unit rates of the bill of quantities.

3-2-J-4 ACCESS

The contractor shall provide suitable and safe means of gaining access to all repair areas to enable the works to be carried out and the Engineer to carry out surveys inspections.

3-2-J-5 CONTRACTOR'S METHOD STATEMENT

Prior to commencing rehabilitation the contractor shall submit for approval a detailed method statement which shall include.

- A program detailing the proposed sequence and duration of each item of work.
- Details of any necessary disruption to the operation of the works and the contractor's proposed methods of providing any temporary service.
- Details of all detailed method statements.
- Details of all materials to be used in the rehabilitation works together with all necessary technical documents, catalogues and samples.

- Descriptions of any items including pipework, mechanical and miscellaneous work related to rehabilitation including proposed schedule of design, procurement and delivery.

The cost of the preparation of the method statement for reservoirs rehabilitation should be considered to be included in the unit rates of the bill of quantities.

3-2-J-6 CONCRETE REMOVAL

3-2-J-6-1 General

Where existing concrete is to cut out it shall be removed over the areas defined by the Engineer. The contractor shall ensure that the cutting out is done in such a manner so as not to cause permanent damage to the surrounding structure.

Where practicable, concrete shall be removed by disc cutting, grinding or similar cutting methods and not by percussive tools.

Where percussive methods are approved by the Engineer, the size and power of tool shall be the minimum appropriate.

Before removing any concrete the Contractor shall provide and erect any temporary propping necessary to ensure the safety of the structure.

The Contractor shall be liable for making good of his own expense any damage arising from cutting out.

Where concrete is to be removed the surface of the concrete over the area to be removed, shall be cut by a grid of straight lines using a disc cutter or similar and the concrete removed by chiseling or by percussive tools.

3-2-J-6-2 Removal of Unsound Concrete

1. Removal for concrete replacement. The minimum depth of removal shall be the greater of the following:

a. A depth no less than 1cm and not greater than the distance from the rearmost point of exposed reinforcement to sound concrete.

b. The depth necessary to reach sound concrete.

Should the removal depth exceed 15 cm, the Project manager may order supplementary anchoring as part of the replacement procedure. The sides of the cavity shall be made at a slight angle, so that the width of the base of the cavity is greater than the opening at the surface, thereby providing a key.

2. Removal for patching material replacement. Feather edges shall not be permitted. The minimum patch depth shall be 1 cm as measured from the theoretical plane of the original concrete surface.

3-2-J-6-3 Corroding Reinforcement

Where the reinforcement bars are corroded, concrete shall be removed to a depth of 25mm behind and along the actively corroding bars until a continuous length of 50 mm of bar which is free from active corrosion is exposed.

The Contractor may be directed by the Engineer to supplement or replace the existing bars with new bars. Bars to be replaced shall be cut out and not removed by burning.

Replacement reinforcement shall be adequately fixed and tied in position such that it will not be displaced during the subsequent reinstatement works.

Where corroding reinforcing bars are to be retained they shall be brushed and cleaned by grit blasting or other method approved by the Engineer and submitted by the Contractor. Cleaning shall be carried out in such a way to include the hidden faces at the backs of bars and at the intersection of bars. Abrasives shall be new, clean and dry and of a grade suitable for the preparation of steel to the qualification required above. The exposed reinforcement shall be thoroughly washed down with clean water.

3-2-J-6-4 Surface Cleaning

Cleaning of structures shall be undertaken to remove all dirt or other contaminants, previous coatings, paint, moss, plant growth and the like, as directed by the Engineer. Cleaning shall be by methods that cause no damage to the existing structure. The Engineer may instruct a change in the method if the method adopted causes damage to the surface or is otherwise unsuitable or ineffective.

Where instructed by the Engineer cleaning shall be by:

a. Grit blasting (wet, dry or vacuum blasting).

b. High pressure water jetting, steam cleaning employing wax free detergents together with power scrubbing as necessary.

Before cleaning begins, the contractor shall remove all surface attachments from the areas to be cleaned or from positions that obstruct access. Unless otherwise directed. All inserts and fixings which have been cast in or mortared into pockets or otherwise attached to the concrete shall be protected or removed from the area to be cleaned.

Before cleaning commences, trials shall be carried out on areas at typical locations to the approval of the Engineer.

3-2-J-6-5 Reinforcement Protective Treatment

Where directed by the Engineer reinforcement shall be coated with a polymer modified cement based primer or slurry coat prior to reinstatement of the concrete. All exposed surfaces of the bars shall be coated with the primer within 3 hours of cleaning. Any reinforcement remaining uncoated at the end of a 3 hours period shall be recleaned.

3-2-J-7 CONCRETE REPAIR METHODS

Defective concrete shall be cut out and reinstated by either a proprietary repair method or in the case of large volumes, by recasting with new concrete. Any defective or corroded reinforcement will either be cleaned and protected by a corrosion protection system or replaced.

Concrete repair methods shall include, but shall not be limited to, the following:

- Hand application of resin based mortars
- Hand application of cementitious mortars.
- Sprayed concrete and mortar
- Recasting with concrete

The Contractor will determine and submit to the Engineer the extent of the concrete to be removed and will select the appropriate repair method and material of repair depending upon the nature and extent of the defect. Repair methods and materials of repair shall be submitted to the Engineer's approval.

In general hand applied resin based mortars and cementitious mortars will be used for patch repairs to areas of less then 0.5 m^2 and depths less then 100 mm. Re-casting into formwork will be used for the reinstatement of large volumes and sprayed concrete (Gunite) will be used to cover large areas.

3-2-J-8 REINSTATEMENT OF CONCRETE

3-2-J-8-1 General

Prior to placing repair materials in any section of the works, all profile guides, formwork and reinforcement shall be fully fixed and cleaned over the entire area of the proposed repair. All dust, debris and loose material shall be removed from the area of the repair.

Plant and tools used for mixing, transportation and spraying of repair materials shall be kept clean and free from accumulated deposits of repair material.

Repair materials shall be mixed and applied in accordance with the manufacturer's recommendations as approved by the Engineer. The entire contents of a pack (or any other type of container) shall be mixed at one time.

Transportation of the repair materials to the point of application shall be such as to prevent contamination, segregation or loss of fine constituent materials.

Repair materials shall be placed in position in as short time as possible after mixing and within times stated in the manufacturer s recommendations. The repair material shall be placed in layers not exceeding those recommended by the manufacturer and approved by the Engineer.

Repairs shall not proceed if the air temperature or concrete substrate temperature is 5°C or less, or such higher temperature as may be recommended by the manufacturer and shall cease if the air temperatures falls below this minimum.

Repair may proceed at low temperatures if specific planned and approved procedures are implemented. These may include:

a. Provision of heated tenting which envelopes the repair area and produces an environment with a sustainable air temperature in excess of the minimum.

b. Where approved by the manufacturer warming materials and the substrate to a temperature above 5°C. The method of warming shall be such that the materials are not damaged and are not caused to dry out in the case of cement based repair materials.

c. Insulating the completed or partially completed repairs in accordance with good practice for winter concreting.

In general the concrete reinstatement patching shall be done as follows:

1- Horizontal or essentially horizontal locations. Concrete or approved patching material shall be used. Class A concrete shall be placed only at locations where removal depths average out greater than 8 cm. Patching material shall be placed only at locations where removal depths average out less than 8 cm. Average depths shall be determined by a measurement procedure acceptable to the Engineer.

2- Vertical or essentially vertical locations. Concrete or approved patching material shall be used. Concrete shall be restricted to the depth limitations noted for horizontal locations. Average depths shall be determined by a measurement procedure acceptable to the Engineer.

3- Overhead. Approved patching material shall be used. Lift thicknesses shall not exceed 2 cm, unless formwork or anchoring devices are employed.

3-2-J-8-2 Materials

Where the repair system comprises two or more materials the Contractor shall ensure that the repair materials are compatible and shall submit to the Engineer certificates provided by the manufacture confirming that the proposed repair materials are compatible.

Where possible repair materials, other than replacement concrete, shall be pre-batched.

All materials shall be mixed, applied and cured in accordance with the manufacturer's recommendations as approved by the Engineer or as otherwise instructed by the Engineer.

3-2-J-8-3 Formwork

Formwork necessary to reform arises, profiles, rebates, soffits, and the like shall be so constructed that it remains true to line and level under the loads and pressure imposed by the repair materials.

Formwork shall be struck without causing damage to the repair materials, and the contractor shall be responsible for determining the age at which the repair material attains a sufficient strength to support its self weight and any other loads which may be imposed thereon.

All profiled guides and formwork shall be coated and/or adequately treated such that they do not absorb water from the repair mortar and do not discolor/contaminate the repair mortar or surrounding concrete.

3-2-J-8-4 Epoxy Mortar

3-2-J-8-4-1 Description

Epoxy mortar is a blend of high strength aggregates bonded together with epoxy resin, designed for speedy and permanent repairs, to concrete. The mortar shall provide shrinkage-free hardening and abrasion and impact-resistance. The mixed material is applied to a suitably prepared and primed surface. It is supplied as a three pack material in pre-weighed quantities ready for on site mixing and use.

3-2-J-8-4-2 Preparation of Concrete Surface

The surface to be prepared will be sandblasted after which it will be thoroughly cleaned and dried prior to epoxy bonding course.

All grease, chemical contamination, dust, cement, laitance, and loose concrete must be removed by scrabbling or light bush hammering to provide a sound substratum.

3-2-J-8-4-3 Priming Surfaces

Surfaces to be repaired shall be primed with an epoxy primer. The epoxy mortar shall be applied when the primer starts to gel but is still tacky, normally between 30 minutes and one hour. If the concrete has absorbed the primer, or the primer has dried, a second primer coat should be applied.

3-2-J-8-4-4 Technical Properties

The contractor shall submit catalogues from manufacturers for approval of the Engineer. It shall conform to the following properties:

	NORMAL TYPE	**L.P. TYPE**
Compressive strength	70-80N/mm^2	50-60N/mm^2
Flexural Strength	20-25N/mm^2	15-20N/mm^2
Bond Strength to concrete	2-3N/ mm^2	2-3N/mm^2
Young's Modulus	27.000N/mm^2	27.000N/mm^2
Mixing Ratio	1 part epoxy to 3 parts silica sand	

where: Normal type : Have storage conditions above 0°C, max. 25°C.

L.P. type : Have storage conditions above 10°C, max. 35°C.

3-2-J-8-4-5 Application

The mixed material should be applied to the surface with a steel trowel, ensuring that it is pressed firmly into cracks to ensure positive adhesion. Epoxy coatings shall be kept dry and above 16°C.

3-2-J-8-4-6 Safety

For health and safety, the instruction of the epoxy manufacturer should be followed.

3-2-J-8-5 Epoxy Resin Bonding Agent

3-2-J-8-5-1 Description

Epoxy resin bonding agent is a solvent-free bonding agent, based on selected epoxy resins. After application to old concrete surfaces, it shall provide a perfect bond for new concrete. It is supplied as a two-component bonding agent ready for mixing with a slow speed electric drill.

3-2-J-8-5-2 Preparation of Concrete Surface

All surfaces must be clean, free from standing water and all loosely adhering particles. Cement laitance must be removed and the surfaces to be treated must be roughened.

3-2-J-8-5-3 Technical Properties

The contractor shall submit catalogues from manufacturers for approval of the Engineer. It shall conform to the following properties:

- Compressive Strength 60-70N/mm^2
- Flexural Strength 30-35N/mm^2
- Tensile Strength 8-20N/mm^2
- Bond Strength to Concrete 2.5-3N/mm^2 (concrete failure)

3-2-J-8-5-4 Application

The mixed material should be applied to the surface by brush, roller or spray, ensuring that it is well brushed in on damp surfaces. New concrete should be poured within specified time when the material is still tacky.

3-2-J-8-5-5 Safety

For health and safety, the instruction of the epoxy manufacturer should be followed.

3-2-J-8-6 Cementitious Mortars.

Cementitious mortars shall be high strength polymer rich proprietary products which produce a dense durable mortar that exhibit minimum shrinkage on drying.

The polymer shall be acrylic, styrene-butadiene rubber or similar polymer which is durable in damp or wet conditions.

Cement shall comply with the Specifications except that cement to BS4027 shall not be used. The mortar shall exhibit high bond strength and excellent adhesion and shall be free of chloride compounds.

The total chloride content of the mortar arising from the cement, aggregate and any other source shall not exceed 0.1% of chloride ion by mass of cement. The chloride content of the cement shall be determined in accordance with BS EN 196-21 and that of the aggregate in accordance with BS S 12: Part 1 17. The use of calcium chloride is prohibited.

It shall be non toxic suitable for contact with drinking water and it shall demonstrate excellent resistance to long term water immersion.

The minimum strength properties measured in accordance with BS 6319 at 28 days shall be as follows:

Compressive Strength: 50 N/mm^2

Tensile Strength: 5 N/mm^2

Flexural Strength: 10 N/mm^2

3-2-J-8-7 Sprayed Concrete

Sprayed concrete shall be microconcrete (Gunite) material.

The material shall be a proprietary pre-batched microconcrete supplied by a manufacturer who operates quality assurance procedures approved by the Engineer. It shall be cementitious with graded non-reactive aggregate modified with polymer. super plasticisers and silica fume and pre-bagged in the required proportions. Only water shall be added to the mix on site.

The water cement ratio shall not be less than 0.32 or greater than 0.45 and shall comply with the manufacturer's instructions.

The proportion of silica fume shall not exceed 10% by mass of cement.

The total chloride content shall not exceed 0.1% mass of cement. Calcium chloride or admixtures containing chloride salts shall not be used. The chloride content of the constituents of the mix shall be determined as follows:

– Cement	- BS EN 196-21
– Aggregate	- BS 812: Part 117
– Admixtures	- BS 5057: Part l

Maximum aggregate size shall be 3 mm.

There shall be no expansion agents contained in or added to the repair material.

The material shall exhibit excellent adhesion to the existing concrete and shall exhibit low shrinkage.

It shall have low water absorption and shall demonstrate excellent resistance to long term water immersion.

The minimum strength properties at 28 days shall be as follows:

Compressive strength	45 N/mm^2
Flexural strength	10 N/mm^2
Adhesive Strength	3 N/mm^2

There shall be no change in source or type of material. manufacturer supply, mix proportions or method of mixing without the approval of the Engineer. Such approval will only be given after further site trials have been carried out to the satisfaction of the Engineer.

3-2-J-8-8 Concrete

Concrete used in recasting shall comply with the specification to give a 28 day characteristic strength of 35 N/mm^2.

Approved water reducing additives, superplasticizers, accelerators, may be used subject to satisfactory testing and the Engineer's approval.

3-2-J-8-8-1 Priming

Concrete surfaces within the repair area shall be treated with a suitable bonding aid or primer which is compatible with the repair material.

Priming coats or bonding aids shall be thoroughly worked into all hollows and crevices in the prepared surface and around the reinforcement if required.

If at any time the primer or bonding aid completely dries out before over-laying, the repair surface shall be re-prepared generally by complete removal of the dried primer or bonding aid or as specified by the manufacturer of the repair materials.

When using cementitious based repair mortars, the concrete substrate shall be thoroughly wetted to obtain a saturated surface dry condition. Any surplus water shall be remoisted before reinstatement begins.

3-2-J-8-8-2 Filling Resin Based and Cementitious Mortar

Mortars shall be applied in self-supporting layers, and in any case, not exceeding the thickness specified by the manufacturer of the mortar.

Each layer shall be thoroughly worked and compacted into the repair zone and around or between reinforcing bars. The technique employed shall ensure that no air is entrapped and that full contact with the primed substrate is achieved.

Successive layers shall be applied as soon as the preceding coat has become sufficiently stiff to support the weight of the additional build-up layer but is still adequately tacky to provide bonding. The time between layers shall be in accordance with manufacturer's recommendations. If sagging occurs the material shall be completely removed and reapplied at a reduced thickness.

If at any time the last layer applied completely dries out before over-laying, the surface shall be prepared according to the manufacturer's recommendations.

The final build-up layer within a repair shall not be less than 10 mm thick and shall be leveled off or profiled to produce a smooth finish.

The repair shall be cured by the method and for the period recommended by the manufacturer of the repair system. During this period the temperature of the material shall not be allowed to drop below the minimum specified by the manufacturer and the repair shall be shaded from direct sunlight. Curing membranes shall only be permitted where they are recommended by the manufacturer.

3-2-J-8-8-3 Filling Sprayed Concrete

Delivery equipment shall be demonstrated to the satisfaction of the Engineer in site trials. The equipment shall deliver a conical uniform discharge stream of uniformly mixed material at the proper velocity from the discharge nozzle at all heights of the work.

Once placed, the applied material shall be capable of being profiled and steel trowel finished to a high standard without detrimental effects.

3-2-J-9 SPECIFIC WORKS

3-2-J-9-1 Crack Repairs

Cracks requiring repair shall be categorized by the Engineer as follows:

- Live cracks.
- Major cracks.
- Stable structural cracks.

- **Repair of Live cracks**

Live cracks shall be chased out using a grinding machine to a minimum depth of 30mm and width of 15 mm.

The rebate shall be cleaned of loose material, primed and filled with a gun applied polyurethane sealant onto a debonding tape within the rebate.

- **Repair of Major Cracks**

Cracks classified by the Engineer as major live cracks shall be repaired by cutting out and subsequent restatement of the concrete.

Reinstatement shall be in accordance with the Engineer s instructions. A joint bridging strip shall be applied over the crack where instructed by the Engineer.

Where the Engineer instructs the concrete shall be cut out over sufficient width and depth to enable examination and any repairs to the reinforcement.

- **Repair of Stable Structural Cracks**

Stable structural cracks shall be filled with proprietary materials applied by pressure injection such that the crack is completely sealed.

Materials shall be polyurethane resin, epoxy resin or liquid silicate. Polyurethane foam may be used as directed by the Engineer for crack sealing in wet conditions.

The material shall exhibit low viscosity and good adhesion to dry or moist concrete. On curing, the material shall form a hard mass impermeable to water.

3-2-J-9-2 Repair around pipe penetrations

Leaks around pipe penetrations, shall be repaired as follows:

1. Where pipes are in good condition the contractor shall chase out a 20 x 20 mm rebate around the pipe and fill the rebate with gun application of elastomeric polyurethane mastic sealant and provision of a butyl flashing ring.
2. Where pipes must be removed and new pipes installed the contractor shall break out and remove the existing pipe. The new pipe shall be installed complete with a puddle flange, and concrete shall be placed from both sides of the wall. The contractor shall ensure a good bond will he formed between old and new concrete.

3-2-J-9-3 Repair of leaking joints and Cracks

Repairs to leaking joints and cracks shall where directed by the Engineer be made on the internal water face using a proprietary joint bridging strip, with a minimum thickness of 2 mm and made of an inert flexible strip such as Hypalon (By Dupont) or equivalent material.

The adhesive shall be an epoxy resin compatible with the concrete and the flexible strips suitable for use in damp conditions. Full contact between the flexible strip and the concrete shall be ensured by means of a roller.

Surface preparation shall be by grit blasting or other approval method to remove all laitence and in accordance with the manufacturer's requirements.

3-2-J-9-4 Refurbishment of Roof Structures

Where directed by the Engineer, all existing internal and external roof screeding, rendering and debris shall be removed from the roof and any defective concrete repaired.
The installation of new waterproofing memebrane, thermal insulation and concrete protection of the roof of the reservoir shall be done if required by the Engineer and with the same material used for new reservoirs and described elsewhere.

3-2-K NEOPRENE PADS

3-2-K-1 GENERAL

Elastomeric supports must comply with the following criteria:

1. To be of simple design under normal execution procedures.
2. To permit:
   a. Horizontal displacement due to any cause,
   b. Rotation of the support due to bending under permanent loads, working loads and the effects of hydraulique shrinkage and thermal phenomena, without building liable stresses outside the elastomeric support.

The elastomeric support can fill all the substrate surface of the wearing walls /or/ only a part of this surface; the unoccupied surface. In this case must be filled by a compressible material to avoid the intrusion of concrete grout between the various elements of the elastomeric support.

3-2-K-2 MATERIAL AND APPLICATION

The elastomeric support is generally constituted by a non-hooped elastomeric polychloroprene (neoprene) which under various movements and loads will sustain deformation, transmitting to the underneath wearing walls, vertical and horizontal efforts.

3-2-K-2-1 Eveness Of The Wearing Substrate

The substrate wearing surface must be evened to avoid any accidental contact outside the designed contact surfaces; anyhow the wearing zones must be made horizontal.

The Contractor must furnish to the Engineer all necessary justifications concerning the elastomeric support and the procedures for the execution of the wearing surface.

3-2-K-2-2 Minimal Characteristics

The following minimal characteristics must be submitted by the Contractor for the Engineer's approval:

Maximal constraint which varies with the type of material used (around 30 bars /or/ 3 MPa for the non-hooped polychoroprene = neoprene)

Minimal constraint to be obtained and which is needed to respect the condition of non-slipping of the elastomeric support on its substrate (around 15 bars or 1.5 MPa for the non-hooped polychloroprene = neoprene)

This condition may result for the elastomeric support to have a maximal dimension implicating sometime the impossibility to design a continuous linear elastomeric support. Thus needing to consider the use of strips or pads of elastomeric material.

A continuous break of ties must be then insured between the pads by incorporating between the pads of neoprene of a compressible material (polystyrene type) and making the joints between pads and polystyrene water tight to avoid concrete grout intrusion.

3-2-K-2-3 Minimal Thickness of The Elastomeric Support

The required thickness of the neoprene support shall depends on the loads, the amount of sliding and permissible rotations.

The Contractor shall submit technical certificate from the manufacturer to the Engineer allowing him to control and approve the chosen sizes and thickness of the elastomeric support.

The minimal thickness is conditioned by two factors:

The maximal distortion of the neoprene (α) which must not exceed $\alpha \leq 0.5$ radians.

The thickness must be large enough to permit rotation of the support avoiding contact in the maximum compression corner zones.

3-2-K-2-4 Determination Of The Horizontal Stresses

As an example, horizontal stresses may be controlled by the following formula (DTU.20.12)

$$H = G \times S \times \frac{U}{e}$$

e = thickness of the support

S = surface of the support in contact with the substrate

G = Transversal elasticity coefficient of the neoprene (around 0.8 to 1.3 MPa or 8 to 13 bars depending of the neoprene quality)

U = displacement

The admissible displacement (U) in relation with the thickness (e) can be first estimated as follows:

Thickness (mm) e =	5	10	15	20
Displacement (mm) U =	2.5	5	7.5	10

3-2-K-2-5 Other Approved Elastomeric Support

The elastomeric constituting the pad may be a mix vulcanised based on Ethylene - Propylene - Diene - Monomer (E.P.D.M) which has the following average characteristics:

A shore hardness of	60 ± 5
Specific weight	1.06 ± 0.02 g/ml
Ultimate resistance (rupture)	≥ 15.0 MPa

Maximum elongation (Rupture)	≥ 400%
Tearing resistance	≥ 15.0 MPa
Permanent deformation after 24 hours at	70oC ≥ 20%
Module "G" of transversal elasticity	0.8 ± 0.1 MPa

3-2-K-2-6 Compression Sollicitation

The admissible load over an elastomeric linear pads support depends of the dimensions and number of elastomeric pads constituting the support.
The average admissible constraint on every single pad is obtained for example by using the following formula
average = 1.2 x β ≤ 5 MPa Where β

(form factor) = $\frac{a \times b}{2xt(a+b)}$

t = thickness of the elastomeric support

a,b = dimensions (in plan) of the elastomeric support

3-2-K-2-7 Special Dispositions

In case the horizontal effort is greater than the value of friction of the interface between the elastomeric support and the substrate, the following dispositions must be taken by the Contractor:

If not otherwise specified by the Engineer the Contractor may stick the pads to avoid uncontrolled displacement when setting the different elements.

A special glue approved by the Engineer must be laid on the primed substrate and on the back side of the pad. After a maturation time, the pad shall be applied on the glued substrate with force.

3-2-K-3 SLIP MEMBRANE

This slip membrane is constituted generally

- A protection sheets
- A slip plate around 3mm thick
- A silicone lubrication or similar
- An elastomeric pad recovered with special slipping cover adhering to it. This system fulfills most of the usual functions of elastomeric support as:
- Uniform distribution of vertical loads
- Horizontal displacement by slipping of the supported construction over it.

This system will permit under small thickness, wide horizontal displacement with minimum limitation of the horizontal stresses transmitted and after the displacement it does not exercise any underpinning stress on the construction at the contact interface.

The Contractor is asked to submit all technical specifications to the Engineer for approval before any purchase of the material.

Part III-3: WATERPROOFING

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PART 3.3 – CIVIL WORKS:

WATERPROOFING

3-3-A FLEXIBLE WATERPROOFING PVC SHEETS 2 MM THICK

3-3-A-1 DESCRIPTION

This work shall consist of furnishing and placing flexible PVC sheets 2 mm thick on prepared surfaces in accordance with the Specifications, and in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer.

3-3-A-2 MATERIALS

Waterproof membranes shall consist of uniform flexible sheets of two (2) mm minimum thickness.

- *3-3-A-2-1 Physical Requirements*

The waterproofing PVC sheets shall comply with the following specifications at 20 °C:

Weight: 2.80 kg/m^2

Thickness: 2 mm

Tensile strength at rupture: 17 daN/cm

Elongation %: 170 %

Bursting Test (C.T.G.R.E.F.): > 12 Bars

Hydrocarbon resistance: Good

Chemical resistance: Very good

Satisfactory for potable water: Good (Excluding Chlorinated Water)

The Contractor shall provide all adhesives, tapes and welding material recommended by waterproofing sheets manufacturer for bonding to substrate (if required), and for waterproof sealing of joints between membrane and flashing, adjoining surfaces and projections through membrane. The Contractor shall also provide all types of flexible sheet material and accessories for flashing and welding as recommended by waterproofing sheet manufacturer.

Each side of the waterproof membrane shall be protected by one layer of heavy duty geotextile sheets, in accordance with the Contract Drawings and Specifications.

3-3-A-3 CONSTRUCTION REQUIREMENT

3-3-A-3-1 Manufacturer's Instructions and Recommendations

At least thirty (30) days prior to the date he intends to order the waterproofing sheet materials the Contractor shall make written request for approval of: the brand of materials and method of installation he intends to apply, from the Project Manager.

The written request shall include all necessary manufacturer's instructions and recommendations relevant to the physical properties of the proposed sheets, the methods of storage, handling, laying, jointing, attachment, and protection. No ordering of waterproofing sheet material shall be affected before obtaining the written approval of the Project Manager on the above.

3-3-A-3-2 Subgrade Preparation

Unless other subgrade preparation is called for on the plans or appears as a pay item in the Bill of Quantities, the Contractor shall, as a part of the work and prior to the delivery of the material for the waterproof membrane, prepare the bed surface by sprinkling, blading, rolling, and lightly scarifying where necessary, until the proper slope is obtained. However, in the process of shaping the bed, the originally compacted crust or top portion of the bed shall be disturbed as little as possible. When completed and ready for waterproof membrane construction, the bed shall be well compacted, smooth, hard and uniform, all irregularities having been bladed out and rolled down.

3-3-A-3-3 Placing

The waterproof sheets shall be unrolled directly on the bearing surface, generally constituted by a layer of heavy-duty geotextile sheets. Waterproof sheets shall be overlapped to a minimum of twenty centimeters, and shall be welded on site by means of a thermoplastic soldering machine to seal the membranes and ensure water tightness to these joints, all in accordance with Manufacturer's instructions and recommendations. The strength of the welding shall be at least equal to that of the sheets.

Installation shall be scheduled to minimize period of exposure of sheet waterproofing materials.

Equipment and vehicles shall not be operated on the fabric. Damaged fabric shall be repaired, at the Contractor's expense, by placing new fabric over the damaged area in a manner that meets the overlap requirements for horizontal placement. Vertically placed fabric shall be replaced in its entirety.

3-3-B GEOTEXTILE SHEETS

Geotextile sheets shall be of the non-woven heavy-duty type, needle punched or needle entangled and shall consist of long chain polymeric filaments of polypropylene, polyester, nylon or any material approved by the Engineer. The fabric shall be a stable network of fibers, which retain their positions relative to each other. The geotextile sheets shall meet the following requirements:

Property		Test reference
Grab strength	: 500N	NFG 38.014
Elongation, Minimum (at peak load) %	: 65/57	NFG 38.014
Puncture strength	: 1500N	NFG 38.019
Permeability m/sec	: 5.5×10^{-3}	NFG 38.016
Surface weight	: 390 Gr/m^2	NF EN 965
Thickness under 2kPa	: 2.0 mm	NF EN 964-1

Geotextiles shall be furnished in rolls wrapped with protective covering to protect them against ultraviolet radiation and abrasion. Torn wrappers shall be repaired within 48 hours, using an approved protective covering. Each roll of fabric shall be marked or tagged to identify the manufacturer, type, length, width, and production identification number.

3-3-C BITUMINOUS PUTTY

3-3-C-1 PUTTY FILLER

Putty filler must have a consistent, semi-rigid and compatible with flexibility inside the joint. Before fillings the joints must be dry and clean and the concrete surfaces in contact with putty must be primed with compatible material with the putty.

Putty must be of type "IGAS" or similar with bituminous base or rubber having the following characteristics:

Density: 15

Flexibility at 20°: null

Adhesivity of cohesiveness: 3 daN

Maximum elongation under service: 10% Excellent adhesivity when laid on cement.

Another type could be used which is the elasto-plastic type conforming to the following requirements:

Black colour

Temperature for use: 100°C to 130°C

Stable at: -30°C to 60°C

Penetration at 25°C: around 55°C

Softening temperature: around 145°C

Practical elongation: 10%

Non-toxic

The selection of which type to be used shall be approved by the engineer.

3-3-C-2 APPLICATION OF THE SEALANT

Before proceeding with filling, the joint, the Contractor shall complete the following works:

- Widening the joint by grinding or sawing when the joint width is less than required.
- Cleaning by grinding and brushing the sides of the joint all along its length.
- Final cleaning shall be done by blowing air immediately before starting the filling.

The putty is applied at a temperature ranging between 100°C and 130°C. It shall be filled in the joint from the bottom up. In case the putty spreads slowly when applied, especially in horizontal joints, more material is immediately added until the joint is completely filled.

3-3-D WATERSTOPS

3-3-D-1 GENERAL

Waterstops shall be PVC type or Vulcanized Caoutchouc class A (rubber water stop) and shall be installed where shown on the drawings or where directed.

The Contractor shall furnish the waterstops and all materials and equipment for splicing waterstops, for fastening waterstops to the forms and to the supporting reinforcing bars, and for completing the installation of the waterstops.

The Contractor shall provide suitable support and protection for the waterstops during the progress of the work and shall repair at the Contractor's expense any damaged waterstops, which in the opinion of the Engineer, have been damaged to such an extent as to affect the serviceability of the waterstops. All waterstops shall be protected from oil, grease and curing compound.

3-3-D-2 MATERIAL

PVC waterstops shall be fabricated from a compound, the basic resin of which shall be domestic virgin PVC. No reclaimed PVC or manufacturer's scrap shall be used. The compound shall contain all additional resins, plasticizers, stabilizers, or other materials needed to ensure that, when the material is compounded, the finished product will have the required physical characteristics listed in the ASTM or similar.

3-3-D-3 FABRICATION

All waterstops shall be moulded or extruded in such a manner that any cross section will be dense, homogeneous and free from porosity and other imperfections.

3-3-D-4 INSTALLATION

Installation of the waterstops shall be in accordance with these specifications and the manufacturer's recommendations. The location and embedment of waterstops shall be as shown on the Plans, with approximately one-half of the width of the waterstop embedded in the concrete on each side of the joint.

In order to eliminate faulty installation that may result in joint leakage, particular care shall be taken that the waterstops are correctly positioned and secured during installation. All waterstops shall be installed so as to form a continuous watertight diaphragm in the joint unless otherwise shown.

Adequate provision shall be made to completely protect the waterstops during the progress of the work.

Concrete surrounding the waterstops shall be given additional vibration, over and above that used for adjacent concrete placement, to assure complete embedment of the waterstops in the concrete. Larger pieces of aggregate near the waterstops shall be removed by hand during embedment to assure complete contact between the waterstop and the surrounding concrete.

Where splices are required between waterstops of different sizes, the splices shall be made as recommended by the manufacturer of the waterstop.

3-3-E WATERPROOFING PROTECTIVE COATING FOR WATER RETAINING STRUCTURES

3-3-E-1 DESCRIPTION

This coating shall be a surface-applied material which waterproofs and protects concrete in depth and shall be suitable for use in water retaining structures. It consists of rapid-hardening Portland cement, specially treated quartz sand, and a compound of active chemicals. It is supplied in powder form and needs only to be mixed with water prior to application.

3-3-E-1-1 Preparation Of Substrate

All concrete to be treated with this coating must be clean and have an "open" capillary system. Laitance, dirt, grease, etc. should be removed by means of high-pressure water jetting, wet sandblasting or wire brushing. Faulty concrete in the form of cracks, honeycombing etc. should be made good. Surfaces must be carefully pre-watered prior to the application of the coating. The concrete surface must be damp but not wet.

3-3-E-1-2 Mixing

The powder material is mechanically mixed with clean water to a consistency of thick oil paint. Approximate mixing ratio is 0.8 parts water to 2 parts powder (by volume).

Materials mixed shall be as can be used within 20 minutes. Mixture should be stirred frequently. If mixture starts to set, no water should be added, the mixture should be stirred to restore workability.

3-3-E-1-3 Application

The mix is applied by masonry brush or appropriate power spray equipment. When two coats are specified the second coat shall be applied while the first coat is still "green".

3-3-E-1-4 Post Treatment

The treated surfaces should be kept damp for a period of five days and must be protected against direct sun, wind and frost by covering with polythene sheeting, damp hessian or similar.

3-3-E-1-5 Safety

The use of rubber gloves and goggles during mixing and application is recommended.

3-3-E-2 GENERAL REQUIREMENTS

Waterproofing material shall be applied to interior concrete surfaces.

It is made of cement base, sand, and other chemical. It is composed of two contents:

- Powder: Mixed of cement and other mixes as specified by the Engineer
- Liquid: Resin base and other mixes as specified by the Engineer

The above product must be:

- Waterproofing
- Weather and chemical product resistant
- Suitable for potable water, not harmful nor poisoning nor unhealthy

Before placing waterproofing on concrete surfaces, mastic of hydraulic cement base shall be used in concrete holes and cracks which provides a complete blockage to water. This mastic is a mixture of powder placed in special can closed tightly and shall be mixed with water before usage as directed by the Engineer.

3-3-F ELASTOMERIC SURFACE JOINT (COMBIFLEX)

This joint shall be as shown on the Plans and as specified herein. The joint is formed of an elastomeric sheet painted on both sides with a viscous resin coating and protected by an aluminium or copper sheet riveted on one side only.

The elastomeric sheet shall conform to the following requirements:

- Thickness 10/10 mm
- Resistance to rupture: 12 kg/cm²
- Elongation at rupture: 300%
- Modulus at 100% elongation: 85 kg/cm²
- Elongation at the elastic limit: 15%

The dimensions of the sheet, the method used in welding and the manufacturer's name shall be indicated. The resin shall be of a quality approved by the Engineer.

3-3-G BITUMINOUS COATING FOR BURIED WALLS

This material shall be applied on the exterior side of the concrete elements buried surfaces.

Ground water should be checked previously by the Contractor for chemicals which may have a deleterious effect on the structure or internal finishes.

The Contractor must obtain the previous approval of the Engineer on the support as well on the type of material proposed.

The bituminous coating for damp-proofing should be cold applied emulsion in two coats (of at least 0.750 kg/m^2 each) and cross applied.

Bitumen primer should be of the same cold bitumen emulsion compound diluated to 50% with water and applied at a minimum rate of 0,400 kg/m^2. The damp-proof bituminous coat shall be applied around 24 hours after the primer application.

3-3-H VAPOR BARRIER

This layer shall meet the following requirements:

- Thickness not less than 2 mm
- Durability against vapor penetration not less than 120,000μ
- Sustains a temperature of minus 10 degrees C without form change.

3-3-I SELF-ADHESIVE POLYETHYLENE SHEET

Flexible, preformed waterproof membrane comprising strong, high density polyethylene film with self-adhesive rubber/bitumen compound, and having the following minimum properties:

- total thickness : min 1.5 mm
- weight : 1.6 kg/m2
- ensile strength : 42 N/mm2
- elongation : 210% long.; 160% trans.
- tear resistance : 340 N/mm long.; 310 N/mm trans.
- puncture resistance : 220 N 65 mm
- Man: Servicised Ltd.

  Ref: Bitu-thene 1000X HC or

  other equal and approved.

3-3-J STEEL ROOF COVER

Steel roof covers to be as follows:

- Coated with natural stone chips, with pressure formed 0.4mm Zinc Aluminum base.
- Tested to withstand:
  - 2000Kg/m2 for snow load.
  - 400 Kg/m2 for uplift wind force.
  - Fire tested (agreed) CSTB T30/1
- Simulated Cyclone Wind loading:
  - 8000 cycles 3.44 kPa (72 psf).
  - 2000cycles 4.13 kPa (86 psf).
  - 200 cycles 5.50 kPa (115 psf).

3-3-J-1 STEEL ROOF COVER TO BE WATER PROOF

Tiles withstand: 100mph Wind speed

160Km/h Wind speed

With rainfall intensity of 203mm of rain/Hour without any leakage.

3-3-J-2 HAIL RESISTANCE

Roof covers should resist damage from hailstone up to 90mm.

3-3-J-3 TECHNICAL SPECIFICATIONS

Base steel	0.39mm
Zinc-aluminum coating	150g/m2
Total substrate thickness	0.43mm
Tile coverage	2.15 tiles/m2
Tile weight	7 Kg/m2

Steel roof cover composition:

1. Backing coat
2. Epoxy primer
3. Aluminum-Zinc coating
4. Steel base
5. Aluminum-Zinc coating
6. Epoxy primer
7. Seal coat
8. Acrylic base coat
9. Natural stone chips
10. Acrylic overglaze.

Part III-4: DOORS & WINDOWS
NOT APPLICABLE

Part III-5: FINISHES
NOT APPLICABLE

Part III-6: EXTERNAL WORKS

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PART 3.6 – CIVIL WORKS:

EXTERNAL WORKS

3-6-A AGGREGATES

3-6-A-1 SOURCES OF MATERIALS

All aggregates for use in the construction of the base course shall be obtained only from sources approved by the Engineer. The quarry pits or quarry extracted gravel shall be in all cases approved by the Engineer.

The Contractor shall determine the location, suitability and quantity of material available as well as the cost and the amount of work required to obtain the material available.

The Contractor shall provide the Engineer prior to the schedule beginning operations with a complete statement of the origin and composition of all stone and/or gravel aggregates to be used in the work. All materials shall comply with the specified requirements for the various aggregates.

The locating and the manufacture of aggregates which will meet the requirements of the specifications are the sole responsibility of the Contractor.

The approval of the Engineer shall in no way relieve the Contractor of the responsibility of producing aggregates which meet the specifications.

No aggregate producing equipment shall be put into operation prior to the approval of the equipment by the Engineer. If after the equipment is put into operation it fails to perform as proposed, the Contractor shall provide additional approved equipment or replace the original equipment with more suitable equipment, as may be directed by the Engineer.

3-6-A-2 TESTING

In order to ascertain the properties of all aggregate materials, the Contractor shall submit, for approval by the Engineer, test certificates from an approved testing laboratory for all materials intended for incorporation in the work prior to starting quarry or pit operations.

Representative samples for such testing shall be taken by the Contractor, at his expense, in the presence of the Engineer, and duplicate samples shall be submitted to the Engineer for future reference.

The Contractor may, if approved by the Engineer, conduct the necessary tests in the laboratory. The tests shall be conducted in the presence of the Engineer. The resume of the qualifications must be submitted to and approved by the Engineer prior to any testing operations.

This testing, whether performed at an approved testing laboratory or in the project laboratory, shall be solely the Contractor's responsibility and will be at the Contractor's expense.

3-6-A-3 APPROVAL AND INSPECTION

All sources of materials shall be approved by the Engineer prior to procuring or processing material from such sources. Test certificates obtained by the Contractor or performed by the Contractor at his expense are intended to assist the Contractor in his estimate of the location, extent, and quantities which will comply with the specifications when properly processed, and will no way obviate the need for further testing by the Engineer. Only materials from approved sources shall be processed for incorporation into the work. Approval of specific sources of materials shall not be construed as final approval and acceptance of materials from such sources.

All processed materials shall be tested and approved before being stored on the site or incorporated in the work and may be inspected and tested at any time during the progress of their preparation and use. Questionable materials shall not be unloaded and incorporated with materials previously approved and accepted. If however, the grading and quality of the material delivered to the site do not conform to the grading and quality as previously inspected and tested, or do not comply with the specifications, the Engineer reserves the right to reject such materials at the site of the work. Only materials conforming to the requirements of the specifications shall be used in the work.

Samples must meet all test requirements. The Contractor shall permit the Engineer to inspect any and all material used or to be used at any time during or after its preparation, or while being used during the process of the work or after the work has been completed. All such materials not complying with the required specifications, whether in place or not, shall be rejected and shall be removed promptly from the work. The Contractor shall supply, or arrange with any producer or manufacturer to supply, all necessary materials, labor, tools and equipment for such inspection.

3-6-A-4 STORAGE

Materials shall be stored so as to insure preservation of their specified quality and fitness for the work. They shall be placed on hard, clean surfaces and, when required by the Engineer, they shall be placed under cover. Stored materials shall be located as to facilitate prompt inspection and control. Private property shall not be used for storage purposes without written consent of the owner or lessee and payment to him, if necessary.

The center of the storage area shall be elevated and sloped to the sides so as to provide proper drainage of excess moisture. The material shall be stored in such a way to prevent segregation and coning to insure proper control of gradations and moisture. Course aggregate storage piles shall be built-up in layers not exceeding one (1) meter. The height of a stockpile shall be limited to a maximum of five (5) meters.

The equipment and methods used for stockpiling aggregates and for removing aggregates from the stockpiles must be approved by the Engineer and shall be such that no detrimental degradation of the aggregate will result and no appreciable amount of foreign material will be incorporated into the aggregate.

3-6-B AGGREGATE BASE COURSE

3-6-B-1 DESCRIPTION

This work shall consist of furnishing and placing well graded aggregate afggregate base course in successive layers of 15 cm, including additives if required, on a prepared surface in accordance with the specifications, and in conformity with the lines, grades, thicknesses and typical cross sections given in the drawings or as required by the Engineer.

3-6-B-2 MATERIALS

Materials shall conform to the requirements for the class of "Aggregate Base Course", specified on the plans or directed by the Engineer. All aggregates for base course shall consist of clean, tough, durable, sharp angle fragments free of any excess of thin or elongated pieces, and reasonably free of soft, disintegrated or decomposed stone, dirt or other deleterious matter.

3-6-B-2-1 Physical Requirements

All base course aggregate shall conform to the following physical requirements: Loss of

Sodium Sulfate Soundness	
Test	10 percent maximum
Loss of Magnesium Sulfate Soundness	
Test	12 percent maximum
Loss by Abrasion Test	35 percent maximum
Thin and Elongated Pieces, by	
Weight (larger than 1-inch, thickness less than 1/5 length	5 percent
Friable Particles	0.25 percent maximum

3-6-B-2-2 Aggregate Base Course - Class A

Material for class A shall consist of crushed gravel or stone fragments conforming to the following requirements:

AASHTO SIEVE	PERCENT PASSING
2 inch	100
1-½ inch	90 - 100
3/4 inch	50 - 80
No. 4	25 - 45
No. 40	10 - 20
No. 200	2 - 7

- Sand equivalent: 40% minimum (Aggregates passing through AASHTO SIEVE no: 4)
- Regular graded aggregate curve
- Loss of abrasion test: 40 % maximum

3-6-B-2-3 Aggregate Base Course - Class B

a. Materials for Class B shall be crushed rock or crushed gravel conforming to the following grading requirements:

AASHTO SIEVE		PERCENT PASSING
2-½	inch	100
2	inch	90 - 100
1-½	inch	35 - 70
1	inch	0 - 15
½	inch	0 - 5

b. Fine materials for Class B base course shall be quarry screenings or natural material and of suitable binding quality as approved by the Engineer. The material shall be free from foreign or organic matter, dirt, shale, clay and clay lumps, or other deleterious matter and shall conform to the following requirements:

AASHTO SIEVE	PERCENT PASSING
3/8 inch	100
No. 4	85 - 100
No. 100	10 - 30
Plasticity Index (AASHTO T 90)	6 maximum Sand
Equivalent (AASHTO T 176)	30 minimum

c. The combined material shall consist of a mixture of all aggregates uniformly graded from course to fine to conform to the following gradation requirements:

AASHTO SIEVE		PERCENT PASSING
2-½	inch	100
2	inch	90 - 100
1-½	inch	60 - 90
1	inch	42 - 77
3/4	inch	35 - 70
½	inch	25 - 60
No. 4		15 - 40
No. 10		10 - 26
No. 40		5 - 15
No. 200		2 - 9

3-6-B-2-4 Aggregate Base Course - Class C

Material for Class C base course shall consist of uniform mixture of crushed rock and/or gravel with sand, silt and clay, conforming to the following requirements

AASHTO SIEVE		PERCENT PASSING
1-1/2	inch	100
1	inch	60 -100
3/4	inch	55 - 85
No. 4		35 - 60
No. 10		25 - 50
AASHTO SIEVE		**PERCENT PASSING**
No. 40		15 - 30
No. 200		8 - 15

The grading is based on aggregates of uniform specific gravity, and the percentage passing the various sieves are subject to correction by the Engineer, when aggregates of varying specific gravities are used.

Liquid Limit (AASHTO T 89)	25 maximum
Plasticity Index (AASHTO T 90)	4-8 maximum
Sand Equivalent (AASHTO T 176)	50 minimum

3-6-B-2-5 Aggregate Base Course Class D

- Density >2.45 kg/dm^3
- Resistance of compression = 500 kg/cm^2 on a test cube 7cm x 7cm x 7cm
- Sand equivalent: 40 min (Aggregates passing through AASHTO SIEVE No. 4)

AASHTO SIEVE		PERCENT PASSING
2	inch	100
1	inch	40 - 95
1/2	inch	40 - 75
No. 4		30 - 60
No. 10		20 - 60
No. 40		15 - 30
No. 200		5 - 20

3-6-B-2-6 Acceptance

The aggregate will be accepted immediately following mixing, based on periodic samples taken. When the aggregate is a total aggregate, it may be accepted at the crusher. Acceptance of the material by the Engineer does not constitute acceptance of the base course, only that the material is approved for use in the base course.

3-6-B-3 CONSTRUCTION REQUIREMENTS

3-6-B-3-1 Subgrade Preparation

The subgrade shall be well compacted, smooth, hard and uniform, all irregularities having been bladed out and rolled down for construction.

At all special grade control points, the subgrade shall be leveled to such depth that the proper thickness of base course may be constructed flush with the existing surface. The transition from normal to special section shall be of sufficient length to present no abrupt or noticeable change of grade and shall be excavated in accordance with the grades and lines shown on the plans or directed by the Engineer.

3-6-B-3-2 Maintenance of Subgrade

The roadbed being prepared shall be maintained true to cross section and grade until the base course is completed.

3-6-B-3-3 Method of Construction

3-6-B-3-3-1 Combining Aggregates and Water

Aggregates for base course shall be combined into a uniform mixture and water added either in a central mixing plant or by watering in a manner approved by the Engineer, before final placement of the material. When binder is to be added, if approved by the Engineer, it may be combined with the aggregate base by thoroughly mixing separate quantities of binder and aggregate base or it may be combined in the central mixing plant. Adding binder by spreading it will not be permitted.

The moisture added to the aggregates shall be that required, as designated by the Engineer, to obtain the specified density thereby preparing an aggregate completely ready for compaction after spreading on the subgrade. In no case will the wetting of aggregates in stockpiles or trucks be permitted.

3-6-B-3-3-2 Spreading and Combining Aggregates

Unless otherwise specified, aggregate for base courses shall be delivered to the roadbed as a uniform mixture and shall be placed on the site prepared subgrade, in a uniform layer. Spreading shall be done by means of approved self-propelled stone spreaders, distributing the material to the required width and loose thickness.

The material shall be so handled, as to avoid segregation. If an aggregate spreader causes segregation in the material, or leaves ridges or other objectionable marks on the surface which cannot be eliminated easily or prevented by adjustment of the spreader operation, the use of such spreader shall be discontinued and replaced. All segregated material shall be removed and replaced with well-graded material. No "skin" patching shall be permitted.

3-6-B-3-3-3 Compaction

Immediately after placing, the base course material shall be compacted as required by AASHTO or equivalent.

The surface of the finished base course will be tested with a three (3) meter straightedge at selected locations. The variation of the surface from the testing straightedge between any two (2) contacts with the surface shall at no point exceed ten (10) millimeters, unless otherwise specified, when placed on or parallel to the centerline or when placed perpendicular to the centerline.

3-6-B-3-3-4 Maintenance

Following the construction of the aggregate base course, the compacted course shall be maintained by the Contractor at his expense. The Contractor shall, broom and maintain the base, keeping it free from raveling and other defects until such time as the bituminous prime or other surface is applied.

3-6-C BITUMINOUS BASE COURSE

3-6-C-1 DESCRIPTION

This Work shall consist of aggregate and bituminous material mixed in a central plant, and spread and compacted on an approved primed subgrade in accordance with the specifications and in conformity with the lines, grades, thickness and typical cross sections or as required by the Engineer.

3-6-C-2 MATERIALS

3-6-C-2-1 Mineral Aggregates

Mineral aggregates for "Bituminous Base Course" shall consist of course aggregates, fine aggregates, and filler material, if required, all complying with the following requirements:

a. Course aggregate which is the material retained on an AASHTO No. 4 sieve, shall consist of crushed rock or crushed gravel. It shall be clean, hard, tough, durable and sound, and shall be of uniform quality and free from decomposed stone, organic matter, shale, clay, lumps and other deleterious substances.

The course aggregate shall be free of excess of flat elongated pieces (in no case more than ten (10) percent) and shall be of such character that when coated with asphalt shall pass a stripping test performed in accordance with AASHTO T 182.

Crushed gravel for use as course aggregate shall consist of the product obtained by crushing material that has first been screened in such a manner that not less than ninety (90) percent of the material to be crushed is retained on a Standard AASHTO No. 3/8 inch sieve, The amount of crushing of gravel shall be regulated so that at least ninety (90) percent by weight of the material retained on an AASHTO No. 4 sieve shall consist of pieces- with at least one (1) mechanically fractured face, and when tested for stability of bituminous mix shows satisfactory stability. Course aggregate, used for "Bituminous Base Course" only, may be uncrushed angular material which meets the angular and other requirements herein.

b. Fine aggregates shall consist of that portion of the total aggregate that passes a standard AASHTO No. 4 sieve and after crushing at least eighty-five (85) percent by weight of the material passing the AASHTO No. 4 sieve and retained on the AASHTO No. 10 sieve, shall consist of pieces having at least one (1) mechanical fractured face. Should natural material passing the AASHTO No. 4 sieve be included in the mixture, this material shall be fed to the dryer as a separate aggregate and the amount used shall be so limited that the mixture of fine aggregates will contain not less than twenty-five (25) percent by weight of the crushed aggregates.

c. When the combined grading of the course and fine aggregates is deficient in material passing the AASHTO No. 200 sieve and depending on laboratory analysis of the Asphalt Institute, mineral filler shall be added as approved by the Engineer. Mineral filler shall consist of finely divided mineral matter such as rock dust including limestone dust, slag dust, hydrated lime, hydraulic cement, or other approved mineral matter. At the time of use it shall be sufficiently dry to flow freely and essentially free from agglomerations.

Filler material shall conform to the requirements of AASHTO M-17. Gradation requirements as follows:

SIEVE	**PERCENT PASSING (BY WEIGHT)**
No. 40	100
No. 200	75 – 100

d. The combined mineral aggregate shall meet the quality requirements and, shall conform to the following physical requirements:

- Loss by abrasion test (L.A.): 30% max.
- Sand equivalent: 50% min. (Aggregates passing through AASHTO SIEVE No. 4)
- Absorbtion shall not exceed 2%
- Gradation requirements are as follows:

AASHTO SIEVE SIZE	**PERCENT PASSING**
¾ inch	100
½ inch	75 - 100
3/8 inch	60 - 85
No. 4	35 - 50
No. 8	20 - 35
No 30	10 - 16
No. 50	6 - 16
No. 100	4 - 12
No. 200	2 – 8

3-6-C-2-2 *Asphalts*

Asphalt for "Bituminous Base Course" shall be petroleum asphalt cement, grade 40-50 penetration, conforming to the requirements in the following table:

The asphalt shall be prepared by the refining of petroleum. It shall be uniform in character and shall not foam when heated to 176.7 degrees C

Specifications for Asphalt Cements

GENERAL REQUIREMENTS	Unit	Asphalt	Asphalt	Asphalt
Penetration, 25° C 100 grams 5 seconds	0.1 mm	40-50	60-70	80-100
Flash point in ° C (Cleveland open cup)	°C	232	232	232
Thin film test (weight loss in % at t = 163 ° C during 5 hours)	%	1	1	1
Ductility: at 25°C	cm	100	100	100
Solubility in Trichloroethylene, percent	%	99.5	99.5	99.5

3-6-C-2-3 *Job-Mix*

At least thirty (30) days prior to the date the Contractor intends to begin production of the Bituminous Base Course, and after receiving approval of the aggregates from the Engineer and after the delivery on site, of the asphalt specified for "Bituminous Base Course", the Contractor shall make written request for the approved job-mix formula from the Engineer.

The job-mix formula will be prepared by the Contractor, under the supervision of the Engineer, in the project laboratory.

The job-mix formula shall combine the mineral aggregates and asphalt in such proportion as to produce a mixture conforming to the following composition limits by weight:

	PERCENT
Total Mineral Aggregates	94 - 95
Asphaltic Binder	5 - 6 (of the total volume)

When tested according to the Marshall Method, the bituminous mixture shall conform to the following requirements:

Stability (kgs)	700 minimum
Flow (mm)	4mm & Less tha n 4 mm
Voids in total mix (percent)	3 - 6

All trial mixes shall be prepared and tested by the Contractor and results are given to the Engineer. The Marshall Test procedure will be used to determine the percentage of liquid asphalt that is to be incorporated into the mixture. For the same reasons, a low asphalt content in the mix is detrimental. The job-mix formula will therefore provide for as high as possible for a mix designed by the Marshall Test procedure. The mix formula will also take into consideration the absorption of asphalt into the aggregates. Thus, for calculations for voids, the adjusted bulk specific gravity of the Marshall specimens, adjusted for the portion of asphalt lost by absorption, shall be used.

The gradation of the combined aggregate, including the mineral filler shall be within the limits specified in the specifications for the Class of "Bituminous Base Course" to be used. The Engineer may vary the specified limits where he deems it necessary, on the basis of the Marshall tests, to obtain optimum stability and life of the completed mix.

Upon receiving the job-mix formula, approved by the Engineer, the Contractor shall adjust his plant to proportion the individual aggregates, mineral filler and asphalt to produce a final mix that, when compared to the job-mix formula, shall be within the following limits:

MAXIMUM VARIATIONS OF PERCENTAGE OF MATERIALS PASSING

AASHTO No. 10 and less	± 2	percent
AASHTO No. 4 and larger	± 5	percent

The Engineer will test the mix periodically and, if necessary, direct the Contractor to readjust the plant to maintain conformity of the job-mix formula. If, during production, the grading of the aggregates alters, the mix shall be redesigned and the plant readjusted as outlined above.

The assistance of the Engineer in the preparation of the job mix formula in no way relieves the Contractor of the responsibility of producing a bituminous mixture meeting the requirements of the specifications.

3-6-C-2-4 Equipment

Equipment used by the Contractor must fit with his obligations and results to fulfill to best the works within the technical specifications and as directed by the Engineer. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of paraffin oil, lime solution, or other approved material to prevent the mixture from adhering to the beds. When required by the Engineer, each vehicle shall be equipped with a canvas cover or other suitable material of such size as to protect the mixture from the weather.

3-6-C-3 CONSTRUCTION REQUIREMENTS

Rolling equipment shall be self-propelled. The wheels on the rollers shall be equipped with adjustable scrapers and the rollers shall have water tanks and sprinkling apparatus which shall be used to keep the wheels wet and prevent the surface material from sticking.

Weights of two-axle tandem steel rollers, three-axle tandem steel rollers, three-wheel steel rollers, and self-propelled pneumatic-tired rollers and the total weight of the pneumatic-tired roller shall be as directed by the Engineer.

3-6-C-3-1 *Preparation of Asphalt Cement*

Asphalt cement shall be heated within a temperature range of 135 degrees °C to 163 degrees °C at the time of mixing. Asphalt cement spreading will be made at 135 degrees °C. Asphalt cement received at temperatures in excess of 163°C but not exceeding 191°C may be used.

3-6-C-3-2 *Preparation of Mineral Aggregates*

Each aggregate ingredient shall be heated and dried at such temperatures that the temperature as recorded in the hot fines bin after screening shall not exceed 163 degrees C. If the aggregates contain sufficient moisture to cause foaming in the mixture or their temperature is in excess of 163 degrees C, they shall be removed from the bins and returned to the respective stockpiles. Immediately after heating, the aggregate or aggregates shall be and conveyed into separate bins ready for batching and mixing with bituminous material.

3-6-C-3-3 *Preparation of Bituminous Mixture*

Dried aggregate as specified for bituminous construction and prepared as prescribed above shall be combined in the plant in the proportionate amounts as approved. Asphalt cement shall be introduced into the mixture in the proportionate amount determined, all according to the job-mix formula.

3-6-C-3-4 *Preparation Of Subgrade Or Existing Surface*

Prior to the placing of the mixture, when designated on the plans or directed by the Engineer, a prime coat shall be applied to the subgrade or existing surface in accordance with the standards specified in Section "Bituminous Prime Coat".

3-6-C-3-5 *Placing of the Mixture*

The bituminous mixtures shall be spread and finished true to crown and grade by the automatically controlled bituminous paver. Bituminous mixtures may be spread and finished by hand methods only where machine methods are impractical as determined by the Engineer.

The automatically controlled paver shall spread the bituminous mixtures without tearing the surface and shall strike a finish that is smooth, true to cross section, uniform in density and texture and free from hollows, transverse corrugations and other irregularities.

The paver shall be operated at a speed which will give the best results for the type of paver being used and which coordinates satisfactorily with the rate of delivery of the mixture to the paver so as to provide a uniform rate of placement without intermittent operation of the paver.

Bituminous mixtures, except on leveling courses, shall be spread so that, after rolling, the nominal thickness of the compacted bituminous material will fit with the finished level as given on shop drawings.

The maximum thickness for layers may be increased slightly when such increase is more adaptable to total pavement thickness with the permission of the Project Engineer.

3-6-C-3-6 *Compaction of Mixtures*

After spreading and strike-off and as soon as the mix conditions permit the rolling to be performed without excessive shoving or tearing, the mixture shall be thoroughly and uniformly compacted.

Rolling shall not be prolonged till cracks appear. Rollers shall be of the steel wheel and/or pneumatic-tire type and shall be in good condition, capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers (between 10 T and 12 T) shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which results in excessive crushing of the aggregate will not be permitted.

Initial or breakdown rolling shall be done by means of either a tandem power steel roller or a three (3) wheel power steel roller. Rolling shall begin as soon as the mixture bear the roller without undue displacement. Rolling shall be longitudinally, beginning at the low side of the spread of material and proceeding toward the high side, overlapping on successive trips by at least one-half (1/2) the width of the rear wheels. Alternate trips of the roller shall be of slightly different lengths.

The motion of the roller shall at all times be slow enough to avoid displacement of the mixture and the speed of the roller controlled. To prevent adhesion of the mixture to the rollers, the wheels of the rollers shall be kept properly moistened with water, but an excess of water will not be permitted.

The initial or breakdown rolling shall be followed by rolling with a pneumatic-tired roller. Final compaction and finish rolling shall be done by means of a tandem power steel roller unless otherwise designated. When the specified density is not obtained, changes in size and/or number of rollers shall be made as corrective measures to satisfy the density requirement.

Rollers shall be operated by competent and experienced roller men and shall be kept in operation continuously, if necessary, so that all parts of the pavement will receive substantially equal compaction at the time desired. The Engineer will order the mixing plant to cease operation at any time proper rolling is not being performed.

The road density requirements shall be equal to or greater than ninety-six (97) percent of the Marshall Density of each day's production.

Any mixture that becomes loose, broken, mixed with foreign material, or which is in any way defective in finish or density, or which does not comply in all other respects with the requirements of the specifications shall be removed replaced with suitable material, and finished in accordance with the specifications.

3-6-C-3-7 *Joints*

Joints between old and new pavements or between successive days work shall be made so as to insure thorough and continuous bond between the old and new mixtures. Transverse construction joints in previously laid material shall be constructed by cutting the material back vertically for its full depth so as to expose a fresh surface.

Before placing the fresh mixture against a cut joint or again old pavement, the contact surface shall be sprayed or painted with a thin uniform coat. Where a finishing machine is used, the longitudinal joint shall be made by over lapping the screed on the previously laid material for a width of at least three (3) centimeters and depositing a sufficient amount of mixture so that the joint forced will be smooth end tight.

3-6-C-3-8 Introduction of Fresh Mixture

The Contractor shall protect all sections of newly compacted mixture from traffic until they have hardened properly.

3-6-C-3-9 Surface Tolerances

The surface will be tested with a four (4) meter straightedge by the Engineer at selected locations. The variation of the surface from the testing edge of the straightedge between any two (2) contacts with the surface shall at no point exceed six (6) millimeters when placed on or parallel to the centerline or six (6) millimeters when placed perpendicular to the centerline of the roadway. The top of the base shall not vary from the required elevation by more than five (5) millimeters. All humps and depressions exceeding the specified tolerance shall be corrected by removing the defective Work and replacing it with new material as directed by the Engineer.

3-6-C-3-10 Weather Limitations

Hot asphaltic mixtures shall be placed only when the air temperature is five (5) degrees C or above and less than 40 degrees C, and when the weather is not foggy or rainy and when the existing surface is free from moisture.

3-6-D BITUMINOUS PRIME COAT

3-6-D-1 DESCRIPTION

This work shall consist of applying a liquid asphalt prime coat on previously constructed aggregate base course before spreading the bituminous base course, and as otherwise specified; in accordance with the specifications, and in conformity with the lines shown on the plans or established by the Engineer.

3-6-D-2 MATERIAL

Medium-curing cutback asphalt shall consist of an asphaltic base fluxed with suitable petroleum distillates. The product shall be free of water and shall conform to all the requirements of Grade MC-0/MC-1 as shown in the following Tables.

CHARACTERISTICS	MC-0	MC-1	MC-2	MC-3	MC-4	MC-5
Flash point (Open Tag), degrees C - Minimum	38	38	66	66	66	66
Furol Viscosity at 25 degrees C, seconds	75-150					
Furol Viscosity at 50 degrees C, seconds		75-150				
Furol Viscosity at 60 degrees C, seconds			100-200	250-500		
Furol Viscosity at 82 degrees C, seconds					125-250	300-600

CHARACTERISTICS	MC-0	MC-1	MC-2	MC-3	MC-4	MC-5
Max % of water in volume	0.1	0.1	0.1	0.1	0.1	0.1
Distillation						
Distillate (percent of total distillate to 360	50	40	33	27	22	18
To 225° degrees C	0-25	0-20	0-10	0-5	-	-
To 260° degrees C	40-70	25-65	15-55	5-40	0-30	0-20
To 316° degrees C	75-93	70-90	60-87	55-85	40-80	20-75
Texts on Residue form Distillation: Penetration, 25 degree C,						
100 grams, 5 seconds	120-300	120-300	120-300	120-300	120-300	120-300
Ductility, 25 degrees C in centimeters	50	50	50	50	50	50
Solubility in carbon Tetrachloride, percent (minimum)	99	99	99	99	99	99
General Requirements	The materials shall be free from water					

	Temperature for Mixing	Temperature for Spraying
Asphalt Cement		
40 - 50	150 - 160	-
60 - 70	135 - 162	140 - 165
80 - 100	135 - 163	140 - 165
Prime Coat		
MC - 0	10 - 49	11 - 60
MC - 1	27 - 66	47 - 85
MC - 2	47 - 82	60 - 102
MC - 3	66 - 93	80 - 121
MC - 4	79 - 107	88 - 130
MC - 5	105 - 121	105 - 143

3-6-D-3 CONSTRUCTION REQUIREMENTS

It shall be the Contractor's sole responsibility to maintain the surface in an approved condition, conforming to the required grades and sections. Any defects which may develop shall be immediately corrected at the Contractor's expense.

Equipment used by the Contractor must fit with these obligations and results to fulfill to best the works within the technical specifications and as directed by the Engineer.

Prior to the application of the bituminous material, all loose materials shall be removed from the surface and the surface shall be cleaned by means of approved mechanical sweepers or blowers and/or hand brooms, until it is as free from dust as is deemed practicable. If deemed necessary by the Engineer, the cleaned surface shall be given a light application of water and allowed to dry to a surface-dry condition before the bituminous material is applied. No traffic shall be permitted on the surface after it has been prepared to receive the bituminous material.

3-6-D-3-1 *Application of the Prime*

Medium-curing cutback asphalt, Grade MC-0 / MC-1, shall be applied at the rate as directed by the Engineer, by approved pressure distributors operated by skilled workmen. The spray nozzles and spray bar shall be adjusted and frequently checked so that uniform distribution is insured. Spraying shall cease immediately upon any clogging or interference of any nozzles, and corrective measures taken before spraying is resumed.

Hand sprays will be approved only for priming small patches or inaccessible areas that cannot be primed by normal operation of the distributor.

Care shall be taken that application of bituminous material at the junction of spreads is not in excess of the specified amount. Any excess shall be squeezed from the surface when ordered by the Engineer. Any skipped areas or recognized deficiencies shall be corrected by means of approved hand sprays.

3-6-D-3-2 *Rate of Application*

The rate of application for prime material is 1000g/m², the Engineer may alter the previously established rate so the Contractor shall, prior to the time he intends to begin his priming operation, prepare a test section of an approved length for the determination of the rate of application for the prime coat.

3-6-D-3-3 *Protection of Adjacent Structures*

When bituminous materials are being applied, the surfaces of all structures and any roadway appurtenances shall be protected in a manner approved by the Engineer to prevent them from being splattered with bituminous material or marred by equipment operation. In the event that any appurtenances become splattered or marred, the Contractor shall at his own expense, remove all traces of bituminous materials, and repair all damage and leave the appurtenances in an approved condition.

3-6-D-3-4 *Blotting*

If deemed necessary by the Engineer after the bituminous material has been applied for forty- eight (48) hours under favorable conditions and the prime coat has not dried sufficiently that it will not be damaged by traffic, a light application of aggregate shall be applied. The blotter material shall be a clean fine sand, chat sand, or other material as approved by the Engineer. Blotting material shall be applied sparingly on only the areas that have not dried. Blotting of the prime coat shall be done only when directed by the Engineer. Normally, additional time shall be allowed for drying of the prime coat when in the opinion of the Engineer this procedure does not seriously delay subsequent operations.

3-6-D-3-5 *Maintenance of Prime Coat*

The Contractor shall maintain the prime coat treatment, and the bituminous base of the subgrade or base course intact until it shall have been covered by the surface course. Any area where the prime coat has been damaged by traffic or by the Contractor's operations, shall be cleaned of all defective base course or subgrade repaired to the satisfaction of the Engineer and the maintenance and repair of the prime coat and the underlying subgrade shall be done at the Contractor's expense.

3-6-D-3-6 *Traffic Control*

The Contractor shall provide detours for the traveling public and for operational use in areas where priming is being done. Where no convenient detour can be made available, the Contractor shall provide traffic control and the priming operation shall be confined to a part of the roadway.

3-6-D-3-7 *Weather and Temperature Limitations*

Application of prime coat shall be performed only when the surface is dry, when the atmospheric temperature is above ten (10) degrees °C and less than 40°C, and when the weather is not foggy or rainy.

Part III-7: METAL WORKS

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PART 3.7 – CIVIL WORKS:

METAL WORKS

3-7-A STEEL DOORS/WINDOWS

See part III-4- Doors and windows.

3-7-B HARDWARE

Hardware sets, hinges, bolts, doors closers, door stops, signs and other items of hardware, unless otherwise specified, shall be satin, anodised aluminum finished. Door hinges shall comply with BS 7352 whereas locks and latches shall comply with BS 8572. Door lock, latch lever and knob furniture are to be products of one approved manufacture.

For all hardware to be used, samples shall be submitted to the Engineer for approval.

3-7-C GRILLS, SCREENS, ETC.

All grills, screens, protective meshes, louvers and guards shall be obtained from an approved manufacturers and shall be entirely suitable for their purpose.

All ferrous metal shall be galvanized, sherardized or coated with bonded zinc. All non-ferous metal shall be finished with an appropriate process to minimize corrosion.

3-7-D COVERS AND FRAMES

Covers recessed for floor finishes shall be provided with galvanized rolled steel angles of height equal to the thickness of floor finishing and fixed to the surface of the structural floor slab along all edges of the trenches so that the top edge is level with the finished floor level. The angles shall be laid so as to form seatings for covers and all additional galvanized rolled steel tee. Sections shall also be provided to support the duct covers.

The covers shall be galvanized to suit the ducts and the seatings described above. A lightweight galvanized steel mesh shall be fixed to the upper surface of the trays to provide a key for floor finishes. The seatings and the trays shall be laid that the finished floor is perfectly level and all trays fully supported at all edges without the use of loose packings. At least one tray in every series of trays covering a length of duct shall be provided with cast-in lifting eyes and a pair of suitable lifting keys. The above shall be handed to the Engineer on completion.

3-7-E FENCES AND GATES

Fences generally shall be in accordance with the relevant parts of BS 1722 Part 1 1986.

Chain link fencing shall be Type PLC.213 Grade A with high plastic covered chain link mesh. The mesh and line wires shall be galvanized prior to being plastic covered.

The straining posts, intermediate posts shall be manufactured and erected complete as specified in BS 1722. The fencing shall be true to line and vertical, following the profile of the ground, previously graded so as to prevent access beneath the bottom wire.

Gates shall be hung on reinforced concrete column, and shall be truly vertical.

Ornamental fabricated metalwork fences and gates shall be constructed of mild steel bar, strip or tube in accordance with the Drawings. All welded joints and drillings for bolts shall be made before painting, and all bolts, nuts and washers shall be galvanized or plated with two coats of bituminous paint.

3-7-F STRUCTURAL STEELWORK

Material for structural steelwork and workmanship shall comply with french standards. The steelwork shall be securely fixed to the foundations or buildings and designed to have such strength and stiffness that its deflection and movement under the loads to be applied shall be within tolerable limits.

All bolts and nuts, mild steel electrodes and high yield steel as well as all structural steel fabrication shall comply with French Standards.

All structural steelwork shall be fabricated using welded joints where possible for shop joints and bolted for field assembly.

3-7-G STAIRCASES

Staircases shall be suitable for superimposed load of 5kN/m² calculated on the plan area of the stair.

Open mesh type flooring shall be used for the treads and on the landings.

Stairs and landings shall be guarded on each side with a continuous handrail which shall be between 840 mm and 1000 mm in height on stairs measured from the tread nosings, and 1000 mm high on landings.

The riser / go dimensions shall fit the formula:

Twice the riser plus ONE TREAD = not less than 570 mm nor more than 635 mm. Consecutive treads shall overlap by not less than 16mm or as shown on the drawings.

3-7-H LADDERS

Ladders shall comply with BS 4211 and shall be of galvanized steel.

Stringers shall be extended 1000 mm above the upper platform and suitably opened out for access, or where ladders are below manhole covers, separate hand holds shall be fixed to the upper platform.

After fabrication, ladders under manhole covers shall dipped with hot galvanized.

3-7-I HANDRAILING

Handrailing shall be designed for horizontal loadings.

Standards and rails shall be manufatured from black mild steel or from extruded aluminum alloy approved by the Engineer. The nominal bore of steel tubing shall not be less than 32 mm.

Adequate provisions shall be made for thermal movement. Steel

handrailing shall be hot dip galvanized after fabrication.

3-7-J RAILWAY

This work shall consist of furnishing and installing railways as and where shown on the drawings or as directed by the Engineer. The anchorage system shall be approved by the Engineer. The Contractor shall submit to the Engineer's approval all the elements and dimensions of the railway. The materials of construction of the railway shall be structural steel.

Structural steel used for railings shall conform with the requirements of the AFNOR. All

elements shall be protected by zinc coating (galvanizing, refer to paragraph below).

The anchorage system shall be such that damaged metal posts and rails can be readily replaced without the need for cutting or coping edge unit into which the anchorage is located.

During erection the railway units shall be securely held in their correct positions until all connections and fixings are complete and the post fixings have gained adequate strength to develop the full holing down moment. The assessment of the adequacy of the post fixing shall be subject to the Engineer's approval. The finished railways shall be true to line and level throughout their length.

3-7-K STEEL ACCESS COVERS

Steel access covers shall be to the duty required and sized to suit the opening shown on the Drawings. They shall be complete with frame and shall be weatherproof (prevent the ingress of water) when closed and shall in all respects be strong and durable.

The covers shall be hinged and lockable and provided with stays to prevent the covers opening more than 105°. The Contractor shall provide with each cover a heavy duty non-corrodible padlock and four keys.

The covers and frames shall be galvanized or painted.

3-7-L GALVANIZING

Where galvanizing has been specified the items shall after fabrication be hot dipped galvanized in accordance with BS 729, or where approved zinc coated in accordance with BS 2569 Part 1 to a thickness of 0.15 mm.
All items to be protected shall be prepared as specified in the above standards.
Articles altered as the minor alternations at site or requiring minor repair at site shall be wire brushed to remove all rust and coated with 3 coats of approved zinc rich cold galvanized compound.

The minimum weight of coating and other requirements shall be as shown in the following table. If there is a conflict between the ASTM and minimum weight columns, the minimum weight column shall apply. The weight shown is ounces per square foot of surface area. The weight of coating shall be determined in accordance with ASTM A 90, modified to determine the coating of each surface separately. All surfaces, when tested separately, shall meet the minimum requirements.

Material	ASTM	Minimum Weight of Coating (oz./sq.ft.)
Steel products including structural shapes, tie rods, handrails, manhole steps, and miscellaneous items.	A 123 A 153 B 633 B 695	2.00 2.00 2.00 2.00
Hardware including cast, rolled, pressed and forged articles.	A 153 B 633 B 695	2.00 2.00 2.00
Bolts, screws, nuts and washers	A 153 B 633 B 695	1.25 1.25 1.25
CSP culverts and underdrains	A 444	1.00
Chain link fence fabric, tie wire only	A 392	1.20
Steel pipe (includes fence posts, braces and rails)	F 1083	1.80
All other chain link fence articles	A 123	1.80
Iron or steel wire fencing	A 116	0.80
Steel or iron sheets	A 525	1.20
Barbed wire	A 121	0.80
Electrolier standards, 7 gage steel and over	A 386	2.00
Electrolier standards, under 7 gage steel	A 386	1.50

The zinc coating shall adhere tenaciously to the surface of the base material. The finished product shall be free from blisters and excess zinc, and the coating shall be even, smooth and uniform throughout. Machine work, die work, cutting, punching, bending, welding, drilling, thread cutting, straightening, and other fabricating shall be done as far as is practicable before the galvanizing. All members, nuts, bolts, washers, etc. shall be galvanized before a structural unit is assembled. All uncoated spots or damaged coatings shall be cause for rejection.

Products that are warped or distorted to the extent of impairment for the use intended shall be rejected.

Zinc coating which has been field or shop cut, burned by welding, abraded, or otherwise damaged to such extent as to expose the base metal, shall be repaired and recoated by one of the following methods:

3-7-L-1 HOT-DIP PROCESS

The damaged areas shall be thoroughly stripped and cleaned and a coating of zinc shall be applied by the hot-dip process.

3-7-L-2 METALIZING PROCESS

This process can not be used unless the Contractor has the approval from the Project Manager.

The damaged area shall be thoroughly cleaned by blasting with sharp sand or steel grit. The blasted area shall lap the undamaged zinc coating at least ½ inch.

Zinc wire containing not less than 99.98 percent zinc shall be used in the metalizing operation. A zinc coating shall be applied to the damaged area with a metalizing gun

to a thickness of not less than 0.005 inch on the damaged area, and shall taper to zero thickness at the edge of the blasted undamaged section.

3-7-M WELDING

3-7-M-1 QUALIFICATION

In addition to the welding of structural steel, all welding shown on the plans or ordered by the Engineer shall conform to the Standard Specifications for Welded Highway and Railway Bridges of the American Welding Society.

Before assigning any welder to work covered by this Section of the specifications, the Contractor shall provide the Engineer with the names of the welders to be employed on the Work together with certification that each of these welders has passed qualification tests using procedures covered in The American Welding Society Standard B3.0, Part II, or such other qualification test acceptable to the Engineer. If required by the Engineer, the Contractor shall submit identifying stenciled test coupons made by any operator whose workmanship is subject to question. The Contractor shall require any welder to retake the test when, in the opinion of the Engineer, the work of the welder creates a reasonable doubt as to the proficiency of the welder. Tests, when required, shall be conducted at no additional expense to the Employer. Recertification of the welder shall be made to the Engineer only after the welder has taken and passed the required retest. Welders shall have passed the qualification tests within the preceding twelve (12) month period.

3-7-M-2 INSPECTION OF WELDS

Radiographic inspection of welds will be required, as specified in the current edition of the Standard Specifications for Welded Highway and Railway Bridges of the American Welding Society. Additional welds to be inspected radiographically will be specified on the plans.

When specified on the plans, other methods of nondestructive inspection of welds will be required.
The Contractor shall secure the services of an approved organization qualified in the inspection of welds and will bear the cost of this inspection service.
Inspection of all welds shall be done only by persons skilled in such inspection and who are acceptable to the Engineer. The Engineer shall review and interpret radiographs and other non-destructive or destructive testing and has the sole authority to accept or reject the inspection or Works.

All film and/or other records of weld inspection shall become the property of the Employer. In the inspection of welds, the presence of any of the following defects in excess of the specified limits will result in rejection of the weld as being detective:

(1) Cracks. Cracks, regardless of length or location, will not be allowed.

(2) Overlaps. Overlaps, lack of penetration or incomplete fusion will not be allowed.

(3) Inclusions, Including slag, Porosity and Other Deleterious Materials. Inclusions less than one and one-half (1.5) millimeters in the greatest dimension will be allowed if well-dispersed, such that the sum of the greatest dimensions of the inclusions in any twenty-five (25) millimeters of welded joint does not exceed nine and one-half (9.5) millimeters and there is no inclusion within twenty-five (25) millimeters of edge of a joint or a point of restraint.

(4) Inclusions, Including Slag, Porosity and Other Deleterious Material. Inclusions one and one-half (1.5) millimeters or larger in greatest dimension will be allowed provided that such defects do not exceed the following limits:

(a) Six and one-half (6.0) millimeters, for T up to nineteen (19) millimeters, one- third(1/3) T, for T from nineteen (19) millimeters to fifty-seven (57) millimeters, nineteen (19) millimeters, for T over fifty-seven (57) millimeters, where T is the thickness of the thinner plate being welded.

(b) Any group of inclusions in line that have an aggregate length greater than T in a length of twelve (12) T will not be allowed.

Defects shall be removed by mechanical means or by oxygen grooving, after which the joints shall be welded again.

Part IV: Mechanical Works

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PART 4 - MECHANICAL WORKS

4-A INTRODUCTION

This Specification sets out the general standards of the Facilities to be supplied by the Contractor and mention of any specific Plant and Equipment does not necessarily imply that such is included in the Facilities.

All component parts of the Facilities shall, unless specified otherwise, comply with the provisions of this Specification.

The names of the manufacturers of the Plant and Equipment proposed for incorporation in the Facilities together with performance, capacities, certified test reports and other significant information shall be provided, when requested, for consideration by the Engineer. The Engineer shall have power to reject any Plant and Equipment which in his opinion is unsatisfactory or not in accordance with this Specification and such Plant and Equipment shall be replaced by the Contractor at no extra cost to the Buyer.

4-B STANDARDS

All ductile iron pipes, pieces, joints, connections, parts and accessories shall comply with the following Standards, Norms and Specifications:

Pipes:	NF A 48-801, NF A 48-806, NF A 48-841, ISO 2531, EN 545-2002, EN598.
Connections and joints:	NF A 48-863, NF A 48-842, NF A 48-830, NF A 48-860, NF A 48-870, BS EN 545-1998, ISO 2531.
Joint's fittings:	NF T 47-305, ISO 4633
External Protection (Zinc coating):	NF A 48-852, ISO 8179
External Protection (Bituminous coating):	EN 545-2002, EN 598
Internal Protection (Cement mortar):	NF A 48-901, NF A 48-806, ISO 4179, EN 545, EN 598.
Excellency of Productions and Installations:	ISO 9001
Testing:	ISO 2531
Special Protection (Polyethylene):	ISO 8180

4-C GENERAL PLANT DESIGN MATERIALS AND WORKMANSHIP

4-C-1 PLANT DESIGN

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

Due attention shall be given to expansion due to temperature changes, the stability of paint finish for high temperatures, the rating of engines, electrical machinery, thermal overload devices, cooling systems, and the choice of lubricants for the possible prolonged high operating

temperatures. Suitable precautions, such as lagging or trace heating, shall be taken where necessary for protection against damage by frost.

Plant shall be designed to provide protection against damage by the entry of vermin and dust, and to minimize fire risk and consequent fire damage. It shall also be protected against damage due to dampness and condensation by sealing or temperature compensation.

All manually controlled Plant located outside a building shall be provided with facilities for making it tamperproof. This is in addition to any requirements for securing Plant under operational conditions.

All component parts of Plant shall be manufactured to strict limits of accuracy and shall be interchangeable with the component parts of similar Plant.

Plant shall be designed for continuous operation for prolonged periods with a minimum of maintenance and shall have a high resistance to change in these properties due to passage of time, exposure to light or any other cause which may affect the performance or life of the Works. Tenderers should be called upon to demonstrate this for any equipment under consideration either by service records of similar equipment, or by the records of extensive type tests.

Materials shall be selected taking into consideration their location and duty. In the case of Plant conveying water, particular attention shall be given to the risk of electrolytic reaction between differing materials of construction and to the effects of corrosion and, where there are impurities in the water, erosion.

Where wear is likely to occur during normal operation, the Plant shall be designed to enable a potentially affected area of a component part to be replaced without replacing the whole component. No part subject to wear shall have a life from new to replacement or repair of less than one year of continual operation. Where major dismantling to replace a part cannot be avoided, the life of such parts shall not be less than 5 years.

4-C-2 SUBSTANCES AND PRODUCTS

Substances and products used in the Works which may be applied to or introduced into water which is to be supplied for drinking, washing or cooking shall not contain any matter which could impart taste, odor, color or toxicity to the water or otherwise be objectionable on health grounds.

4-C-3 METALS

Unless stated otherwise cast iron shall be gray iron to ISO 185 Grade 220.

Mild steel shall be to ISO 1052.

Stainless steel shall have a corrosion resistance, in the relevant environment, not less than required for steel in accordance with ISO 683 - 13. The minimum grades of stainless steel used shall be:

Submerged conditions; Austenitic grade 316S12

Exposed to the ambient atmosphere; Martensitic grade 416S21

Stainless steels used for welding shall be a grade not subject to inter-granular corrosion.

Prevention of seizure, by fretting where two corrosion resistant metals are in contact, shall be by selection of suitable relative hardness and surface finish and/or lubrication.

Where bronze is specified, or used, it shall be zinc free.

Dissimilar metals in contact shall be selected so that the electrolytic potential difference does not exceed 0.6 volt unless the surface area of the lower potential metal is negligible. Alternatively an approved insulation material shall be used.

When the Engineer requires the submission of material samples for assessment they shall be submitted by and at the expense of the Contractor not less than thirty calendar days prior to the time that the material is required for incorporation into any Plant and Equipment. Samples shall be subject to written approval by the Engineer and shall not be used without such approval.

4-C-4 WELDING

Metal arc welding shall comply with ISO 3834.
In all cases where welds are liable to be highly stressed the Contractor shall supply to the Engineer before fabrication commences detailed drawings of all welds and weld preparations proposed. No such welding shall be carried out before the Engineer has signified his approval of the details proposed. No alteration shall be made to any previously approved detail of weld preparation without prior approval of the Engineer.
All other welding shall be carried out by welders qualified in accordance with the requirements of the appropriate section of ISO 9606.
Radiographic examination which may be required of highly stressed welds shall comply with the provisions of ISO 1106 or ISO 2504, except as otherwise specified or ordered by the Engineer.
Mechanical and other non-radiographic tests, if required, shall be carried out in the presence of the Engineer.
All welded constructions shall be heat treated to relieve residual stresses prior to finish machining.

4-C-5 CASTINGS

The structure of the castings shall be homogeneous and free from non-metallic inclusions and other defects. All surfaces of castings which are not machined shall be fettled to remove all foundry irregularities.
Minor defects not exceeding 10 mm in depth or 10% of total metal thickness whichever is less or which will not ultimately affect the strength and serviceability of the casting may be repaired by welding. If the removal of metal for repair should reduce the stress-resisting cross-section of the casting by more than 25%, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25%, then that casting shall be rejected.
Castings repaired by welding for major defects shall be stress-relieved after such welding, or as otherwise instructed in writing by the Engineer.
Non-destructive tests may be required for any casting containing defects whose effect cannot otherwise be established, or to determine that repair welds have been properly made.
Unless otherwise specified castings shall be produced to the following standards:

Flake graphite cast iron	BS 1452 Grade 220
Carbon steel	BS 3100 Steel alloy
Stainless steel	BS 3100 Steel 316C16 Copper
& copper alloy	BS 1400 Group A grade LG2 Group B grade CT1, AB2 Group C grade G1

4-C-6 FORGINGS

All major stress-bearing forgings shall be made to a standard specification which shall be submitted to the Engineer for approval before work is commenced. They shall be subject to internal examination and non-destructive tests for the detection of flaws, and shall be heat-treated for the relief of residual stresses. The name of the maker and particulars of the heat treatment proposed for each such forging shall be submitted to the Engineer. The Engineer may inspect such forgings at the place of manufacture with a representative of the Contractor.

4-C-7 BALANCING

All complete rotating assemblies shall be dynamically balanced. Balance quality shall not be less than G6.3 in accordance with ISO 1940/1

4-C-8 NON-METALLIC MATERIALS

Fabrics, cork, paper and similar materials which are not subsequently to be protected by impregnation, shall be treated with a fungicide. Sleeving and fabrics treated with linseed oil varnish will not be permitted.
The use of organic materials shall be avoided as far as possible but where these have to be used they shall be treated to make them fire resistant and non-flame propagating.

The use of wood shall be avoided as far as possible. If used, woodwork shall be thoroughly seasoned teak or similar hardwood which is resistant to fungal decay and other blemishes. All woodwork shall be treated to protect it against damage by fire, moisture, fungus, vermin, insect, bacteria or chemical attack, unless it is naturally resistant to all these. All joints in woodwork shall be dovetailed or tongued and pinned. Metal fittings on wood shall be of non-ferrous material. Adhesives shall be impervious to moisture and fungus growth. Synthetic resin cement only shall be used for joining wood. Casein cement shall not be used.

4-C-9 BOLTS, SCREWS, STUDS, WASHERS AND NUTS

Bolts, screws, studs and nuts shall comply with ISO 225, ISO 272, ISO 885, ISO 888, ISO 898, ISO 8992 and ISO 4759/1. Washers complying with ISO 887 and ISO 4759/3 shall be used under all nuts and hexagon bolts and screws.

Bolts, screws, nuts and washers exposed to the weather or in damp atmospheres inside buildings shall be zinc coated and painted or stainless steel.

Zinc coated items shall be hot dip galvanized, in accordance with ISO 1459, ISO 1460 and ISO 1461, and centrifuged. The threads of nuts shall be cut oversize.

Stainless steel items shall be manufactured from Grade 316S31.

Bolting for pipes and fittings shall comply with ISO 7005. Spheroidal graphite iron bolts for use with ductile iron pipes and fittings shall be manufactured from iron complying with ISO 1083.

Bolt lengths shall be sufficient to ensure that nuts are full threaded when tightened in their final position.

4-C-9-1 Fixing Bolts

Fixing bolts, nuts and washers for concrete, brick or masonry shall be of stainless steel. The bolts may be rag or indented bolts, expansion bolts, or resin bonded bolts. The Contractor shall submit details of the type he proposes to use, including manufacturer's specification literature, for the Engineer's approval.
When the bolts etc., are used for fixing aluminum items they shall be insulated from the aluminum by a non-metallic sleeve and under-washer.

The building-in material for use with rag or indented bolts shall be a proprietary epoxy non-shrink grout or a proprietary non-shrink mortar or caulking compound. Bolts shall not be brought into service until they are effectively anchored and the building in material has achieved adequate strength.

4-C-10 SAFEGUARDING PLANT

All designs and equipment shall be safe. The installation layout and plant design shall not allow any item of plant to be so positioned that danger to operating personnel could arise during normal operation and maintenance. Particular attention shall be paid to the position of hot pipes, valve hand wheels, air vents and rotating machinery.

4-C-11 RATING PLATES, NAME PLATES AND LABELS

Each main and auxiliary item of Plant and equipment shall have permanently attached to it in a conspicuous position a nameplate and rating plate. Upon these shall be engraved the manufacturer's name, direction of rotation, type and serial number of plant, details of the loading and duty at which the item of Plant has been designed to operate, and such diagrams as are deemed necessary. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their function and proper manner of use. Provision shall be made to incorporate descriptive numbering codes.

All valves shall have an identification plate bearing the valve number and a short description of valve function.

Nameplates, rating plates and labels shall be of a non-flame propagating material, either non-hygroscopic or transparent plastic, with engraved lettering of a contrasting color. Fixing shall be by means of screws. No drive rivets or adhesives shall be used.

4-C-12 LUBRICATION

4-C-12-1 General

Provision shall be made for suitable lubrication to ensure smooth operation, heat removal and freedom from undue wear. Plant selected shall require minimum lubrication attendance and down time for lubricant change.
All grease nipples, oil cups and dip sticks shall be readily accessible, being piped to a point as near as practicable to the lubrication point.

4-C-12-2 Oil Lubrication

Gear boxes and oil baths shall be provided with adequately sized filling and draining plugs and suitable means of oil level indication.
Roller chain drives shall have oil bath reservoir lubrication.
Drain points shall be located or piped to a position such that an adequately sized container can be placed beneath them. Where a large quantity of oil is involved or drainage to a container difficult, a drain valve and plug shall be provided at the point of discharge.
Bearings equipped with forced fed oil lubrication shall be automatically charged prior to machinery starting up and pressure monitored during operation with automatic shutdown of machinery and alarm on low oil pressure.
All points where oil leakage may occur shall be suitably trapped to prevent oil contamination of water. Oil filling and drain points shall be arranged so as to avoid the risk of contamination of water by accidental spillage.

Access, without the use of portable ladders, to lubrication systems shall be such as to permit maintenance, draining and re-filling, without contamination of the charged lubricant.
The design of breathers shall take into account the humidity and atmospheric contamination at the vent point and measures be incorporated to prevent contamination of the lubricant.

4-C-12-3 Grease Lubrication

Grease application shall be by steel lubrication nipples.
Anti friction bearings requiring infrequent charging shall be fitted with hydraulic type nipples.

Plain bearings requiring frequent charging shall be fitted with button head pattern nipples.

A separate nipple shall be provided to serve each lubrication point. Where a number of nipples supply remote lubricating points they shall be grouped together on a conveniently placed battery plate.

4-C-13 GASKETS AND JOINT RINGS

Joint rings suitable for hot or cold water or specified hydrocarbon fluids or for drainage applications shall be of chloroprene rubber or other approved synthetic material suitable for temperatures up to 80 C, or greater to suit the application.
Until immediately required for incorporation in a joint, each rubber ring or gasket shall be stored in the dark free from the deleterious effects of heat or cold, and kept flat so as to prevent any part of the rubber being in tension.
Graphite grease or similar shall be applied to the threads of bolts before joints are made.

4-C-14 ELECTROPLATING, GALVANIZING AND SHERARDIZING

Hot dip galvanizing shall be carried out with a deposition rate of at least 460 g/square meter. After galvanizing all parts shall be passivated to minimize discoloration.
Electroplating or galvanizing will be acceptable as an alternative to painting for small ferrous components.
All fixing bolts, washers, nuts and other fixings required for erection shall be spun galvanized, or sherardized unless otherwise specified. Stainless steel shall be used in wetted areas.

4-C-15 NOISE

No item of Plant intended for installation in a building shall produce a sound pressure level exceeding 85 dB (A) and preferably 56 dB(A) when measured at a distance of 1 m from the reference surface of that item in a horizontal direction and under environmental conditions appropriate to the test requirements of I.S.O. 3746 "Acoustic Determination of Sound Power Levels of Noise Services - Survey Methods".
Plant such as compressors, diesel engines, blowers etc. where reduction of noise emission to below 85 dB at 1 m is impractical will be installed in a separate room constructed in or containing sound absorbing material.

4-C-16 VIBRATION

All items of rotating machinery shall be dynamically balanced so that the level of vibration is within the limits set by BS4675, Pt 1, for a class IV machine to grade B.

This limit on vibration shall extend to the communicating pipework and mounting arrangements and include adjacent machinery either in operation or not.

4-C-17 ACCESS STEELWORK

Gaps between items of Plant and the surrounding structure shall be covered, and access ladders, platforms and handrails must be attached to items of Plant to facilitate operation, inspection or maintenance.

Adequate access shall be provided to all hand wheels, sight glasses, gauges, lubrication points and any other items to which access is necessary for routine maintenance.

Handrails shall consist of double ball forged steel standards with tubular rails. Chequer plating shall be of 'Durbar' or other non-slip pattern, not less than 4.5 mm thick (exclusive of pattern).

Diamond type pattern chequer plate shall not be used. Open type or solid type chequer plate flooring shall be used as appropriate for the location, taking into account ease of cleaning, precautions against slipping and areas below walkways.

All components for access steelwork shall be hot dip galvanized after manufacture.

4-C-18 HANDRAILING

Handrailing shall be double rail 1,100 mm high and 900 mm high on stairs measured vertically from the nose of the tread.

In case of no special requirements of the Engineer or on drawings, standard handrailing shall be 38 mm diameter solid forged steel with 60 mm diameter solid forged steel balls at handrail locating points. Standards shall have a minimum base width of 65 mm and be set at maximum 1 800 mm centers.

Handrails shall be 33.7 mm OD x 3.2 mm thick tubular steel Joints shall be arranged to coincide with the spacing of standards where possible, otherwise they shall have butt joints with a tubular steel ferrule, plug welded or fixed with a 5 mm diameter countersunk head pin.

Removable sections of handrail shall have half-lap joints secured with a countersunk head pin.

Chains across openings shall be 10 mm x 3 links per 100 mm galvanized mild steel. The hooks and retaining eyes shall be securely fixed to the balls of the standards.

All components for handrailing shall be hot dip galvanized after manufacture.

4-C-19 PAINTING AND PROTECTION

4-C-19-1 General

Protective coatings shall comply with BS 5493 "Code of practice for the protective coating of iron and steel against corrosion" except as otherwise specified in this section. For coatings designed to BS 5493 exterior conditions shall be assumed to be "polluted inland" conditions and the interiors of buildings shall be assumed to be "frequently damp or wet" except for control rooms. The thickness of coatings stated in this section of the specification is the minimum allowable thickness as defined in Clause 19 of BS 5493. Where the paints that are available do not provide dry film thickness as specified additional coatings shall be applied. Protective coatings for surfaces of tanks and other plant in contact with chemicals or otherwise in conditions not foreseen in this section of the specification or in BS 5493 shall be suitable for those conditions and shall be the subject of design submissions supported by evidence proving satisfactory experience of the proposals elsewhere.

Where dissimilar metals are in contact, insulation shall be provided to prevent electrochemical corrosion.

The protective coating system shall have a minimum 10 year life to first maintenance. A five year minimum performance warranty shall be given in respect of the paint as applied.

All coatings applied to any part of the plant in contact with water to be used for drinking, washing or cooking shall be non-toxic, non-carcinogenic, shall not impart taste, odor, color or turbidity to the water or foster microbial growth and they shall be approved by an international recognized authority for use on potable water.

To avoid the possibility of the presence of carcinogenic polyaromatic hydrocarbons all bituminous paints and coatings must be manufactured from petroleum or asphaltic bitumen and not from coal tar bitumen.

Lead based paints shall not be used.

All machined, polished or bright surfaces, both external and internal, shall be afforded suitable and adequate protection against corrosion, damage and deterioration.

No manufacturer's name plate identification, vented filler plugs in gearboxes or grease nipples shall be painted over.

Steel subject to hydrogen embrittlement through galvanizing shall not be used.

All iron and steelwork to be painted shall be blast cleaned to achieve a surface profile with a minimum amplitude of 0.025mm and a maximum of 0.100mm.

Following blast cleaning, steel surfaces shall be pure zinc metal sprayed where specified.

Aluminum structures and fittings shall not necessarily be painted.

All steel fabricated pipework and other plant, where specified, shall have a lining and coating, not less than 250 microns thick, of 100% solids, thermosetting fusion bonded, dry power epoxy coating.

GRP covers and guards shall be pigmented to give the finished color without painting.

4-C-19-2 *Coating Systems*

Tables A and B identify the coating systems to be used and minimum coating thickness.

TABLE A: REQUIRED COATING SYSTEMS AND MINIMUM COATING THICKNESSES FOR PLANT AND EQUIPMENT

	APPLIED PRIOR TO DELIVERY AND ERECTION						I IN
	SUBSTRATE	**PRETREATMENT**		**FIRST COAT**	**SECOND COAT**	**THIRD COAT**	
ABOVE WATER LEVEL Machinery & Steelwork not in contact with Sewage, sludge or Water to be used for drinking, washing or cooking	Steel (galvanized)	Etch Prime Wash	or T	Zinc Phosphate/CR Alkyd Primer Undercoat (0.050mm)	High Build Chlorinated rubber Paint (0.075mm)		Hi chl pai
	Steel Zinc Sprayed (0.070mm)	Etch Prime					

	Steel, Cast iron, Ductile iron	Blast clean BS 4232 2nd quality		Zinc Phosphate/CR Alkyd Blast Primer (0.050mm)	Zinc Phosphate Alkyd Primer (0.050mm)	High Build Chlorinated Rubber (0.075mm)	
BELOW WATER LEVEL Machinery and Steelwork in Contact with Water to be used for drinking, washing or cooking	Steel (Galvanized)	Etch Prime Wash	or T	Epoxy Primer High Build (0.125mm)	Epoxy High Build (0.50mm)	Epoxy High Build (0.075mm)	
	Steel, Cast iron, Ductile iron Zinc Sprayed (0.70mm)	Etch Prime					
Pipework	Steel	As specified					
Switchboard Shells, Frames and Backplates	Steel	As specified					

TABLE B: REQUIRED HEAT RESISTANT COATING SYSTEMS FOR STEELWORK

WORKING TEMPERATURE	ÁL: SURFACE TREATMENT	FIRST COAT	SECOND COAT	THIRD COAT
50°C to 175°C	Blast clean BS 4232 2nd quality	Polyvinyl Butyral (0.025mm) Zinc Chromate Primer (0.023m-0.015mm)	Aluminum heat resistant @ 200°C (0.025mm)	Aluminum heat resistant @ 200°C (0.025mm)
175°C to 500°C	Blast clean BS 4232 2nd quality	Aluminum pigmented silicone heat resistant (0.025mm)	Aluminum pigmented silicone heat resistant (0.025mm)	
	NB A minimum temperature of 350°C within a short time after application is required.			

4-C-20 MACHINERY, LIFTING AND DISMANTLING

Machinery bedplate design, packing and fixing shall be such as to minimize distortion and vibration. Aligned machinery shall be mounted on either bed or sole plates, permitting removal and reinstatement without a requirement to re-grout. Bedplates shall incorporate fine adjustment of the vertical and horizontal alignment between driver and driven members.

All machinery shall be fitted with lifting facilities. Large structures shall be provided with jacking points.

Tapped holes or other provision must be made in all main castings, for the insertion of jacking screws or the fixing of drawing gear to facilitate dismantling on items of machinery subject to frequent dismantling. Bolts or studs shall be employed in preference to set screws.

4-C-21 SEALS

4-C-21-1 General

Seals compatible with the Plant and best suited for the worst conditions likely to be met when the Plant is in operation shall be selected.
All seal materials shall be compatible with and/or resistant to the fluid or gas being handled.
For potable water, seal materials shall be specifically approved.

4-C-21-2 Soft Packed Glands

Shafts shall be provided with renewable gland sleeves. Glands subject to abrasive liquors or negative pressures shall embody suitably positioned lantern rings and a clean water continuous flushing system, operative whenever the Plant is in motion.
Gland adjustment nuts shall be readily accessible for routine maintenance.

Gland drain pipework, shall be installed, incorporating rodding facilities and adequate inclines, of 25mm minimum diameter on water reclamation plant and 12.5mm on water supply plant, discharging to the nearest sump or drainage channel.

4-C-21-3 Mechanical Seals

Mechanical seals which are subject to abrasive liquor or gas, negative pressures or corrosive elements, shall be provided with a clean water continuous gland flushing system, operative when the item of plant is in motion or the corrosive element present. A back-to-back sealing arrangement with a flushing/cooling system shall be accepted as satisfying the requirements of this clause.

4-C-22 BEARINGS

4-C-22-1 Below Water Bearings

The Contractor shall select the most appropriate type of bearing for the Plant being supplied.

Equipment with vertical shafts shall have thrust and guide bearings. All bearings shall be designed to exclude the ingress of dust and water.

Sealed for life units are acceptable subject to a minimum design life of 50,000 hours operation at maximum loading.

Plant which may be subject to vibration whilst stationary shall be provided with bearings designed to withstand damage from such a cause.

Below water bearings shall be of the journal type, of ferrobestos, gunmetal or equivalent and journals of stainless steel.

4-C-22-2 Above Water Bearings

Single journal plain bearings shall be phosphor bronze or synthetic lubrication impregnated bushes with carbon or stainless steel journals respectively. Synthetic bearings shall only be used where bearing condition can be inspected readily.

Plain type bearings shall be self-lubricating by either grease, forced oil or impregnation.

Ball and roller type bearings shall be adequately lubricated by oil or grease and sealed to prevent leakage of lubricant along the shaft. Attention shall be given to ensure the dismantling of

bearings is simple and free from risk of damage.

Bearings fitted to gear boxes shall a minimum design life of 100,000 hours at maximum loading.

4-C-23 GEARBOXES

Where driven plant requires a drive system incorporating a speed reducing or increasing gearbox, the drive system shall be supplied by the driven plant manufacturer.
The gear form shall be in accordance with the relevant ISO or AGMA standard. The gear load carrying capacity for strength and wear shall be determined in accordance with the relevant ISO or AGMA standard but the following parameters shall be taken as a minimum.

i- 24 hours per day operation

Service factor of 1.4 based on the rated output of the respective prime mover. iii- Rated

life of 100,000 hours

The surface hardness of gears shall be determined in accordance with the relevant ISO or AGMA standard and for case hardened gears the depth of case shall be not less than 0.4 mm after profile grinding to counteract distortion.
The gears shall be enclosed in a cast or fabricated case. Fabricated steel cases shall be stress relieved prior to final machining. The case shall be split or provided with covers to facilitate inspection of the gears without dismantling the shafts.
Shaft bearings shall be selected with a rated life of 100,000 hours at the maximum speed and power rating of the gears. Any end thrust from the gears shall be accommodated by the shaft bearings.
Input and output shafts shall be adequately sealed to retain lubricant and prevent ingress of contaminants under all operating conditions.
Drain and filling plugs shall be provided. Where necessary extension tubes shall also be provided to facilitate filling and draining. Breathers shall be provided with filters to prevent ingress of dust and moisture etc.
Oil lubricated gearboxes shall be fitted with a sight glass indicating both the hot and cold oil levels.
Dependence on splash lubrication alone is not acceptable but it may be used in conjunction with a forced feed method to reach all bearings and gears.
Each gearbox shall be equipped with an embossed nameplate including at least the following information:

i- Manufacturer's name

ii- Gearbox type reference

iii- Serial or Order Number iv-

Power rating of gears

Speed ratio
Lubrication specification (type and viscosity)

4-C-24 FLEXIBLE COUPLINGS

Flexible couplings where supplied, shall be generously rated to cover the full range of duty.

Couplings liable to impregnation by oil shall be of the all metal flexible type.

General service couplings shall be of the flexible multi-pin and bush type, having not less than six bushes and each bush shall have an inner sleeve to allow rotation on the pin (bushes shall not be in direct contact with the pin). All pins shall have shoulders to allow positive location and securing to the bosses.
Bosses shall be a tight fit on the shafts and secured with hand fitted keys.
Couplings shall be supplied in matching balanced sets and shall be machined, balanced and marked before leaving manufacturer's works.

4-C-25 STRAINERS

Strainers shall be flange mounted type. Foot strainers shall be installed at least 0.5m (or as directed by the Engineer) above the bottom of the water reservoirs. The strainer basket shall be of the perforated cylinder type made from galvanized steel or stainless steel. It shall be easily accessible via a removable flange.
Also inline strainers shall be installed upstream the flow and water meters.

4-C-26 SAFETY SIGNS

Safety signs are required for all hazardous plant areas. The signs shall be of durable quality and shall comprise a substrate of 22 gauge aluminum, pre-drilled for fixing and with radiussed corners free of burrs or sharp edges. Symbols and lettering shall be screen printed.

4-C-27 SAFETY GUARDS

All sections of the plant which constitute a safety hazard shall be covered by substantial guards or barriers.
All moving parts of plant shall be adequately guarded to ISO/TR 12100.
All parts that in normal working are hotter than 60°C or colder than -5°C shall either be adequately fenced or shall be lagged.
All live electrical conductors, including conductors forming part of electrical apparatus, shall be either insulated or so fenced or placed as to prevent danger.
Guards shall be fabricated in mild steel wire mesh or expanded steel sheet, or should a fully enclosed type be necessary, in mild steel sheet.
Guards shall be designed to provide ready access to bearings, greasing points, thermometer pockets and other check points to allow routine observations to be made by the operating staff without danger or the need to dismantle any part of the guard. Hinged doors let into the guards with padlocking facilities shall be provided where necessary to facilitate access to the check points.

Guards shall be bolted in position in such a way that they cannot be unintentionally dismantled or removed.
All mild steel used in the construction of guards, including bolts, nuts, washers and brackets shall be hot dip galvanized unless otherwise specified.
Drawings of safety guards shall be submitted to the Engineer for approval before manufacture.

4-C-28 PLANT IDENTIFICATION

All pipework equipment, panels and valves shall be identified. Pipework shall be painted or color banded and labeled. Adhesive labels shall be used to identify tanks. Equipment shall be identified using engraved plates of a non-corrodible metal fixed on to the item using four screws. Engraved tags of a non-corrodible metal shall be used for valve identification. Tags shall of a uniform shape and shall be fastened by a jack chain.

4-D VALVES AND ACCESSORIES

4-D-1 VALVES

4-D-1-1 General

The valve, components and all its related parts and accessories shall comply to one of the International Standards Institutes requirements (i.e. ISO, BSS, DIN, etc…).
Manufacturer(s) must have the Label of Quality ISO 9001 to be qualified as supplier. The contractor shall not submit any materials for approval if not compatible with the required specifications and from an approved manufacture.

4-D-1-2 Ductile Iron Gate valves

The Ductile Iron Gate valves should have the following characteristics:
Working Pressures up to 25 kg/cm2 (PN 6/10/16 and 25).
Working Temperature: From –10 °C up to 70 °C, resilient type Soft sealing for PN10 /16 /25, metal seated for PN25 and DN>300
Body and bonnet in spherical graphite ductile iron EN-GJS-400-15 (GGG- 40), with blue Ral 5015 epoxy powder coating electrostatically applied (EN1563) with min 250 microns
Wedge in spherical graphite ductile iron EN-GJS-400-15 (GGG-40), fully coated by EPDM, or NBR (DVGW). EN1563
Wedge lock nut in copper alloy with high resistance to corrosion, EN 12165
Stem in stainless steel AISI-420 (X20C13), EN 10080
Body-bonnet gasket in EPDM or NBR (DVGW), EN681-1
Body-bonnet bolting in steel quality 8.8, with anticorrosive coating DIN 912

Gate valves are supplied with handwheel in stamped steel, or square cap in EN-GJS-400-15 (GGG-40) for 30x30 T-key. They can also be operated with gear-box, electric, pneumatic actuator, extensions,… EN 10088 / EN1563.
Gate Valves should be tested according to EN 12166-1, DIN 3230, and according to EN 1074 (2.500 cycles endurance resistance) or BS 5163 part2. Seat: 1.1 x PN, Body: 1.5 x PN
Third Party approval: product conformity certificate from Bureau VERITAS or similar in addition to a proof of suitability for drinking water
Dimensions: as per EN558 or BS 5163 part1
Flanges and drilling EN1092-2

The Metal Seated Gate valve for DN>300 and PN 25 should be according to BS5163 & BS5150 and having the additional following characteristics:
Wedge in Ductile Iron, BS EN 1563 / EN-GJS 400/15.
Wedge Face Aluminum bronze, EN1982 CC331G.

- Hydraulic test to BS 5150 / EN 1171, Seat: 1.1 x PN, Body: 1.5 x PN

For all valves types for DN>350mm., bypasses are required.

4-D-1-3 Butterfly Valves

Butterfly valves, manual or motorized, fitted with maintenance free worm gear including mechanical position indicator and hand wheel, other Combined gear type may be used for specified application if particular min number of turns is specified. Where required, valves shall be electrically actuated with a manual override.

The Ductile Iron Butterfly Valves should have the following characteristics:

On /Off duties manufactured according to EN593, eccentric (double offset) design, tight in both flow directions according to EN 1074-2

Possible to replace profile sealing ring without disassembling the disk

Installation: Underground, or in chamber

Permissible working temperature: 70 C

Hydrostatic test 1.5 PN for body 1.1PN for seat, according to EN 1074 1 and 2, and ISO 5208:

Working pressure classes PN10/ PN16 /PN25 /PN40

Body in ductile iron EN-JS 1030 Former GGG40

Disc in ductile iron EN-JS 1050 or EN-JS 1030, EN1563

Sealing seat in 316L stainless steel

Valve sealing in EPDM

Shaft Bearing in zinc free bronze

Valve shaft Stainless steel EN10088 Gr 1.4057.

Wetted bolts in S.S A4, outside bolts S.S A2

Face to face dimension EN558-1, Basic series 14

Flanges drilling to EN 1092-2

Third Party approval: product conformity certificate from Bureau VERITAS or similar in addition to a proof of suitability for drinking water

Epoxy coating blue electrostatically applied EN 14901 min 250 microns

Drinking water compliance approved with third party certificate

Handwheel in Steel

4-D-1-4 Ball Float Valves

Ball float valves which are to be installed within reservoirs shall be of the delayed action type to eliminate inflow at small valve openings. They shall comply with B.S. 1212 and shall be fitted with a stilling chamber, auxiliary float valve and inlet bellmouth with regulating valve. The main valve shall be fitted with long actuating lever to provide a long float travel for slow valve closure.

Valves shall be of the right angle pattern type with flanged inlet and have a resilient synthetic rubber disc which forms a drop tight seal against a removable seat insert. Valves shall be free of vibration under the specified working conditions. Flanged tapers shall be provides on the inlets as necessary to suit the size of valves proposed.

Valves shall be capable of withstanding the maximum static pressure and of passing the maximum flow rate. Orifice plates shall be provided as necessary to absorb excess working pressure at the initial flow rates indicated.

The pressure rating of the valve shall be cast into the body of the valve.

4-D-1-5 Check Valves

Check valves shall be of the swing, nozzle, dual disc, titled as directed by the Engineer. When used, Swing type shall be fitted with lever and counterweight to improve the response and anti-slam feature. When the check valve is installed next to surge vessel it should be titled disc or nozzle or dual disc type. They shall be installed on horizontal or upward vertical pipes. All check valves shall be of a type that will operate without shock. Valve bodies shall be of ductile iron unless otherwise specified by the Engineer and shall be fitted with renewable type seating (resilient or similar). Covers shall be provided to allow ample access for cleaning and service and shall be supplied complete with tapped bosses.

In the case of swing gate type valves the hinge pin shall be of stainless steel, mounted in zinc free bronze bushes and extended and fitted with external levers and counter balance weights, all protected by a screen guard.

Other types of valves will be considered. In every case the non return valve shall be selected with full consideration of the system characteristics, and shall avoid valve slam, and have low maintenance requirements.

Where specified, limit switches shall be provided to operate from the external lever. The screen guard being slotted to allow the guard to be removed without disturbing the switch cabling.

4-D-1-6 Cast Steel Valves

The cast steel valves shall be used where ductile iron valves are not permissible to operate at pressure > 25 bars, and shall comply to NF E 29-328, NF E29-331. The specifications of other valve parts shall be at least the same of the ones of ductile iron valves.

4-D-2 VALVE ACCESSORIES

Hand wheel: in steel DIN 17100 or cast iron epoxy coated DIN 1691

Stem cap in cast iron DIN 1691 or ductile iron EN1563

Extension spindle: Mild steel ST3/ZN6

Operation keys: Combination prizing bar and lifting key tube, with 1.5 m vertical bar and 0.5 m horizontal bar.

4-D-3 AIR-RELEASE VALVES

Air-release valves, body and components shall comply to SG 400-15 ductile iron, and are to be installed as specified on the drawings, where needed and as directed by the Engineer.

Air-release valves are introduced into the water main in order to eliminate air collections at high spots and changes in slopes.

Single air-release valves are meant to discharge the trapped air automatically under normal operating conditions, (when pipes are under pressure).

In addition to the role mentioned in paragraph a), double air-release valves (triple function air valves) permit bulk air vent under pressure, blowing off air when filling the pipes with water, and air ingress during emptying. They are also used at steep slopes to protect against sharp pressure drop in case of accidental breakage.

Air-release valves shall be supplied with an isolating valve which permits the complete removal of the air-release valve from the main without affecting the flow of water.

Air-release valve are mounted on a vertical branch connection with at the top of the main.

Air-release valves shall operate automatically and shall be constructed in a manner that the operating mechanism will not jam in either position (open or close).

Air-release valves shall be of single orifice valves (SOV) for distribution networks, and of double orifice valves (DOV) for transmission lines, pumping lines, and inside reservoirs valve chambers.

4-D-4 PRESSURE REDUCING VALVES

The pressure reducing valves shall be of the spring loaded type and of an approved design with a single external hydraulic relay system to ensure a constant downstream pressure for a variable upstream pressure.

The main valve body, cover and internal valve shall be of meehanite cast iron. The liner shall be bronze to BS 2870. The indicator rod shall be of stainless steel to BS 970 with all other components being of appropriate non corroding materials.

The relay system body shall be in bronze as shall all control valves. All connection piping and internal fittings shall be in non corroding materials.
Each valve shall be subjected to a body pressure test in the manufacturers works and witnessed by the manufacturer accordingly.
The relay system shall be capable of being checked or replaced without breaking the supply.

4-D-5 DOWNSTREAM LEVEL CONTROL VALVE AND PRESSURE HEAD BREAKER

This valve is installed in order to fulfill both functions of:

Adjusting the upstream pipeline flow rate with the downstream side consumed flow rate.
Local energy dissipation.

The downstream level control and head breaker valve should be installed at the end of a pressure pipeline before discharging into a water basin. It should control the water level within the water basin, where it is installed, regardless of the flow variations. This valve should be of Self – Centering Disc Obturator type from Alstom or Hydrostec or equivalent.

The upstream pipeline is connected to a vertical orifice (nozzle) at its end, above which is placed a flat disc linked with an operating rod. When exposed to the jet of water, the disc centers itself even in the absence of any lateral guiding. Using a rocker arm, the disc is operated by a cylindrical float having a vertical axis; the float moves in a chamber communicated with the downstream reservoir.

The type of obturator to be used is the hooded disc obturator type – OBCA, where the orifice and disc are located above the water level to be controlled. The orifice is a sharp – lipped nozzle and the disc is flat. A completely watertight seal should be insured by a reinforced rubber lining on the underside of the disc. This valve should include the following accessories:

Roker arm
Bearing
Swivel ring
Self – centering disc
Deflector hood
Convergent nozzle
Adjustable stop
Float

Through the rock arm, the float controls the self – centering disc, which regulates the aperture trough the water flows. When the water level in the reservoir rises, the float is lifted thus tending to close the abturator. The float chamber communicates with the reservoir trough on orifice, which is equipped with a control valve, thus providing and adjustable damping effect.

4-D-6 FLAP VALVES

Flap valves shall be normally closed, by weight of the door only, and shall open under minimum flow conditions. They shall be capable of withstanding 1.5 times the specified maximum seating head.
Where flap valves are required for flange mounting, they shall be supplied with rubber gasket and the full number of holes to BS.4504 NP 16.
All flap valves shall be operated and painted in accordance with metal painting and protection requirements.

4-D-7 STRAINERS

Strainers shall be flange mounted type. Foot strainers shall be installed at least 0.5 m above the bottom of the water reservoirs.
The strainer basket shall be of the perforated cylinder type made from galvanized steel or stainless steel. It shall be easily accessible via a removable flange.

4-D-8 MANHOLES FOR POTABLE WATER

The construction of manholes and valve chambers shall be located as specified on the drawings and as directed by the Engineer during constructions:
Excavation and backfilling generally shall comply with appropriate requirements of PART III-1-EARTHWORK.
Concrete works generally shall comply with the appropriate requirements of PART III-2-CONCRETE AND MASONRY.
Ductile iron cover shall comply to ISO 1083, EN 124, or equivalent.
Cement to be ordinary Portland cement or PA-S cement.
Coating: Protective bituminous coating for external surfaces of concrete manholes, valve chambers, or other equal approved.
Manholes are to be precast or cast in situ as shown on the drawings and shall be completely water-tight. Particular attention shall be given to the joints between the pipes and the walls to ensure proper tightness against any leaks into the manholes.
Where valves are directed to be fixed in a chamber, etc. the necessary frames shall be placed in position using approved expanding shell bolts or an approved proprietary resin anchor system.
For precast units the Contractor shall obtain the Engineer's approval to all details of the precast units and method statement before commencing casting units.
All manhole covers located in roads shall be brought to the final finishing level of the pavements. The covers and frames shall have accurate seating faces to prevent rocking and the ingress of sand or water, and shall be fitted tight to resist overflow conditions or any leakage from under the frame base.

4-D-9 FLANGED ANCHORING PIPE WITH PUDDLE FLANGE

Flanged anchoring pipes with puddle flange shall be used in the concrete walls of manholes, valve chambers and water tanks as specified in the drawings or as instructed by the Engineer. The puddles flange will provide additional fixation to the pipe in the wall in addition to reduce or eliminate the water leakage.

The flanged anchoring pipe with puddle flange is made of ductile iron and shall comply to the appropriate requirements.

The installation requirements and fixation in concrete shall follow the manufacturing recommendations.

4-D-10 DISMANTLING JOINTS

Self- restrained dismantling joints, made from ductile iron, are used to ensure extensible connections between sections of pipe work, to be mounted next to valves to enable easy dismantling from pipe work or to permit jointing pipe work when butterfly valves is removed for maintenance.
The dismantling piece is to be flanged type composed of two parts, one sliding into the other, and a free flange to compress a trapezoidal section seal to ensure water tightness.

4-D-13 FLEXIBLE JOINTS

Flexible joints shall be flanged type, the body shall be made of rubber and the flanges of mild or stainless steel. The working pressure of the flexible joints shall be 1.2 x the maximum pressure of the pump. Flexible joints shall be fit for suction and delivery, eliminate sound & vibration and shall be able to resist the effect of heat, water and weathering.

4-D-14 FLOW STRAIGHTENER / STABILIZER

The required type of the flow straighteners / stabilizers shall be selected to stop the turbulence in the water pipes.

4-D-15 DUCTILE/CAST IRON GRATING

The cover and frame shall be manufactured to ISO 1083, EN 124, or equivalent. Use rectangular grate and frames as specified on the plans and according to the following classification: Class D400; heavy duty; for minimum test load 40 tons.

The contractor shall submit certifications of Test Load according to British Standard Institute or equivalent and Quality Assurance according to the European Standard EN 124 section 10 or equivalent. The grate shall bear the following information:

The name of the manufacture, initials and identification mark,

Initial and number relevant standards, example EN 124,

Production excellency stamped by one of the known agencies Example: The French standard Institute (AFNOR) or the British Standard Institute (BSI),

Initial of material used, example: GS for Ductile Iron,

Load capacity. Example: D400 for minimum test load 40 tons.

4-D-16 DUCTILE IRON FRAME AND COVER

The cover and frame shall be made of ductile iron manufactured to ISO 1083, EN 124, or equivalent. For Manholes, Use only round covers and frames, minimum 600 mms for cover and 850 mms for frame, as specified on the plans and their use according to the following classifications:

Class E 600: Super heavy duty; used for industrial plants, ports, airports, etc…Minimum test load 60 tons.

Class D400: Heavy duty; for streets, roads. Minimum test load 40 tons.

Class C250: Medium duty; for sidewalks, gullies, parking areas accessible for lorries. Minimum test load 25 tons.

Class B125: Light duty; for sidewalks, parking areas only accessible to passenger cars.

The contractor shall submit certifications of Test Load according to British Standard Institute or equivalent and Quality Assurance according to the European Standard EN 124 section 10 or equivalent.

The cover shall bear the following information:

The name of the manufacture, initials and identification mark,

Initial and number relevant standards, example EN 124,

Production excellency stamped by one of the known agencies Example: The French standard Institute (AFNOR) or the British Standard Institute (BSI),

Initial of material used, example: DI for Ductile Iron,

Nominal diameter and class designations,

Load capacity. Example: D400 for minimum test load 40 tons.

4-D-17 GALVANIZED STEEL STEPS OR LADDERS

Every inspection chamber and manhole which height exceeds 1 meter shall be fitted with metallic steps to allow easy access to the manhole from the opening in the frame.

Manholes and pressure breaker basin shall be furnished with 1 inch galvanized steel steps: to BS 729.

The steel steps can be installed during the construction of the concerned structures or after construction in case or precast units as specified in the drawings or as directed by the Engineer.

When drilling into the concrete walls for installing the steel steps, the hole shall be cleaned thoroughly and the space between the rod and the concrete shall be filled properly with non-shrink cement mortar as specified by the manufacture and provide good finishing to the surface.

4-D-18 FERRULES

Gunmetal or Bronze Swivel Ferrules / vertical tapping valve / push-fit outlet for HDPE. The ferrule shall be designed for use underground and to handle potable water at temperatures of up to 40°C.

The ferrule shall work at pressures up to 16 bars without leakage.

The ferrule stem, banjo, inner plug and top cap shall be manufactured of gunmetal/bronze to BS1400 LG2, inlet shall be a male taper thread to BS 21 (ISO 7/1)

Its design shall permit service pipe installations via conventional drilling and tapping machines, under pressure or dry, with or without service saddles.

Ferrules shall be designed with a Push-fit outlet for PE pipe with grip ring, All ferrules shall be designed as a main stem with a 360° swivel outlet at 90° with control of water flow via a threaded inner plug.

4-D-19 STOP VALVES

Gunmetal stopcock valves /House connections/Push-fit for HDPE

Easily operated, underground Stopcock BS valve type BS5433

gunmetal stop -valves, highly resistant to corrosion All metallic

parts in gunmetal/Bronze, Gaskets in EPDM

Supplied with crutch heads or square heads for operation by underground stopcock key 5/8 size, common design of British water authorities

Supplied with plastic guard pipe and plastic chamber base with retaining clips for valve, chamber base designed to fit 160 mm guard tube.

Ductile iron Stop valves / house connections / Push–fit for HDPE Gate

type with female thread connection acc. to ISO 228 on both sides Resilient

seated (EPDM) in accordance with EN 1074

Face-to-face length acc. to EN 558-1

Body: Ductile cast iron EN-GJS-400-15 or EN-GJS-500-7 Wedge:

Brass CuZn40 Pb2 and ductile for DN 11/2" and 2" Stem: Stainless

steel X20 Cr13 EN 10088, Fix washer in bronze Gaskets in EPDM,

EN681-1

Supplied with bare square head or with extension spindle set for buried house connections, in this case the Extension spindle is made in ST3 / ZN6 min 20*20 with guard plastic pipe appropriate to valve body

Ductile iron Stop valves / house connections / threaded outlets Gate

type with female thread connection acc. to ISO 228 on both sides

Resilient seated (EPDM) in accordance with EN 1074

Face-to-face length EN 558-1

Body: Ductile cast iron EN-GJS-400-15 or EN-GJS-500-7 Wedge:

Brass CuZn40 Pb2 and ductile for DN 11/2" and 2" Stem: Stainless

steel X20 Cr13 EN 10088, Fix washer in bronze Gaskets in EPDM,

EN681-1

Supplied with bare square head or with complete extension spindle set for deeply buried house connections, in this case the Extension spindle is made in ST3 / ZN6 min 20*20 with guard plastic pipe appropriate to valve body.

4-D-20 SURFACE BOX FOR HOUSE CONNECTIONS

Manufactured in compliance with EN124, Load class: C250 Made in

ductile iron with protective coating

Base inlet clear opening dimension 160mm to receive plastic guard pipe of same diameter Min

Top Clear opening 100 mm

Base Diameter 250 mm, Min H:120 mm Marking:

Water Authority

4-D-21 SADDLES FOR HOUSE CONNECTIONS

Saddles on Ductile Iron Pipes

Saddle body in ductile iron EN-GJS-400-15 or EN-GJS-500-7 / EN1563, Epoxy or Rilsan coated min 250 microns EN 1563. PN16

Fitted with straps in stainless steel covered with rubber Strip of min. 2 mm

Stainless Steel Strap, bolts washers and nuts A2 70 DIN 933/ DIN 125

Single strap design allowed only for pipes of DN 50mm- 250mm, 2 straps design for larger diameters

Saddles on HDPE Pipes

Electrofusion Saddles specially designed for Plastic pipes to be welded to the distribution line and to the outlet pipe, PN16.

4-D-22 WATER METERS FOR SERVICE CONNECTIONS

Water meters shall be of the volumetric type, turbine single jet liquid filled type magnetically driven or with mechanical-transmission. The meters body shall be bronze, and meters shall withstand a service pressure of 16 bars.

The accuracy at normal flow rates shall be better than ±2%. Meters shall be calibrated in cubic meters, and shall be compatible with the pipework in which they are being incorporated. The minimum reading must be 0.1 liter with head loss lower than 0.1 bar at nominal flow (Qn). The maximum working temperature is 30°C for cold water and 90°C for hot water.

Water meters shall also be equipped with:

Tamper proof counter,

Five (or more) reading rolls totally immersed in a hermetically sealed casing and filled with a lubricating fluid

The maximum reading shall be 100.000 m3 (or more),

Index wiper,

The meter must be Class C (BS 5728/1, ISO 4064., EEC 75/33, OIML N049) for horizontal position and class B in any other position, and must have an external adjusting screw tamper proof.

4-D-23 FIRE HYDRANTS

Fire hydrants shall conform fully with BS 750 Type 2. with 'captive' internal valve.

Fire hydrants shall be Pillar type with triple delivery (2 x 65mm + 1 x 100mm) and visible outlets made of cast iron or ductile iron. The inlet flanges to fire hydrant shall be DN 100mm.

Fire hydrants shall be subjected to a works hydrostatic test pressure in accordance with the procedures set down in BS 750. The pressure rating shall be cast into the body of the hydrant.

The fire hydrants shall be capable of passing a minimum flow of 17 L/sec at a constant running pressure of 1.7 bar.

4-E TESTING

4-E-1 TESTING OF GATE VALVES

Gate valves shall be tested in accordance with BS 5150 or BS 5163 as relevant. In either case, valve seat tests shall be made under open-end conditions, the test pressure being applied to each face of the valve in turn.

4-E-2 TESTING OF BUTTERFLY VALVES

Butterfly valves shall be tested in accordance with BS 5155. The seat test shall be for tight shut-off and low leakage. Valves shall be tested under maximum unbalanced water test pressure in either direction.

4-E-3 TESTING OF AIR VALVES

Air valves shall be water tested for drop-tightness at all pressures from 0.2 bar in steps of 2 bar up to the specified pressure. The valve body shall be water tested at 1.5 times the specified pressure, at which pressure no damage or permanent deformation of the valve body, ball or seat shall occur.

Two valves of each type and size incorporating large orifices shall be tested for exhaust of air at a differential pressure up to 1 bar in steps of 0.1 bar and for inflow of air at a differential pressure up to 0.5 bar in steps of 0.1 bar. During the tests the airflow rates shall be measured by orifice plates in accordance with BS 1042. Pressures (positive or vacuum) shall be measured by Bourdon tube gauges or by means of mercury-in-glass manometers. The temperature of the flowing air shall be measured in accordance with BS 1041: Part 1 and Part 2. The barometric pressure shall also be measured.

If the manufacturer provides results of independently witnessed airflow tests similar to those specified and these are accepted by the Engineer, then the specified airflow tests shall be deemed to be completed.

4-E-4 TESTING OF CHECK VALVES

Check valves shall be tested in accordance with the requirements of BS 5153.

4-E-5 TESTING OF PRESSURE AND FLOW CONTROL VALVES

Pressure and flow control valves shall be tested hydrostatically as follows:

- Body strength : closed-end test, valve open, test pressu 1.5 times working pressu
- Valve element strength : open-end test, valve closed, test pressure applied to inlet end of 1.5 times working pressure.
- Leak tightness : open-end test, valve closed, test pressure of the working pressure applied to inlet end, no visible leakage permitted.

4-E-6 TESTING OF BALL FLOAT VALVES

Ball float valves shall be tested hydrostatically in the closed position and a pressure of 1.5 times the working pressure applied to the inlet end.

Valves shall be tested for drop-tightness at the working pressure.

4-E-7 TESTING OF PLUG VALVES

Plug valves shall be subject to hydrostatic shell and seat tests in accordance with BS 5158.

4-E-8 TESTING OF PENSTOCKS

Penstocks shall be operated from fully closed to fully open positions to verify correct operation. For penstocks fitted with power-operated mechanism, the test shall be carried out to demonstrate correct manual and power operation.
A leakage test shall be carried out to prove the penstock is drop tight under seating and unseating conditions.

4-E-10 TESTING OF ELECTRIC ACTUATORS

Electric actuators shall be tested in accordance with the Reference Standards. Compliance with the specified functional and performance criteria shall be demonstrated.

4-E-11 TESTING OF PIPEWORK

Pipework shall be tested in accordance with the appropriate Reference Standards.

4-E-12 TESTING OF CASTINGS

Castings shall be tested hydrostatically to 1.5 times the maximum working pressure for a minimum period of 1 hour.

4-E-13 TESTING OF AUTOMATIC IN-LINE STRAINERS

Automatic in-line strainers shall be tested in accordance with the Reference Standards and with manufacturer's own requirements.

4-E-14 TESTS AT SITE

The Contractor shall submit to the Engineer detailed proposals for testing. The proposals shall give values of test parameters and make reference to standards and manufacturers' literature. The proposed format of test sheets shall be submitted at the same time. A separate sheet shall be used for each test. The testing shall not commence until the proposals and test sheets have been approved in writing by the Engineer.

The following inspections and tests shall be carried out as appropriate.

Inspection to check the assembly of the Plant and conformity with the Specification.

Rotational checking of all electric motors.

Hydrostatic testing of all gravity flow pipework systems and penstocks at the maximum head or differential head that can occur in service. Leakage from penstocks shall be measured and recorded but shall not exceed the maximum value stated in the Contract or otherwise required for safe operation.

Hydrostatic testing of all pressurized pipework systems at 1.5 x maximum working pressure for a period of at least one hour.

Performance testing of each pump to prove correct operation, absence of fluid leaks, correct bearing temperatures and absence of undue vibration and noise.

Functional testing of auxiliary items including automatic in-line strainers and valve actuators.

Functional testing of valves to demonstrate correct operation.

Overhead cranes shall be tested with a load of 1.25 x Safe Working Load and results recorded in accordance with the Reference Standards.

Part V: Electrical Works

Part V: Electrical Equipment

NOT APPLICABLE

Part VI: Geotechnical Investigation

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PART 6 – GEOTECHNICAL INVESTIGATION

6.A. SCOPE

The purpose of the work specified herein is to determine the type, nature and characteristics of subsurface materials and the extent and conditions of the various materials of foundation soils and conclusion of soils bearing capacity and to identify any potential geotechnical problem (sliding, instability, settlement, etc.). This is to be accomplished by means of core drilling, field testing sampling and analysis, laboratory testing. The Contractor will provide access roads as he deems necessary for the execution of work. The Contractor will also provide a report summarizing and interpreting field and laboratory results.

6.B. QUANTITIES AND LOCATIONS OF HOLES

The locations of the drill holes to be executed by the Contractor are distributed on all the project sites (pumping stations, reservoirs, pipelines, access roads, treatment plant, springs, etc.) and wherever requested by the Engineer. The approximate number and location of drill holes and test pits shall be proposed by the Contractor and approved by the Engineer. The Engineer reserves the right to increase or decrease the quantity of work for the Contract items to such an extent that the total contract amount would be increased or decreased by 50 percent with no change in Contract unit prices. In case of test pits required by the Engineer, these will be paid as unclassified excavations.

6.C. MOBILISATION AND DEMOBILISATION

a. Mobilization: mobilization shall consist of the delivery to the site of all plant, equipment, materials, and supplies to be furnished by the Contractor; the complete assembly in satisfactory working order of all such plant and equipment on the job; and the satisfactory storage at the site of all such materials and supplies.

b. Demobilization: demobilization shall consist of the removal from the site of all plant and equipment after completion of the work and shall include restoration of the area as requested and approved by the Engineer.

6.D. INSPECTION

No work shall be performed in the absence of the Engineer unless authorized by him. The Contractor shall not remove casing or equipment from any completed boring or test pit except with the express permission of the Engineer and not until the Engineer has had the opportunity to obtain all relevant data prior to removal.

6.E. RECORDS

The Contractor shall keep accurate driller's logs and records of all work accomplished under this Contract and shall deliver complete, legible copies of these logs and records to the Engineer on completion of the work in each hole or pit, or at other times as he may be directed. All such records shall be preserved in good condition and order by the Contractor until they are delivered and accepted. The Engineer shall have the right to examine such records at any time prior to their

delivery to him. Separate logs shall be made for each hole and test pit. The following information shall be included on the logs or in the records for each hole:

1. Full information on the location, type of boring, diameter, ground elevation, inclination.
2. Location, elevation, depth, type, and number of each sample taken.
3. Driving energy and blow count data for each 15 centimeter penetration of drive sampler and 30 centimeter penetration of casing where the casing is driven.
4. Average rpm and hydraulic advance pressure of drill rig on undisturbed samples, cores, and casing, where the casing is advanced by drilling.
5. Length in centimeters of sampling or coring drive or run.
6. Length and percent of recovery for all samples and cores.
7. Driller's classification or description by depths of the materials sampled, cored, or penetrated, including a description of thickness of zones, moisture conditions, and of conditions of compactness or stiffness of soils materials encountered. This classification or description shall be made immediately following the taking of the samples or cores.
8. Size and lengths of casing used in each bore hole and where added.
9. Elevation of rock if encountered.
10. Elevation of depth of water in holes, daily, at the start of work and after completion of the bore hole until true water table conditions have been established as approved by the Engineer.
11. Elevations and depths of seepage tests and artesian measurements.
12. Elevations and depths at which drill water is lost and regained, and amounts and color of return water.
13. Elevation and depth of bottom of hole.
14. Dates and time by depths when test-pitting, drilling, sampling, seepage testing, and artesian measuring operations were performed.
15. Time required for drilling each run.
16. Time required for seepage tests and artesian measurements.
17. Pressure employed in seepage tests and artesian measurements.
18. Any changes in the drilling action which would be supplemental information to the sampling or coring.
19. Any information or data that the driller may deem pertinent or that may be requested by the Engineer.

The presence of the Engineer or the keeping of separate drilling records by the Engineer shall not relieve the Contractor of the responsibility for the work specified in this paragraph.

6.F. CONTAINERS

a. General: The Contractor shall furnish litter size wide mouth jars, 10kg capacity moisture proof bags, undisturbed sample and core boxes, and accessories meeting the specified requirements, or approved as equal by the Engineer. The Contractor shall furnish as many containers as may be required. All such containers will become the property of the Engineer and the cost thereof shall be included in the Contract price for the applicable item for which payment is provided.

b. Core Boxes. Longitudinally partitioned core boxes constructed of lumber or other approved materials, shall be used for all rock cores, selected cores of soil, and selected cores of weathered zones taken from within the rock. Where the Contractor elects to advance a hole by coring in overburden, such core as may be designated by the Engineer shall also be placed in core boxes. The soil and

weathered zones shall be preserved in undisturbed boxes or core boxes as directed by the Engineer. As many core boxes as may be required shall be used in submitting each core or group of cores. Core boxes shall be completely equipped with all necessary partitions, covers, hinges, screws for holding down the cover, identification plates, tags and other accessories.

6.G. LABELS

Each bag and core box shall have printed or typewritten labels shall be identified with water-proof and wear-proof labels or markings indicating the following:

Project
Hole No. _____ Location _____

Hole No. _____ of_____Jars

Jar No. _____ of_____Bags

Top Elev. of Hole _____

Depth of Sample _____ to_____

Description of Material _____

6.H. BORINGS

a. General. The Contractor shall make vertical borings of minimum 101 mm in bedrock and 200 mm in overburden. Coring will be continuous from the top of rock to the bottom of hole.

b. Equipment and Supplies. The Contractor shall furnish and use sufficient numbers of drill rigs and associated equipment to successfully complete the project within the designated time scheduler. The drill rigs shall be capable of drilling vertical holes to a depth of 30 meters. Some rigs shall be provided with whirling capability but all rigs shall be provided with hydraulic feed mechanic lams and catheads, and capable of taking drive samples and double tube core barrel rock cores to the depths required. The Contractor shall supply such equipment or accessories necessary for proper positioning of vertical borings.

All borings may be drilled with minimum 101 mm. Drilling mud will not be allowed because of permeability testing requirements.

The Contractor shall provide sufficient heavy-duty casing of such a type to be driven or drilled through the overburden to sound rock. The Contractor shall furnish drill rods, piping, pumps, water, tools, power and all other supplies required to execute the borings to the required depths by the procedure described. Prior to mobilization, the Contractor shall submit to the Engineer for approval a list of equipment he will use.

c. Additional Equipment. If it appears during the course of the work that the Contractor will not complete the contract work within the specified contract period, he shall be required to obtain additional equipment, as deemed adequate by the Engineer, to insure completion of the work as specified. When the Contractor is ordered by the Engineer to use additional equipment or rigs to complete the work on schedule, he shall employ the most expeditious measures and act with the utmost promptness to comply with the Engineer's instructions.

d. Advancing and/or Cleaning the Drill Hole. Samples taken above the water table shall be taken from a dry hole. Advancing and/or cleaning the dry hole to the sampling depth shall be accomplished using a clean out auger or approved equivalent so as to keep the hole dry and not disturb the virgin material at the depth to be sampled. Below the water table any method of cleaning the hole to the sampling depth that does not disturb the virgin material shall be used. If jetting is used, upward or baffled jets shall be required. Below the water table, a head of water greater or equal to the water table, shall be kept in the boring at all times, including the duration of the withdrawal of tools. Where seepage tests or double tube core barrel has introduced water into the hole above the water table, methods other than those required in a dry hole may be used at the convenience of the Contractor where approved by the Engineer. When core drilling through a boulder or ledge rock has been accomplished the cored portion of the hole shall be reamed out as required to advance the casing. If blasting is done, the Contractor shall obtain all necessary permits and shall comply with all laws, rules, regulations and ordinances governing blasting operations. Recirculated or clean water shall be used in overburden below the water table, in holes where seepage tests are designated or requested, and in rock coring. The holes shall be flushed out with clean water prior to testing in accordance with the appropriate Technical provision.

The Contractor shall be responsible for keeping the hole open at all times during the drilling and until all tests or other work in connection with the hole has been completed and the Contractor has been authorized by the Engineer to backfill the hole. In the event of collapse of the hole prior to receipt of authorization to backfill, the hole shall be reopened, in a manner specified by the Engineer, at the Contractor's expense.

e. Artesian Flow. Artesian flow may be encountered when drilling. Each time such flow is encountered, the advancement of the bore hole shall be immediately interrupted and the artesian rise in water or pressure in the casing measured.

f. Advancing the Casing. The casing shall be advanced by hammer, rotary drill, or any method approved by the Engineer, in such a manner to keep the hole open, and insure a tight seal in sound rock. The casing shall be advanced at a sufficient distance behind the sampling operation so as not to disturb the material to be sampled.

6.I. SAMPLING AND CORING IN BORINGS

a. General. Samples and cores shall be taken at designated elevations, with the designated sampler or core barrel as directed by the Engineer. The hole shall be properly advanced and cleaned in accordance with Subparagraph 7-H-d, Advancing and/or Cleaning Drill Hole, prior to sampling. Sampling shall be done by such means as to prevent the inclusion of wash in the sampler. The depths of starting and stopping drives or runs shall be accurately established to the nearest 10 cm.

b. Coring in Overburden. Where specifically requested by the Engineer, double tube core barrels with or without liners will be used to core overburden, generally in dense materials, boulders, and highly weathered rock. The speed of rotation, rate of hydraulic advance, and length of run shall be adjusted so as to provide minimum soil disturbance and maximum recovery. The speed of rotation shall not exceed 200 RPM unless otherwise approved by the Engineer and the maximum length of run shall be such as to provide a 150 cm long sample within the liner, when approved by the Engineer.

c. Rock Core Drilling. The casing through overburden or weathered rock shall be sealed tightly in sound rock prior to commencement of rock coring. The coring of rock with double tube core barrels 101 mm shall be in accordance with Subparagraph b, except that the maximum length of run may be increased to 3 meters when approved by the Engineer. The Contractor shall exercise particular care in recording water losses, rod jerks, and other unusual coring experiences that, supplementing the core record, will indicate the nature and the extent of any fracturing.

6.J. CASING

a. General. The advancing of casing shall be as mentioned in Subparagraph 7-H-f.

b. Removal of Casing. Except as otherwise authorized by the Engineer, all casing shall be removed on completion of the work, and it shall remain the property of the Contractor. Casing shall not be removed until authorized by the Engineer.

6.K. TEST PITS

a. General. A test pit shall be any excavation in soil, cinders, hardpan, decomposed rock or other unconsolidated or partially consolidated overburden which has an open cross- sectional area large enough to permit safe, efficient engineering inspection in situ density testing and undisturbed bag sampling. Bag samples totaling 450 kg or more may be required. The Contractor shall comply with all safety regulations governing this work.

b. Equipment and Supplies. The Contractor shall furnish all equipment and supplies necessary to perform the work.

c. Excavation. The test pits shall be excavated to the required depths.

d. Sampling. All sampling shall be performed by the Contractor as requested by the Engineer and labeled and preserved as specified in 7-G and 7-M, respectively.

e. Barricades. Immediately upon completion of excavation operations for each pit the Contractor shall construct an enclosure guard around each pit, set back about 1 meter from the edge of the pit. The enclosure shall be constructed of materials selected by the Contractor. The enclosure shall be constructed in such a manner that no person or animal can fall into the test pit. Barricades will not be measured for payment, and all costs in connection therewith shall be considered a subsidiary obligation of the Contractor. In addition, it is the Contractor's responsibility to ensure that the barricades are placed; the liability associated with the failure to do so shall lie with the Contractor.

f. Refilling of Test Pits and Test Trends. The test pits shall be refilled when directed by the Engineer. The refilling of test pits will not be measured for payment and all costs in connection therewith shall be considered a subsidiary obligation of the Contractor.

6.L. ABANDONED BORINGS AND FALSE STARTS

No measurement or payment will be made for borings abandoned or lost before reaching the required depths. Except with the specific permission of the Engineer, the Contractor shall not abandon or complete any boring, or remove any casing or drilling equipment, without first affording the Engineer the opportunity of obtaining the position and depth of the boring prior to abandonment or completion, and any other information which the Engineer may require. The Contractor shall furnish the Engineer with complete records and samples for the depth penetrated in the manner hereinafter prescribed for completed borings.

6.M. PRESERVING SAMPLES AND CORES

a. General. The Contractor shall provide all material, equipment and labor necessary for preserving soil samples and rock cores. Wax for sealing sample containers shall be Socony Vacuum Oil Company Product 2300, or approved equal. The preserving and storage of samples and cores shall be a subsidiary obligation of the Contractor in connection with obtaining the samples or cores and no extra payment shall be made for preservation or storage of samples and cores.

b. Test pit Samples. Bulk samples selected by the Engineer from test pits shall be preserved in waterproof bags and shall be clearly marked with two (2) waterproof labels, one wired to the bag and one placed inside the bag. Jar samples taken as directed by the Engineer shall be scaled by double dipping the cap and threads into wax immediately after capping. Undisturbed samples requested by the Engineer shall be moisture proofed and handled accordingly and as requested by the Engineer.

c. Undisturbed Samples in Liners. After inspection by the Engineer, the ends of the sample tubes shall be cleaned out to a depth of 2 inches and a seal provided of micro crystalline wax, such as Socony Product

2300 or equal. A metal disc, having a diameter slightly less than the inner diameter of the tube shall be inserted into the wax at a distance of 2.5 cm from the end of the soil sample. The wax plug shall be flush with the ends of the tube and a metal cap shall be placed over the ends, taped and sealed with two coats of wax. Liners which are only partially full should be filled with wax before capping. Special care shall be made to mark the top and bottom of liner. Material taken from the shoe and the top shall be placed in separate litter jars and marked accordingly and sealed in accordance with the requirements of Subparagraph b.

d. Undisturbed Double Tube Core Samples Without Liners. After inspection by the Engineer, the undisturbed core sample shall be wrapped in polyethylene, coated with wax twice, and wrapped in cardboard, or other stiff material approved by the Engineer. Special care should be taken not to break or disturb the sample during the handling.

e. Soil and Rock Cores. All rock cores and all soil cores such as undisturbed samples shall be arranged neatly in the partitioned boxes constructed and marked in the same sequence in which they occurred before removal from the hole. Facing the open box with the hinged cover above the open box below, cores shall be arranged neatly in descending sequence beginning at the left end of the partition nearest the hinges and continuing in the other partitions from left to right. The highest core shall be placed in box 1 and the lowest portions of the core shall be placed in the other boxes in consecutive order. The runs shall be sectionalized by wood Spacers showing depth, length of run, fractures and their estimated width, and recovery. Core loss blocks shall be used to indicate areas in which no core is recovered. Core sections as designated by the Engineer, shall be wrapped in polyethylene sheets, coated with wax twice, and wrapped in cardboard or other stiff material approved by the Engineer.

6.N. STORAGE AND DELIVERY OF SAMPLES AND ROCK CORES

a. General. The Contractor shall be solely responsible for preserving all samples in good condition. He shall keep samples from undue exposure to the weather. The Contractor shall keep all descriptive labels and designations on sample jars and boxes clean and legible until final acceptance by the Engineer. The Contractor shall comply with all requests of the Engineer concerning the care and protection of samples.

b. Storage. Upon completion of drilling and sampling operations in each hole, or as necessary to protect samples, all boxes containing samples and cores shall be delivered to a structure provided by the Contractor near the work site. Undisturbed samples shall be transported with the tubes in a vertical position, top down, to prevent consolidation and segregation of pore water. Boxes containing disturbed samples and core boxes shall be so arranged in the storage area that the samples and cores can be conveniently and readily examined by the Engineer. Undisturbed samples shall also be stored in an orderly method. Upon request of the Engineer, the Contractor shall furnish a laborer to assist the Engineer in inspecting the samples and cores. The Contractor shall provide all transportation and labor required for storage of the samples and cores at the desired location.

c. Shipment of Selected Samples. Upon request by the Engineer, soil samples and cores shall be boxed by the

Contractor as described below and shipped to the Laboratory approved by the Engineer. Samples not directed to be shipped to the above address shall remain at the core storage area at the site. Every precaution shall be taken to avoid damage to samples and cores, especially to undisturbed samples, as a result of careless handling and undue delay in shipping. Undisturbed samples shall be shipped in partitioned wooden boxes made from lumber 6cm, or heavier lumber. The sample tube shall be placed vertically top down, in the box and well-packed in excelsior or other equal material to protect the sample against vibration. The undisturbed sample and core boxes shall be marked "Do Not Jar or Vibrate" and "Handle, Haul and Ship in a Vertical Position". Containers containing glass jars shall be marked as such.

6.O. SEEPAGE TESTS

a. General. Seepage tests shall be performed in bore holes and at depths designated by the Engineer. Prior to performing the seepage tests, the bore hole shall be cleaned out and flushed with clean water to the bottom of the hole by means of a shielded jet or deflected jet as approved by the Engineer, so that all material is removed from inside the bore hole and a clean surface of undisturbed material exists at the bottom of the hole. The rate of seepage shall be determined by one of two methods described below. After performing the above tests the bore hole may be advanced without advancing casing, cleaned as described above and the rate of seepage again determined. Ground water table shall be determined for each seepage test. The data to be recorded for each test which are common to each of the two test methods are as follows:

1. Inside diameter of casing.
2. Height of top of casing above ground surface.
3. Length of casing during test.
4. Diameter of bore hole below casing.
5. Depth to bottom of boring from top of casing.
6. Depth to standing water level from top of casing.
7. Description of exposed material tested.

b. Falling Water Level Method. The casing shall be filled with water and the rate of drop in the water level in the casing determined by observing the depth of the water surface below the top of the casing at 1, 2 and 5 minutes after the start of the test, and at 5 minute intervals thereafter. The record of measurements shall include the depth of the water surface below the top of casing before and after filling of the casing, the time, and tile amount of the drop measured from the start of testing for each observation. Observations shall be continued until the rate of drop in water level becomes negligible or until stopped by the Engineer. If the drop in water level, as described above, is too rapid to permit accurate observations to be made, then the method described below shall be used.

c. Constant Water Level. Water shall be added in accurately measured quantities by pouring from calibrated containers or by pumping through a water meter at a rate of flow sufficient to maintain a constant water level at or near the top of the casing for a period of not less than 20 minutes, until stopped by the Engineer.

The record of measurements shall include the depth of the water surface below the top of casing before filling and during the test period, the length of time during which the water in the casing was maintained at constant level, and the amount of water necessary to be added to maintain the constant water level in the casing at 1, 2, and 5 minutes, and at 5-minute intervals thereafter, as directed by the Engineer.

6.P. PRESSURE TESTING IN ROCK

a. General. Pressure testing of weathered and sound rock shall be performed as directed. The apparatus used shall consist of a single pneumatic or mechanical expanding packer to seal off a section of the bore hole for testing. The packer and drill rods shall be calibrated to determine friction losses in the system. The length of the packer when expanded shall be about five (5) times the diameter of the hole. It is the Contractor's responsibility that the packers used are compatible with the size casing used in each borehole. Water lines shall be arranged so that water may be pumped below the packer. The system shall include a pressure gage, water meter, a manually adjusted automatic pressure relief valve, and a pressure pump. After each three (3) meter depth of hole is drilled, the packer shall be seated so that the entire three (3) meter length of hole can be pressure tested. Water under pressure shall be pumped into the test section and the readings recorded. Upon completion of the test, the packer shall be removed, the hole drilled deeper, and the packer reinserted after an additional three (3) meters of hole have been drilled. The packer shall be seated each time at an elevation that will allow the full three (3) meter length of newly drilled hole to be tested.

b. Water Pressures, Duration of Tests, Data to be Recorded The pressure testing shall be performed in five (5) steps for each complete pressure test with the maximum pressure (P_3) based upon the vertical depth to the mid-point of the test section. The value of P_3 will be determined by the Engineer but will be in the range of 0.35 to 10 Kg/cm². In no case will the pressure at the test section exceed 0.23 Kg/cm^2 per meter of depth. The following table shows "specified ratios" of pressure and times specified for each step of pressure test.

Step No.	Pressure (P)	Time(minutes)
1	$P_1 = 1/3\ P_3$	5
2	$P_2 = 2/3\ P_3$	5
3	P_3 (determined by test depth)	10
4	P4 = 2/3 P3	5
5	P5 = 1/3 P3	5

Additional data to be recorded in each test are as follows:

1. Elevation of bottom of hole at time of each test.
2. Elevation of packer.
3. Elevation of ground water table at the time of the test.
4. Elevation of piezometric level in artesian strata.
5. Length of test section.

6. Radius of hole.
7. Length of packer.
8. Height of pressure gauge above ground surface.

6.Q. ARTESIAN MEASUREMENTS

a. General. Where artesian flow is encountered the Contractor shall measure its pressure as directed by the Engineer.

b. Equipment. The Contractor shall supply all necessary equipment for performing these measurements, including two Bourbon Gages, a watertight casing cap with "Y" connection and bleeder valve, and expansion plugs to seal off a portion of the hole for testing. The expansion plugs shall be expandable rubber packer having a length about 5 times the diameter of the hole. The Bourbon Gages shall be calibrated in meters of water relative to atmospheric pressure. One gage shall have a range of 0 to 6 meters and the other a range of 0 to 30 meters.

c. Procedure. Where the artesian pressure is of such magnitude that the water in the borehole does not rise above the top of the casing, the pressure shall be measured and recorded as the number of meters and tenths of a meter between the natural ground water level and the level of the water in the casing. Where the artesian pressure is of such a magnitude that the water rises above the highest elevation to which the casing can be practicably extended, the pressure shall be measured by means of a Bourbon Gage fitted to a watertight casing cap by means of a "Y" connection equipped with a bleeder valve.

After each measurement of artesian pressure, the bottom of the borehole shall be advanced at least 0.3 meters but not more than 1.5 meters below the elevation at which the artesian pressure is encountered. If the artisan condition persists after advancing and cleaning out the borehole, additional measurements shall be made.

Records shall be kept of the gage readings and the vertical distances in meters and tenths of meters between the center of the gage, the natural ground surface and the natural ground water level.

6.R. SURVEYING AND HOLE MARKERS

Upon completion, each test boring, test pit, and well shall be surveyed to determine its exact location and elevation. A piece of plastic pipe filled with neat cement shall be installed by the Contractor to mark the hole. A suitable rust proof metal tag shall be attached to each marker showing the whole number, depth, and surface elevation. No separate payment will be made for whole markers, and all costs in connection therewith shall be considered a subsidiary obligation of the Contractor.

6.S. LABORATORY TESTING OF SOIL SAMPLES AND ROCK CORES

a. General. Laboratory testing will be completed on disturbed and undisturbed samples of soil and on lengths of rock core selected by the Engineer and shipped to a laboratory proposed by the Contractor and approved by the Engineer, as described in subparagraph 7-N, Storage and Delivery of Samples and Rock Cores.

b. Testing Laboratory. The laboratory testing shall be performed by an approved laboratory.

c. Type and Approximate Number of Tests. The complete laboratory testing program cannot be determined until the field exploration has been completed and the number and condition of all the samples known.

d. Submittal of a final report. A written detailed report containing the results of the laboratory testing program shall be submitted following the completion of the work in 5 copies to the Engineer for review, then the Contractor will issue the finalized report (5 copies also). The report should identify also the soil strata of the site. The report shall contain the summary of the results and the procedures used. The report shall contain the results of the field testing and the summary of the results as well as the results of the laboratory tests and all conclusions.

2- جدول الأسعار وتقدير الكميات

BILL of QUANTITIES

PREAMBULE

1-Pricing

1.01 The items in the Bill of Quantities do not necessarily contain full description of the required Works, and when pricing, the Tenderer shall allow in his unit rates for all obligations, liabilities and services stipulated in the relevant sections of all Tender and Contract Documents to provide and maintain a complete construction and installation.

1.02 The Tenderer shall, during his study of the Tender, address his queries, if any, to the Employer, who will study and clarify all such queries. Should the Tenderer during his study of the Tender, consider that there is any shortage, error or inconsistency in the Contract Documents, which would affect the rates/prices of his Tender, or the value of the works, the Tenderer must have all such points clarified by the Employer before submitting his Tender.

1.03 Tenders shall be strictly in accordance with the Tender Documents and shall not be qualified in any way. Any such qualification is liable to result in a Tender which is otherwise favorable, not being considered. The Tenderer shall therefore ensure that any explanatory or descriptive matter included with his Tender does not constitute a qualification to the Contract requirements and the provisions and conditions as stipulated in the Documents.

1.04 The Tenderer shall not alter the text of the Bill of Quantities. Any alteration to the text inserted by the Tenderer shall lead to the rejection of the Tender.

1.05 The Bill of Quantities shall be priced in United States Dollars. All payment made to the successful Tenderer in accordance with all certificates, accounts and similar documents relating to this Contract shall be in US$.

1.06 The Tenderer shall satisfy himself as to the meaning of each item in the Bill of Quantities. Unless otherwise itemized separately, the rates inserted by the Tenderer shall be deemed to cover all costs, expenses, risks, liabilities, obligations and services described in the Tender Documents, the full cost of the Works, including all direct and indirect expenses, sundry labors, overhead and profit, and all matters for the proper construction, completion and maintenance of the Works.

1.07 Unless otherwise itemized separately, these rates shall allow, but not by way of limitation,

- for complying with all Contract Documents;
- for any design required by the Contractor where explicitly stated in the Contract;
- for all necessary mobilization to site and demobilization on completion of the Works;
- for all labor and material including samples, sampling and testing, waste, transport, mockups, and shop, fabrication and as-built drawings;
- for all temporary work of each description required including any that may be required by Sub-Contractors whether nominated or otherwise;
- for the provision and use of all equipment and plant of every kind, whether mechanical, non-

mechanical or manual, required for the expeditious carrying out of the Works in their proper sequence;

- for shifting, altering and adapting such temporary work and equipment as may be required during the progress of the Works and removing at completion and making good any surfaces disturbed;
- for full customs and other import duties;
- for cooperation and coordination of the Works with Sub-Contractors whether nominated or otherwise;
- for providing all required guarantees and bonds;
- for providing all required insurances and the like;
- for all necessary temporary services associated with the Works;
- for establishing and furnishing the Engineer's site office;
- for providing until handing over, clean and uncontaminated water and all necessary adequate electrical power required for the works;
- for the work in connection with measurement and re-measurement, and the final account;
- for daily site cleaning during execution of the Works and final cleaning after completion of the works including removing all waste, scrap and resulting materials to approved dumping areas;
- for overhead and profit;
- and for all other establishment charges and all costs of whatever nature.
- No claim for additional payment or extension of time will be considered for any error or misunderstanding by the Tenderer in these respects.

1.08 Any item, which is not priced, shall be deemed to have been included in other rates and prices, and in the Contract Price.

1.09 The rates and final Contract Price inserted by the Tenderer in the Bill of Quantities shall be in words and in figures. In case of discrepancy between the two, the unit rates written in words shall govern.

1.10 When pricing the Bill of Quantities, the Tenderer must be aware of all site conditions.

1.11 The unit rates and prices inserted by the Tenderer shall apply throughout the Contract and to any additional work, which might be ordered by the Employer.

1.12 The Tenderer shall submit to the Employer, unless stated otherwise, a detailed breakdown of all his rates and lump sums prior to the signing of the Contract. The Tenderer shall liaise on this matter with the Employer.

1.13 The Tenderer should price all items he considers of value. If items are not priced by the Tenderer, they will be deemed to be of no value or that their value has been spread throughout the rates of other items.

1.14 The Tenderer shall complete the collections and summaries at the end of each Division and carry the totals to the "General Summary".

1.15 The Tenderer shall allow in his rates for protecting all Works against damage by whatever method deemed necessary and approved. Any work damaged before the Works are handed over shall be replaced or made good at the Tenderer's expense and to Engineer's satisfaction.

1.16 The Tenderer is expected to take all necessary precautions to avoid damaging services and where they are interrupted to reconnect them immediately.

1.17 Any underground utility/service structure related to any local authority shall be properly disconnected, disposed, relocated and/or diverted under the supervision of the Engineer, and under the control of the relevant authority at no additional cost.

1.18 No separate payment shall be made for any cost related thereto, and the rates in the Bill of Quantities shall be deemed to cover adequately all costs.

1.19 The Tenderer's attention is drawn to the fact that the service authorities may impose, in addition to the cost of repair, statutory penalties. Details of these requirements may be obtained from the respective authorities.

1.20 The Tenderer shall price all items excluding VAT.

1.21 Unit rates and lump sums inserted by the Tenderer in the Bill of Quantities shall be fixed and not subject to variation. The Tenderer shall not be able to claim for any compensation due to difficulties in the works, shortage of labor, equipment or material, bad weather or unforeseen circumstances.

1.22 Any "Optional" or "Provisional" item included in the Bill of Quantities, which is not carried out, shall be omitted from the interim and final statements. Any additional item of work carried out on the Engineer's written instructions shall be included in the relevant interim and final statements.

1.23 Any discount offered by the Tenderer shall be applied uniformly on a pro-rate basis to all items in the Bill of Quantities, and to items of any necessary variation (if any) made by the Employer, which shall be a part of the Tender Documents. Discount shall not be applied against Provisional Sums inserted by the Employer in the Bill of Quantities.

1.24 The Contractor shall include in his rate the cost and time effect of coordinating and fully assisting any Nominated Sub-Contractors, if any, appointed by the Employer, during schedule overlapping in the utilization of all equipment and facilities, and maintaining all equipment (cranes, generators, safety barriers, site security, etc.) operational until the end of all trades of the entire project. No claim for additional payment or extension of time will be considered in these respects.

1.25 Prior to signature of the Contract, the Employer reserves the right to omit any items or works from the project.

2-Measurement

2.01 The Quantities set-out in the Bill of Quantities are estimated quantities and are intended to give a reasonable indication of the works shown on the Drawings, they are not to be taken as the actual and correct quantities of the Works to be executed by the Tenderer in fulfillment of his obligations under the Contract

2.02 This is a Remeasured Contract. Notwithstanding the quantities given, all Works itemized in the Bill of Quantities shall be subject to re-measurement on site as executed and approved by the Engineer, and in the unit of measurement indicated in the Bill of Quantities, and payment will be made at the corresponding unit rates on the re-measured quantities

2.03 All Works shall be measured net as installed with no allowance made for laps or waste, and irrespective of any trade, general or local customs. Measurement shall be applicable to finished work only as completed and no allowance shall be made for wastage, working spaces, bulking, shrinkage, overlaps, etc.; the principle of net measurement shall be applied to all Works under this Contract. All measurement shall be rounded up or down to the nearest integer number and exact half units shall be rounded up. Any thickness stated in this Document, shall be the finished and specified thickness. The unit of measurement for each item shall be as indicated in the Bill of Quantities

2.04 Certain items in the Bill of Quantities are designated "Provisional" or "Optional". The provision of such facilities as described in the items so designated, shall be used only upon written direction of the Engineer. If not used either wholly or in part, the amount not used shall be deducted from the Contract Price and no claim shall be entertained with respect to overhead charges or any other cost that may allegedly result therefrom.

2.05 Lump Sum items shall not be paid until all the requirements and obligations set forth in these respects are accomplished completely to the satisfaction of the Engineer; However, where Lump Sum items involve the Contractor in periodic costs, payment will be made at the Engineer's discretion

3-Expressions, Notations and Abbreviations

3.01 The expression "approved shop drawings" shall be deemed to mean "shop drawings submitted by the Contractor and approved by the Engineer".

3.02 Whenever the expression "shown on the drawings" appears in the Bill of Quantities, it shall be deemed to mean "shown on the Tender drawings and on approved shop drawings".

3.03 When the expression "ditto" appears under an item in the Bill of Quantities, it shall be deemed to mean that the said item shall include the whole relevant description of the preceding item together with any description written before and/or after the said expression.

3.04 When the expression "extra-over" appears under an item in the Bill of Quantities, it shall be deemed to mean that he said item shall be measured and paid for in addition to the measurement of the basic item to which it relates.

3.05 The following notations and abbreviations are used in the Bill of Quantities:

- Millimeter ..... mm
- Centimeter .....cm
- Linear Meter .....lm
- Kilometer .....km
- Square Meter ..... m^2
- Cubic Meter ..... m^3
- Kilogram .....kg
- Mega Pascal .....MPa
- Nominal Diameter.....DN
- Flange Pressure Rating .....PN
- Kilowatt .....Kw
- Unit .....U
- Number ..... №
- Lump Sum .....LS
- Provisional Sum .....PS
- Drawing .....Dwg
- Value Added Tax .....VAT
- Bill of Quantities .....BOQ

Bill A – GENERAL REQUIREMENTS

Item	Description	Unit	Estimated Quantity	Unit Rate L.L.	Amount L.L.
1	**Preliminaries**				
	The Contractor shall fully price the following selected "Preliminaries" items scheduled hereunder. If the Contractor fails to provide the prices required under this Bill, the cost of these selected items shall be deemed to be included within his unit rates and lump sums for other work items. All other Preliminaries and General Requirements described in the Preamble of the Bill of Quantities and in the General Requirements Specifications, shall be deemed to be included in the Contractor's unit rates and lump sums for other work items.				
1.1	Mobilization and Demobilization Mobilization to site & demobilization on completion of Works of all resources and equipment necessary for the execution and completion of works complete including all necessary offices, stores, workshops, clinics and facilities, insurance of works, equipment and personnel, protection of properties, testing of materials, necessary temporary works, equipment, site protection, watching, fencing, water, lighting, electrical power, sanitary facilities, access & service roads, signboard, Engineer's site office, remedying of all damages caused by the execution of the works, programme of works, monthly progress reports and all other services of a temporary nature required and described in the Contract. Unit Rate in Words for the Item:	Item	1		
1.2	Setting Out and Accuracy Include all necessary temporary survey works and tasks required for "Setting Out and Accuracy" described in the Contract. Unit Rate in Words for the Item:.....	Item	1		

1.3	As-Built Drawings and Manuals Prepare and furnish to the approval of the Engineer all required "As-Built Drawings" on completion of the Works and "Manuals" in the type, number and presentation as described in the Contract. Unit Rate in Words for the Item:.....	Item	1		
1.4	Serviceability of Utilities during Construction Ensure the serviceability of all utilities during the construction of works complete including supply of all required materials, construction of diversions or structures necessary for the preservation of all existing utilities of any type, repair any damage caused by construction works to any utility, and all other related works, all to the Engineer's satisfaction Unit Rate in Words for the Item:.....	Item	1		
2	**Dayworks** Comply with the relevant Sub-Clause of the Conditions of Contract. General: Amounts paid for work executed on a daywork basis shall be based upon the time that labor and plant are employed on the site for the daywork item. Payments for traveling time, standing time and idle time will not be allowed. Rates apply only to works classified by the Engineer as Dayworks. Labor: Rates inserted for labor executed on a daywork basis shall be deemed to include for wages paid to work people and for all other costs including relevant and necessary tools and allowances in connection with labor, and for supervision, overheads and profit. Equipment: Rates for equipment owned or hired shall include for the cost of maintaining in proper working order, attendance in starting up and shutting down, refueling and all fuel power, oils, grease and cleaning materials, replacement and/or sharpening of tools, provision of tools and all other ancillary items, profits and overheads, including				

	consumable spares. Idle time in maintenance or traveling to the Site will not be allowed. Materials: Materials for work executed on a daywork basis shall be paid for at the net invoiced prices including the cost of delivery to the site, plus the percentage addition inserted by the Contractor. Percentage Addition: Percentage addition to the Provisional Sum for materials shall include, but not limited to: – Storage of materials including handling and waste; – Contractor's supervisory and administrative arrangements including on site and head-office charges; – Contractor's equipment except those employed on dayworks; – Contractor's facilities and temporary works; – Protection of material and finished work; – Any other costs and obligations for the purpose of Dayworks such as insurances, transport, social securities, surveying, water pumping, shoring, electrical generators, temporary site lighting, signage, pedestrian and traffic protection, etc. – overheads and profit.				
2.1	Schedule of Daywork Rates:				
2.1.1	Skilled craftsmen Unit Rate in Words for the Day: :.....	Day	15		
2.1.2	Skilled electrical and mechanical engineering craftsmen Unit Rate in Words for the Day: :.....	Day	5		
2.1.3	Semi-skilled craftsmen Unit Rate in Words for the Day:.....	Day	25		
2.1.4	Laborers Unit Rate in Words for the Day: :.....	Day	50		

2.1.5	Bar Benders Unit Rate in Words for the Day: :.....	Day	5		
2.1.6	Concreters Unit Rate in Words for the Day: :.....	Day	5		
2.1.7	Transport drivers Unit Rate in Words for the Day: :.....	Day	5		
2.1.8	Fitter / Mechanics Unit Rate in Words for the Day: :.....	Day	5		
2.1.9	Gangers (in charge of laborers) Unit Rate in Words for the Day: :.....	Day	5		
2.1.10	Foreman Unit Rate in Words for the Day: :.....	Day	5		
2.1.11	Watchmen Unit Rate in Words for the Day: :.....	Day	5		
2.1.12	Welders Unit Rate in Words for the Day: :.....	Day	5		
2.2	Equipment				
2.2.1	Compressor (working pressure 3.5 kg/cm²) Unit Rate in Words for the Day: :.....	Day	5		
2.2.2	Tilting drum concrete mixer up to 200-liter wet capacity Unit Rate in Words for the Day: :.....	Day	5		
2.2.3	Lorry mounted concrete pump (with boom, piping & pipe cleaning equipment) up to 50m³/hr. capacity Unit Rate in Words for the Day: :.....	Day	5		
2.2.4	Concrete vibrator poker, petrol driven Unit Rate in Words for the Day: :.....	Day	5		

2.2.5	Dumper trucks, up to 1000 kg capacity Unit Rate in Words for the Day:	Day	5		
2.2.6	Asphalt cutter Unit Rate in Words for the Day:	Day	5		
2.2.7	Trucks, ordinary up to 16-ton capacity Unit Rate in Words for the Day:	Day	5		
2.2.8	Ditto, but up to 8-ton capacity Unit Rate in Words for the Day:.....	Day	5		
2.2.9	Tractor (crawler) with bull or angle dozer, marker's rated flywheel, up to 100 kW capacity Unit Rate in Words for the Day:	Day	5		
2.2.10	Mobile water tanker, up to 4450-liter capacity Unit Rate in Words for the Day:	Day	5		
2.2.11	Wheel loader (90 hp max. power, toothless shovel) Unit Rate in Words for the Day:	Day	5		
2.2.12	Backhoe loader (90 hp max. power, toothless bucket) Unit Rate in Words for the Day: :.....	Day	5		
2.2.13	Skid steel loader, similar to "Bobcat" (70 hp maximum power) Unit Rate in Words for the Day: :.....	Day	5		
2.3	Materials				
2.3.1	Include a Provisional Sum of US$ 25000 for materials related to dayworks. Provisional Sum in Words: Twenty-Five Thousand Only	PS	1	25,000	
2.3.2	Add percentage addition to the PS for "Materials". Percentage in Words: :.....	%			

	Total Amount of Bill of Quantities (BOQ): Bill A	
	Add 11 % VAT : Bill A	
	Total Amount of BOQ including VAT:Bill A	
	Total Amount of BOQ including VAT in Words :Bill A	

BILL B – PIPELINES INSTALLATION

Item	Description	Unit	Estimated Quantity	Unit Rate L.L.	Amount L.L.
3	**Service Access Road**				
3.1	Construct and remove upon completion of works the following service access road in aggregate base course complete including all necessary earthworks, sub-grade preparation and compaction, 200mm thick aggregate base course (4-day soaked CBR>80), and all other related works, all as specified, shown on the drawings and to the satisfaction of the Engineer				
3.1.1	Service access road, 4m wide approximately, where directed and approved by the Engineer. Unit Rate in Words: :…… ……	lm	1750		
4	**Breaking Out and Reinstatement of Existing Paved Surfaces for Pipes and Manholes** Breaking out existing paved surfaces in bituminous courses, concrete, or pavers of any type and of any thickness, and reinstatement to match previously existing with 200mm thick aggregate sub-base layer, 200mm thick aggregate base layer and 2x50 mm thick asphalt layers, complete including removal and replacement of aggregate base & sub-base courses, bituminous courses, concrete roads, curbs, pavers, street lamps, roads signs, marking, safety barriers, and all other structure or street furniture, removing and disposing of resulting materials to approved				

	dumps, making good disturbed surfaces, and all other related works, all as specified, shown on the drawings and to the satisfaction of the Engineer.				
4.1	For DN 400 (80cm width) Unit Rate in Words: :.....	lm	300		
4.2	Trench Excavation for Potable Water Pipes Trench excavation in any type of soil including rock complete including, but not limited to: - Grading or leveling and compacting or trimming bottom of excavation; - Planking, strutting or trimming sides of excavation; - Keeping excavation free from all water sources; - Protection of existing service utilities (if any) and provision of necessary temporary works to maintain utilities in use during and until completion of works; - Backfilling with selected excavated or imported fill materials; - Compacting in layers to required density; - Removing and disposing of resulting and surplus materials to approved dumping area; - and all other related works, all as specified, shown on drawings and to the satisfaction of the Engineer. - Trench depth for pipes shall be measured from top of existing ground level down to pipe invert level.				
4.2.1	For DN 400 (80cm width), trench depth up to 2 m. Unit Rate in Words: :.....	lm	1510		
4.2.2	For DN 400 (80cm width), trench depth up to 2.5 m. Unit Rate in Words: :.....	lm	625		
4.2.3	For DN 400 (80cm width), trench depth up to 3 m. Unit Rate in Words: :.....	lm	75		

4.4	General Excavation Excavation in any type of soil including rock and to any depth required complete including keeping excavation free from all water sources, storing in approved location all selected excavated materials, disposing of all resulting unsuitable and surplus materials to approved dumps outside the site, and all other related works, all as specified, shown on drawings and to the satisfaction of the Engineer.				
4.4.1	General excavation for pipe supporting & structure. Unit Rate in Words: :.....	m^3	450		
5	**Pipes for Water Network** Supply, install, connect and test the following pipes for water network complete including detectable warning tape, pipe fittings & accessories (bends, tees, reducers, adaptors, universal/stepped couplings, blank flanges, end caps, etc.), corrosion protection for iron pipes, connection to existing network/reservoir, chlorination, disinfection and water quality testing, and all other related works, all as specified, shown on the drawings and to the satisfaction of the Engineer.				
5.1	Ductile Iron Pipe, Class C30 (30 bar Allowable Working Pressure) to ISO 2531, EN 545 & EN 598 Internally: Cement mortar lining to ISO 4179 /EN 545 Externally: Zinc coating (min. 130g/m² to ISO 8179) + bitumen painting (min. 70 microns to ISO 8179)				
5.1.1	DN400mm. Unit Rate in Words: :.....	lm	1055		
5.2	Spiral Welded Steel Pipe to API Class X52 Internally: Epoxy lining to EN 10289 or AWWA C210, Externally: Coated with 3 layers of HDPE to EN 10288, or AWWA C215				
5.2.1	OD 406.4 mm, 8.7 mm minimum wall thickness. Unit Rate in Words: :.....	lm	1155		
6	**Sand Material for Pipe Bedding and Cover** Supply and install sand material for pipe bedding and cover of the following pipes complete all as specified, shown on the drawings and to the satisfaction of the Engineer.				

6.1	Ductile iron pipe, DN400mm. Unit Rate in Words: :.....	lm	1055		
6.2	Spiral welded steel pipe, OD 406.4 mm. Unit Rate in Words: :.....	lm	1155		
7	**Reinforced Concrete Works** Cast-in-place reinforced concrete works using ordinary Portland cement to ASTM C150, Type I, 25 MPa, minimum cement content 250 or 350 kg/m³ of concrete (as indicated), complete including all necessary formwork, reinforcement, accessories, couplings, steel expansion joints / flexible joints at both sides of concrete thrust blocks and supports, and all other related works, all as specified, shown on drawings and to the satisfaction of the Engineer.				
7.1	Reinforced concrete for pipe encasement. (minimum cement content 250 kg/m³ of concrete) Unit Rate in Words: :.....	m³	120		
7.2	Reinforced concrete thrust blocks and supports for fittings and accessories. (minimum cement content 350 kg/m³ of concrete) Unit Rate in Words: :.....	m³	150		
8	**Valves Assemblies** Supply and install the following valves assemblies to BS or ISO standard, complete including all necessary valves, wheels, flange spigots, flange sockets, flange adaptors, dismantling joints, double flanged pipes, socket/spigot pieces, all necessary fittings (bends, reducers, tees, etc.), gate and flap valves, accessories, concrete supports, corrosion protection, connecting, testing and all other related works, all as specified, shown on the drawings and to the satisfaction of the Engineer.				
8.1	Triple Function Air Valve Assemblies				
8.1.1	DN 100 mm, PN 64. Unit Rate in Words: :.....	№	3		

8.1.2	DN 100 mm, PN 25. Unit Rate in Words: :.....	№	1		
8.2	Anti-Shock Air Valve Assemblies				
8.2.1	DN 80 mm * 9 AS, PN 16. Unit Rate in Words: :.....	№	2		
8.3	Washout Valve Assemblies				
8.3.1	DN 200 mm, PN 30. Unit Rate in Words: :.....	№	1		
8.3.2	DN 200 mm, PN 64. Unit Rate in Words: :.....	№	2		
8.4	In-Line Check Valve Assemblies				
8.4.1	DN 400 mm, PN 16. Unit Rate in Words: :.....	№	1		
8.4.2	DN 400 mm, PN 64. Unit Rate in Words: :.....	№	1		
9	**Reinforced Concrete Valve Chambers** Supply all required materials and construct the following reinforced concrete valve chambers, complete including, but not limited to, the following: - Breaking out and reinstatement of existing paved surfaces; - Site clearing and all necessary excavation in any type of soil; - Keeping excavation free from all water sources; - Cast-in-place concrete, using ordinary Portland cement to ASTM C150, Type I, 14 MPa for blinding, and 25 MPa for reinforced concrete, including formwork, reinforcement & accessories; - Concrete supports for fittings; - Protective coating of concrete external surfaces in contact with soil;				

	– Breaking into pipes; – Backfilling with selected excavated or borrow fill materials; – Compacting in layers to required density; – Removing and disposing off resulting and surplus materials to approved dumping area; – Covers and frames, steps, and all necessary accessories; – And all other related works, all as specified, shown on approved shop drawings and to the satisfaction of the Engineer.				
9.1	Type B external size 1500 x 1200mm, depth up to 2.5m Unit Rate in Words: :.....	№	2		
9.2	Type B, external size 1500 x 1200mm, depth up to 3.0m Unit Rate in Words: :.....	№	2		
9.3	Type C, external size 1800 x 1400mm, depth up to 2.5m Unit Rate in Words: :.....	№	1		
9.4	Type D, external size 2200 x 1600mm, depth up to 3.0m Unit Rate in Words: :.....	№	3		
9.5	Type E, external size 3100 x 2300mm, depth up to 3.0m Unit Rate in Words: :.....	№	2		
10	**Filling and Backfilling Works** Filling and backfilling with selected excavated or borrow fill materials, and compacting in layers not exceeding 200 mm thick after compaction to required density, complete all as specified, shown on the drawings and to the satisfaction of the Engineer.				
10.1	Backfilling works for thrust blocks and pipe supports. Unit Rate in Words: :.....	m^3	110		
11	**<u>Instrumentation/Telemetry Cable</u>** Supply, install, connect, test and commission the following instrumentation/telemetry cables complete including cable termination, cable labeling, cable trays, bends, tees and				

	hangers, all necessary accessories and connections, and all other related works, all as specified, shown on the drawings and to the satisfaction of the Engineer.				
11.1	Telemetry cable from pumping station to downstream reservoir. Unit Rate in Words: :.....	lm	2220		
11.2	Instrumentation/Telemetry Ducts Supply all required materials and construct the following instrumentation/telemetry ducts complete including all necessary excavation, HDPE conduits PN 10 or double-wall PE conduits, sand bedding, concrete encasement for road crossing, accessories, protective tile, warning tape, backfilling, compaction in layers to required density, removal of surplus material to approved dumping areas, and all other related works, all as specified, shown on the drawings and to the satisfaction of the Engineer.				
11.2.1	Telemetry ducts, Outer Diameter 63mm, from pumping station to downstream Bsaba reservoir. Unit Rate in Words: :.....	lm	2220		
11.3	Instrumentation/Telemetry Manholes Supply all required materials and construct the following instrumentation/telemetry manholes complete including excavation, concrete works using moderate sulphate resistant cement to ASTM C150, Type II, 14 MPa on cylinder for blinding and 30 MPa on cylinder for reinforced concrete works, all necessary formwork, reinforcement, accessories, application of two coats of bituminous paint to concrete surfaces in contact with soil, backfilling, compaction, removal of surplus materials to approved dumping areas, covers and frames, and all other related works, all as specified, shown on the drawings, to the satisfaction of the Engineer.				
11.3.1	Instrumentation/telemetry manholes Unit Rate in Words: :.....	№	23		
12	**<u>Anti-Water Hammer System</u>** Supply and install the following anti-water hammer system complete including bladder surge vessel (similar to				

	Charlatte or Massal), flanged connection, isolating valves, pipeworks, fittings, valves, panelboard with necessary protection and control devices, cabling, cable lugs, labeling, cable trays, cable trenches, all necessary electrical installations and connections, testing and commissioning, and all other related works, all as specified, shown on the drawings and to the satisfaction of the Engineer ***Note:*** *The contractor shall perform the necessary hydraulic and surge analysis calculations to verify the appropriate surge protection requirements (Pressure ratings, surge vessel, backflow restrictor, etc), ensuring effective pressure regulation, controlled reverse flow, and protection against transient events. The calculated design shall be submitted for review and approval prior to implementation.*				
12.1	Anti-water hammer system AT THE DISCHARGE OF PUMPS comprising bladder surge vessel 1500 L capacity, pre-charge pressure 12.5 bar, factory test pressure 90 bar, fitted with glass level gauge, equipped with a PN64 DN300 flange connection with isolating valve, free from any restrictor or check valve. Unit Rate in Words: :.....	№	2		
13	**Water Service Connection from Existing Water Network** Supply all required materials and construct the following water service connection from existing water network at any depth required, complete including, but not limited to, the following: - Breaking out and reinstatement of existing paved surfaces; - All necessary excavation in any type of soil; - All necessary temporary works to maintain services in use during connection works; - All necessary breaking into existing chamber/structure; - Connection to existing water network including all necessary pipe cutting, pipeworks, pipe fittings (saddles, adaptors, reducers, elbows, tees, etc.),				

	valves and accessories, of any type and diameter; - All necessary proprietary pipe seals; - All necessary pipe sleeves, supports and protection; - Making good all disturbed surfaces; - Testing and commissioning; - Backfilling with selected excavated or imported fill materials; - Compacting in layers to required density; - Removing and disposing of resulting and surplus materials to approved dumping area; - and all other related works, all as specified, shown on drawings, to the satisfaction of the Engineer, and with full coordination with relevant authorities and ensuring outage occurs for only short periods.				
13.1	Connection of new Bisri pipeline to existing valve chamber of Bsaba reservoir or direct connection to the existing reservoir with all required fittings, valves, accessories and testing to complete the works. Unit Rate in Words: :.....	Item	1		
14	**<u>One Way Surge Shaft System</u>** Supply, installation, and complete commissioning of a one-way surge shaft system, constructed in either rectangular or circular cross-section, with a minimum internal diameter of 2000 mm, and fabricated from Steel, GRP, HDPE, or Reinforced Concrete, as approved. - The shaft shall be installed such that the static head between the tank bottom and the tie-in point to the main pipeline is no less than 16 meters. - The minimum internal shaft height shall be 2.8 meters, providing a minimum storage volume of 15 m^3. - The surge shaft shall be equipped with a discharge outlet connection in Ductile Iron (DI) pipe, DN350 or DN400 mm, fitted with a PN16 non-return valve (NRV) oriented to allow flow only towards the pumping main. - A DN50 mm feed/bypass line shall be connected upstream of the NRV, terminating in a PN16 float valve				

	(DN50 mm). The float valve shall be normally closed and preset to open at a level no less than +2.7 m above the shaft bottom. - The vent(s) on the shaft shall be sized and designed in accordance with the findings of the surge analysis report to ensure proper pressure relief and air exchange during transient events. - Including connection to the main line and all other related works, all as specified, shown on the drawings and to the satisfaction of the Engineer All design and installation works shall comply with the relevant standards and shall be carried out as per the details shown in the contract drawings.				
14.1	One Way Surge Shaft at station 2+043,15m3 capacity comprising one non return valve DN350 or 400 , Gate valve, dismantling joint, inlet bypass DN50mm with isolating valve and float valve, all tees, accessories and connection to the main line, Pressure rating 16 bar. Unit Rate in Words: :.....	№	1		

	Total Amount of Bill of Quantities (BOQ): Bill B	
	Add 11 % VAT : Bill B	
	Total Amount of BOQ including VAT:Bill B	
	Total Amount of BOQ including VAT in Words :Bill B	

SUMMARY

	Grand Total Amount of Bill of Quantities (BOQ):	
	Add 11 % VAT :	
	Grand Total Amount of BOQ including VAT:	
	Grand Total Amount of BOQ including VAT in Words :	

العارض :

التوقيع :

تاريخ :

طابع أميري :

3- تصريح / تعهد

إمداد إقليم الخروب بالمياه ضمن نطاق مؤسسة مياه بيروت وجبل لبنان

أنا الموقع أدناه .....

الممثل بالتوقيع عن مؤسسة/شركة .....

المتخذ لي محل اقامة ..... منطقة ..... حي .....

شارع ..... ملك .....

رقم الهاتف ..... مكتب ..... فاكس .....

البريد الالكتروني .....

اعترف بانني اطلعت على دفتر الشروط المتضمن التعهد، الشروط الادارية والفنية الخاصة للاشتراك في هذا التلزيم التي تسلمت نسخة عنها.

واصرح انني وبعد الاطلاع على هذه المستندات التي لا يمكن باي حال الادعاء بتجاهلها وعلى تفاصيل الاعمال المطلوبة، اتعهد بقبول كافة الشروط المبينة فيها وبالتقيد بها وتنفيذها كاملة دون أي نوع من انواع التحفظ او الاستدراك.

وأنني تقدمت لهذا الإلتزام للإشتراك ب:

.....

كما اصرح بانني وضعت الاسعار وقبلت الاحكام المدرجة في دفتر الشروط هذا آخذاً بعين الاعتبار كل شروط التلزيم ومصاعب تنفيذه في حال وجوده.

كما أتعهد برفع السرية المصرفية عن الحساب المصرفي الذي يودع فيه أو ينتقل إليه أي مبلغ من المال العام، وذلك لمصلحة الإدارة في كل عقد من أيٍ نوعٍ كان، يتناول مالاً عامًا.

التاريخ _____

ختم وتوقيع العارض

طوابع بقيمة
مليون ليرة لبنانية

4- تصريح النزاهة

عنوان الصفقة: .....

مؤسسة مياه بيروت وجبل لبنان

اسم العارض / المفوض بالتوقيع عن الشركة .....

إسم الشركة: .....

نحن الموقعون أدناه نؤكد ما يلي:

1- ليس لنا، أو لموظفينا، أو شركائنا، أو وكلائنا، أو المساهمين، أو المستشارين، أو أقاربهم، أي علاقات قد تؤدي إلى تضارب في المصالح بموضوع هذه الصفقة.

2- سنقوم بإبلاغ هيئة الشراء العام والجهة المتعاقدة في حال حصول أو اكتشاف تضارب في المصالح.

3- لم ولن نقوم، ولا أيّ من موظفينا، أو شركائنا، أو وكلائنا، أو المساهمين، أو المستشارين، أو أقاربهم، بممارسات احتيالية أو فاسدة، أو قسرية أو مُعرقلة في ما يخص عرضنا أو اقتراحنا.

4- لم نقدم، ولا أيّ من شركائنا، أو وكلائنا، أو المساهمين، أو المستشارين، أو أقاربهم، على دفع أي مبالغ للعاملين، أو الشركاء، أو للموظفين المشاركين بعملية الشراء بالنيابة عن الجهة المتعاقدة، أو لأي كان.

5- في حال مخالفتنا لهذا التصريح والتعهد، لن نكون مؤهلين للمشاركة في أي صفقة عمومية أياً كان موضوعها ونقبل سلفاً بأي تدبير إقصاء يُؤخذ بحقنا ونتعهد بملء إرادتنا بعدم المنازعة بشأنه.

إن أي معلومات كاذبة تُعرضنا للملاحقة القضائية من قبل المراجع المختصة.

التاريخ: _____

الختم والتوقيع

5- تعهـد برفع السرّية عن الحسابات المصرفية المتعلقة بهذا الإلتزام

أنا الموقع أدناه .....

المتخذ محل إقامة في .....

محل معترفاً باطلاعي على جدول الأسعار وتقدير الكميات ودفتر الشروط ومرفقاته العائد لـ **إمداد إقليم الخروب بالمياه ضمن نطاق مؤسسة مياه بيروت وجبل لبنان**

أتعهد، بالاستناد إلى ملف الإلتزام الذي اطلعت عليه، وعملاً بالقرار رقم 4 تاريخ 2020/4/28 الصادر عن مجلس الوزراء اللبناني المتعلق بتطبيق المادة الخامسة من قانون السرّية المصرفية التي تجيز رفع السرية عن الحسابات المصرفية المتعلقة بهذا الإلتزام لصالح مؤسسة مياه بيروت وجبل لبنان، بأن أرفع السرية عن الحسابات المصرفية المتعلقة بهذا الإلتزام لصالح مؤسسة مياه بيروت وجبل لبنان، فور تبلغي قرار إسناد الإلتزام إليّ.

ربطاً

مستندات العرض المطلوبة

المتعهّد

رقم الهاتف:

طابع أميري /1.000.000/ل.ل.

نُظّم في

6- تصريح بمعاينة مواقع العمل نافي للجهالة للإشتراك بمناقصة حفر وتجربة آبار ضمن نطاق مؤسسة مياه بيروت وجبل لبنان

أنا الموقع أدناه .....

بصفتي .....

ومفوضًا بالتوقيع من قبل .....

أصرح باسم .....

بأنني قد عاينت مواقع العمل الخاصة بالتلزيم المذكور أعلاه ولن أتذرع فيما بعد بالجهل أو بأي عذر آخر متعلق بحالة المواقع المذكورة.

إن المعلومات التي تقدمها سلطة التعاقد (سواء في دفتر الشروط هذا أو في غيره) هي لإرشاد العارضين المحتملين في تحضير عروضهم. على كل عارض بذل جهده الخاص للتحقق من المخاطر التجارية المرتبطة بتنفيذ الالتزام ولا تتحمل سلطة التعاقد أية مسؤولية عن أية معلومات غير صحيحة قد يحصل عليها أي عارض.

إن أية مصاريف أو تكاليف تكبدها أي عارض من أجل معاينة مواقع العمل وتقديم عرضه هي على مسؤوليته الكاملة وليس على سلطة التعاقد أي مسؤولية من أي نوع كانت مرتبطة بذلك.

توقيع وختم العارض التاريخ

تفيد مؤسسة مياه بيروت وجبل لبنان بأن العارض الموقع أعلاه قد عاين مواقع العمل المُحددة في دفتر الشروط الخاص بالصفقة برفقة مندوب من قبل الإدارة.

توقيع وختم سلطة التعاقد التاريخ