

THE REPUBLIC OF ECUADOR

C. I. R. I. M. I.

Centro de Rehabilitación de Manabí

WATER TRANSBASIN PROJECT FOR CHONE, PORTOMELO RIVER BASINS

TENDER DOCUMENTS

FOR

CONSTRUCTION OF CIVIL WORKS

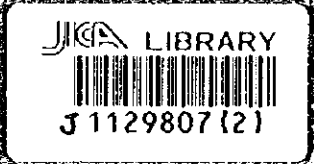
PACKAGE 1

MANEJO DE TIERRA Y OBRAS DE TRANSBASA

VOLUME - III

GENERAL AND TECHNICAL SPECIFICATIONS

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WATER TRANSBASIN PROJECT FOR CHONE - PORTOVIEJO RIVER BASINS

TENDER DOCUMENTS
FOR
CONSTRUCTION OF CIVIL WORKS

PACKAGE 1

DAULE - PERIPA ~ LA ESPERANZA TRANSBASIN

VOLUME - III

GENERAL AND TECHNICAL SPECIFICATIONS

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SECTION B DIVERSION AND CARE OF THE RIVER AND CONTROL
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MARCH 1995



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**WATER TRANSBASIN PROJECT FOR CHONE-PORTOVIEJO RIVER BASINS
CONSTRUCTION OF CIVIL WORKS**

PACKAGE 1

DAULE-PERIPA~LA ESPERANZA TRANSBASIN

VOLUME III - GENERAL AND TECHNICAL SPECIFICATIONS

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CONSTRUCTION OF CIVIL WORKS

PACKAGE 1

DAULE-PERIPA~LA ESPERANZA TRANSBASIN

VOLUME III - GENERAL AND TECHNICAL SPECIFICATIONS

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GENERAL ITEMS

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GENERAL SPECIFICATIONS

SECTION A GENERAL ITEMS

A.1 SCOPE OF THE WORKS

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

The Works to be carried out by the Contractor under the Contract are listed as follows but are not necessarily limited thereto;

- (1) General items such as construction and removal of the Contractor's temporary works; maintenance of the existing and newly constructed access roads; provision of the CRM's laboratory equipment, office equipment and furnitures; construction and maintenance of the CRM's and the Supervision's base camp including offices and housings with utility facilities; exploratory boring and test pits, etc.
- (2) Construction of the Conguillo inlet including valve chamber and dredging.
- (3) Construction of the Daule-Peripa-La Esperanza diversion tunnel including the Conguillo work adit, the El Guasmo work adit and the Membrillo work adit.
- (4) Construction of the Membrillo outlet.
- (5) Construction and maintenance of the Conguillo access road, El Guasmo access road and Membrillo outlet access road.

Details of the works as stated in the foregoing items (1) to (5) are given in the General and Technical Specifications and on the Drawings, which form an integral part of the Tender Documents.

A.2 WORKS BY OTHER CONTRACTORS

The CRM will arrange for the works necessary for completion of the Project other than that covered by this Contract, to be executed by the other contractors. The Contractor shall cooperate with the CRM and the other contractors for the following Packages to ensure the satisfactory completion of the Project as a whole.

Package 2 : Civil Works for La Esperanza~Poza Honda Transbasin and Poza Honda~Mancha Grande Transbasin

Construction of the Severino pumping station, penstock, head tank, 138 kV substation, Severino open channel, Severino~Caña Dulce inspection road, Caña Dulce inlet, La

Esperanza~Poza Honda diversion tunnel including La Seca work adit and Los Cuyuyes work adit, Los Cuyuyes outlet, Poza Honda inlet including valve chamber, Poza Honda~Mancha Grande diversion tunnel including Poza Honda work adit, Mancha Grande outlet, Severino access road, Caña Dulce inlet access road, La Seca access road, Los Cuyuyes access road, Poza Honda inlet access road and Daule-Peripa 138 kV switchgear yard.

Package 3 : Electrical and Mechanical Works for the Daule-Peripa~La Esperanza Transbasin, La Esperanza~Poza Honda Transbasin and Poza Honda~Mancha Grande Transbasin

Supply and installation of the hydromechanical works including Severino pumping equipment and penstock, Conguillo inlet equipment, and Poza Honda inlet equipment; supply and installation of the electrical works including electric motors, switchgears, transformers, supervisory equipment and auxiliary equipment; and construction of 138 kV power transmission line.

A.3 SECURITY, SAFETY AND HEALTH CONTROL

A.3.1 General

All security, safety and health controls necessary for the execution of the Works such as land clearing of the Site, explosives and fuel, temporary fencing, safety precautions, fire prevention and sanitary arrangements shall be established and maintained by the Contractor at his own expense. The Contractor shall make himself responsible for all security, safety and health controls and shall provide the personnel, equipment and written programs necessary to accomplish such matters.

All written programs for security, safety, and others stipulated below shall be submitted to the Supervision for approval within twenty-eight (28) calendar days after commencement of the Works. Approval of such programs shall not relieve the Contractor in any way from his responsibilities in this regard. No separate payment will be made for complying with the provisions of this Paragraph and all the costs related thereto shall be deemed to be included in the unit prices and lump sum prices for the various items in the Bill of Quantities.

A.3.2 Security Control System

The Contractor shall establish a security control system and its organization for the Works and submit a written program regarding it to the Supervision for his approval. The security control system shall be based on the laws and regulations of the Republic of Ecuador.

The security control system shall be operated in accordance with the approved program.

The Supervision shall have the right to instruct the Contractor in the operation of the approved security program and system from time to time, if it is deemed necessary in the opinion of the Supervision.

A.3.3 Lighting

The Contractor shall provide sufficient lighting to ensure that security and safe working conditions are to be established, that the Works can be constructed in complete compliance with the Contract, and that a complete inspection of all Works in progress can be made by the Supervision. Unless otherwise directed by the Supervision, the minimum illumination on ground or working surface to be provided for the various operations or work areas shall be as follows:

Operation or Work Area	Illumination (Lux) Minimum Value
Earthworks	20
Concrete placing	50
Haul roads and bridges where hazardous conditions exist	10
Underground works	50
Workshops and auxiliary building	200

Illumination for areas or operation not listed above shall be as instructed by the Supervision.

All mobile equipment or plant used during night operations shall be equipped with sufficient lights and/or reflectors to ensure safe working conditions.

At least fourteen (14) days prior to start of the night operation the Contractor shall submit his proposals for lighting systems in the areas which he proposes to work at night to the Supervision for approval. The Contractor shall modify the proposals, if required by the Supervision, and shall not begin such operations in such places as the case may be, until the proposals for lighting systems have been approved by the Supervision.

Approval of the Contractor's proposals for lighting shall not relieve the Contractor of any of his liabilities or obligations under the Contract.

A.3.4 Sanitary Arrangement

The Contractor shall keep the Site in a clean sanitary conditions and shall provide and maintain necessary units of sanitary conveniences/lavatories for the use of persons employed in the Works to the extent and in the manner and at such places as approved by the Supervision and by any local or other authorities concerned, and all persons connected with the Works shall be obliged to use these conveniences.

The Contractor shall be use his best endeavors to ensure, to the satisfaction of the Supervision, the health of his employees at work, especially measures to control flies, mosquitos, pests and any infections disease in working, living and recreational areas including chemical spraying, if necessary, in compliance with the rules and regulations of the appropriate Public Health Authority.

A.3.5 Sign

The Contractor shall provide all necessary signs for the Works. These shall include but not be limited to the followings:

- (a) Standard road traffic signs
- (b) Warning signs
- (c) Danger signs
- (d) Control signs
- (e) Safety signs
- (f) Direction signs

Wording on all signs shall be in both English and Spanish. The size, color, lettering and locations of all signs shall be subject to approval of the Supervision. The Contractor shall maintain all signs so placed as well as those placed by the CRM.

If the Supervision assesses that the system of signs provided by the Contractor is inadequate to ensure safety, or unsatisfactory in other respects, the Contractor shall add to, amend, or otherwise change the system to the satisfaction of the Supervision.

The Contractor shall pay particular care on the traffic control of the public roads on which the Contractor's equipment or vehicles may frequently pass. The Contractor shall post fragment at key places on such roads in addition to the signs. Roads closed to public and/or private traffic shall be barricaded and posted with adequate warning signals. Suitable warning or red lights shall be kept on such places from sunset to sunrise.

A.3.6 Explosives and Fuels

The Contractor shall make arrangements to transport, store and handle explosives and fuels in a safe manner for protecting the public in accordance with the laws and security regulations in force in the Republic of Ecuador. In this regard, he shall submit a written program to the Supervision for approval for the safe handling and storage of explosives and fuel.

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

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

Explosive magazines and above-ground storage tanks for gasoline and liquefied petroleum gas storage tanks shall not be located within the limits of the campsite or closer than 100 meter to any building on the Site. Moreover, all the locations of explosive magazines shall be approved by the Supervision. The Contractor shall not make use of any explosives without the written approval of the Supervision and the Government Authority. It must be clearly understood that the approval by the Supervision and the Government Authority shall not relieve the Contractor of his obligations and responsibilities for all blasting operation.

During thunderstorms and other electrical disturbances, no charging and firing will be permitted.

The Contractor shall install an approval automatic lightning detection and alarm system outside each tunnel portal in use as access to a working face during drilling and blasting operations. When atmospheric electrical activity in the vicinity of the portals reaches danger levels and the alarm is activated, all blasting operations shall be suspended until such electrical activity again reaches safe levels.

A.3.7 Precautions for Safety

The Contractor shall take all necessary precautions against risks of loss of life or of injury to any person; employed on the Works or to employees of the CRM and the Supervision or to visitors or to persons having good and sufficient reasons to be about the Works, and to this end he shall properly safeguard the Works to the satisfaction of the Supervision.

The Contractor shall furthermore take all necessary precautions against damage to the property of the CRM or of others located at or adjacent to the Site. The Contractor shall at all times comply with any accident prevention regulations and any safety regulations of any local or national authorities in the Republic of Ecuador.

The Contractor shall appoint a safety officer and the necessary number of assistants who will hold periodical safety meetings with his own personnel and those of his Sub-contractors. The Contractor shall report promptly to the Supervision all accidents involving the death of or serious injury to any person on the Site resulting from the Contractor's operations.

A.3.8 Safety Instructions

The Contractor shall supply and issue to all of his employees and those of his Sub-contractors a printed booklet of the size approved by the Supervision in English and Spanish languages used by his employees at the Site for instructions on safety based on good practice, at his own expense. Within fifty-six (56) days after the issuance of the Supervision's order to Commence the Works, sample copies of the booklet shall be submitted to the Supervision for his approval before printing, and if necessary, amendments shall be made to the booklet to the full satisfaction of the Supervision. The Contractor shall issue the booklet immediately after printing as required herein and ensure that all employees are fully conversant with the instructions. Safety instructions shall deal with all safety measures including but no limited to the following:

- (a) Protective clothing, helmet and footwear.
- (b) Use of lifting equipment.
- (c) Precautions against electrical shock.
- (d) Welding.
- (e) Routine procedure in case of accidents, fires, etc.
- (f) Watchmen, warning notices and barriers.
- (g) Use of drilling equipment (and dust suppression).
- (h) Use and storage of explosives.
- (i) Tunnelling practices.

A.3.9 Fire Prevention

The Contractor shall supply, maintain and operate an efficient fire fighting service for the protection of the Works, the Contractor's residential quarters, labour camps and other areas so designated by the Supervision. The Contractor shall be responsible for maintaining a trained and qualified fire fighting crew on the Site at all times as well as installing and maintaining an efficient fire alarm system. He shall also submit a fire prevention and fire fighting program for the Supervision's approval.

The Contractor shall take every precaution to prevent fire from occurring on or about the Site and shall provide what the Supervision considers to be suitable and adequate fire fighting equipment, for ready use in all structures, buildings or the Works under construction, including residential quarters, labour camps and ancillary buildings. The Contractor shall maintain all fire fighting equipment in good working condition until the Works are accepted by the Supervision.

The Contractor shall diligently fight any fire which occurs on the Site, wherever the fire may originate. In this regard, he shall employ all requisite equipment and manpower at the Site, including the equipment and manpower of his Sub-contractors.

A.3.10 Temporary Fencing

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

A.4 TEMPORARY WORKS

A.4.1 General

All the Contractor's Temporary Works, including but not be limited to the Site office, staff quarters, labour camps, buildings, water supply and treatment system, sewerage system, air supply system, electric power supply system, telecommunication system, dewatering system temporary construction roads, and other facilities, shall be designed furnished, installed, operated and maintained and subsequently removed by the Contractor as approved by the Supervision. The Tender Drawings for the Temporary Works are for the Contractor's

reference only and the Contractor shall make own arrangement in respect of such Temporary Works.

At least fifty-six (56) days prior to installation of the Temporary Works, the Contractor shall prepare and submit to the Supervision for his approval the details pertaining to such Temporary Works including scale, capacity, layout, installation program and schedule, and foundations. The drawings shall show the locations and other pertinent details of the principal components of the offices, camp quarters, buildings, storage areas, construction plant, roads, etc. which the Contractor proposes to construct at the Site. Particulars shall include plant and equipment capacities, foundation details, and program of construction. The Supervision shall have the right to direct the Contractor to modify or change the Contractor's proposals if it is deemed necessary in the opinion of the Supervision. Such direction of the Supervision shall not relieve the Contractor of his obligations and responsibilities under the Contract.

The Contractor shall also obtain any necessary approvals or licenses from relevant Government authorities, and actual construction of any Temporary Works shall not be started without the Supervision's written approval for respective parts.

Unless otherwise specified, on completion of the Works and upon the approval of the Supervision, all Temporary Works constructed by the Contractor shall be removed from the Site. The Contractor shall make safe all areas affected by the Temporary Works and reinstate natural drainage and revegetate the areas to the satisfaction of the Supervision.

Payment as outlined herein, will be made only for the following Temporary Works:

- Temporary buildings
- Water supply system
- Electric power supply system
- Telecommunication system
- Testing laboratory equipment
- Temporary construction roads

The CRM reserves the right, with agreement of the Supervision, to request the Contractor to leave the whole or a part of the Contractor's Temporary Works on the Site for his own use after completion of the Permanent Works. In this event, an equitable adjustment for the relevant payment will be made on the basis of negotiation between CRM and the Contractor.

A.4.2 Works Area

The Works area shall be the land or space to be used for the execution of the Works and shall be granted by the CRM to the Contractor for use free of charge. The Contractor shall submit to the Supervision for his approval drawings showing his proposed general arrangement of Temporary Works including roads, buildings, power supply and water supply within the Works area. Plans for the reinstatement of the land after completion of the Permanent Works shall be included in his proposal.

If the Contractor intends to locate some of the Temporary Works outside the boundaries of the Site shown on the Drawings, such proposal shall be optional but all costs incurred in doing so, including right-of-way, rent of land and the like shall be borne by the Contractor and shall be deemed to be included in the relevant items in the Bill of Quantities. Any delay or restriction caused by such matters shall not relieve the Contractor of his obligation to meet the requirements of the Contractor and no extension of time shall be allowed for any delay caused thereby.

Clearing and/or excavation of land or embankment and other establishment on land by the Contractor for construction of his Temporary Works shall not be made without the written approval of the Supervision and shall be kept to a minimum. Tree cutting is generally not permitted.

No separate payment will be made for land preparation including excavation, embankment, surfacing, drainage and soil conservation works, and all the cost thereof shall be deemed to be included in the relevant unit prices and lump sum prices tendered in the Bill of Quantities.

A.4.3 Temporary Buildings

The Contractor shall provide, maintain and subsequently remove where directed, such temporary buildings as the Contractor's offices, workshops, staff and labour camps, first aid station and other buildings necessary for the execution of the Works. The Contractor shall design and submit site plans and general particulars of the proposed temporary buildings to the execution of the Works. The Contractor shall design and submit site plans and general particulars of the proposed temporary buildings to the Supervision for his approval.

The Contractor shall furnish, maintain and subsequently remove, where directed, temporary accommodations and living facilities for his employees, including all necessary services for water supply, drainage, lighting and heating, roads, paths, parking places and refuse disposal as approved by the Supervision.

Payment for temporary buildings to the Contractor will be made by the lump sum price for Item 1/01 in the Bill of Quantities in the following manner:

- (1) Seventy (70) percent of the lump sum price will be paid when the Supervision certifies that the temporary buildings have been acceptably furnished and have become accommodative,
- (2) The remaining thirty (30) percent of the lump sum price will be paid when the Provisional Reception Certificate is issued by the Supervision in accordance with Clause II.2.11 of the General Dispositions, and
- (3) No separate payment for the costs incurred from repairing, maintaining and subsequently removing of the temporary buildings will be made and such costs shall be deemed to be included in the lump sum price for the Item 1/01 in the Bill of Quantities.

A.4.4 Water Supply and Treatment System

- (1) The Contractor shall supply, install, operate, maintain and subsequently remove temporary water supply and treatment system including adequate supply of potable water for the Contractor's staff quarters, labour camps, offices, laboratory, workshops, stores, and huts and other places of the Works on the Site to meet the Contractor's own requirement.

The Contractor shall design the temporary water supply system at such places of the work sites and the buildings as need water and install the system according to the plans and design. Detailed plans and drawings shall be prepared by the Contractor and submitted to the Supervision for his approval. The water source of such water supply system shall be decided by the Contractor.

The Contractor shall also provide ample clean water for producing concrete, washing of the aggregates and for other purposes.

The temporary water supply system shall be operated and maintained by the Contractor until the Provisional Reception Certificate is issued under Clause II.2.11 of the General Dispositions, or for such longer period as may be directed by the Supervision.

The CRM has the right, with agreement of the Supervision, to request the Contractor to leave the water supply and treatment system in its site for his use during the period of operation and maintenance. In that case, the equitable adjustment will be done on the basis of negotiation between the CRM and the Contractor.

- (2) Costs for depreciation, freight, insurance and others incurred from the transportation of all imported equipment and materials, erection and installation, and subsequent removal of the temporary water supply system shall be included in the lump sum price for Item 1./02 in the Bill of Quantities. Costs for operation, maintenance and repairing of the temporary water supply and treatment system shall be included in the lump sum price for Item 1./02 in the Bill of Quantities.

Payment to the Contractor will be made by the lump sum price for Item 1./02 in the Bill of Quantities in the following manner:

- (a) Seventy (70) percent of the lump sum price will be paid when the Supervision certifies that the water supply system has been acceptably installed and has become operation, and
- (b) The remaining thirty (30) percent of the lump sum price will be paid when the Provisional Reception Certificate is issued by the Supervision.

A.4.5 Electric Power Supply System

- (1) The temporary electric power distribution facilities shall be furnished, installed and maintained by the Contractor as shown on the working drawing to be approved by the Supervision.

The electric power supply system shall include for the CRM's and the Supervision's base camp areas as well as to his own buildings, and to the requirements for the construction, tests and maintenance of the Works.

The electric power supply will be at the Contractor's own expense and shall cover all the power requirements above mentioned during the period of the Contract, therefore, he must consider the procurement, erection, operation and maintenance of all the equipment and facilities needed that compliment the actual ones.

Voltage levels for domestic use shall be of 210-110 volts, 60 cycles. Three-phase wiring must be set at workshops and laboratories.

The Contractor shall submit his plans and detailed drawings to the Supervision for the approval. The Contractor shall not install the temporary electric power supply system without the approval of the Supervision. Approval of the Contractor's plans shall not relieve the Contractor of any of his liabilities or obligation under the Contract.

- (2) Payment of the temporary power supply system will be made by the lump sum price for Item 1./03 in the Bill of Quantities in the following manner:
 - (a) Eighty (80) percent of the lump sum price will be paid when the Supervision certifies that the temporary power supply system has been acceptably installed and has become operational, and
 - (b) The remaining twenty (20) percent of the lump sum price will be paid when the Provisional Reception Certificate is issued by the Supervision.

The Contractor shall not be entitled to payment for any extra cost and/or to extension of the Contract period for any delay of performance of the Works incurred from any failure of electric power supply.

The costs for the operation and maintenance of the temporary power supply facilities provided by the Contractor shall be also deemed to be included in the unit prices and lump sum prices for the various items in the Bill of Quantities.

The CRM has the right, with agreement of the Supervision, to request the Contractor to leave the temporary electric power supply system in its place for his use during the period of operation and maintenance. The compensation will be determined on the basis of negotiation between the CRM and the Contractor.

A.4.6 Temporary Communication System

- (1) The Contractor shall provide, install and maintain during all the Contract period a radio VHF communication system of the Kachina type, model KC-100 or similar, for the communication between the CRM's base camp in the site, and in Portoviejo.

All equipment shall be properly operating and must be commissioned as soon as possible once the works start, and if not possible, within a period not greater than six (6) months.

The Contractor shall install his radio communication system, telex and telephone that may be required for the work execution and for the staff needs.

The private automatic branch exchange shall have the necessary numbers of links at a place of his main site office, and the lines shall be extended to such places in the work sites, the Contractor's offices, work shops, camps, buildings, laboratory, first-aid station and others as may be deemed necessary.

The Contractor shall submit his plans and detailed drawings to the Supervision for the approval. The Contractor shall not install the private internal telecommunication system without the approval of the Supervision.

The CRM has the right to request the Contractor to leave such systems in the places for his use after the issue of the Provisional Reception Certificate without any cost to the CRM.

The Contractor shall also provide handy talky and install sirens and loudspeakers for warning of expected danger to ensure safety of the workmen and public.

- (2) Payment for the private internal telecommunication system and the VHF radio communication system will be made to the Contractor by the lump sum price for Item 1./04 in the Bill of Quantities in the following manner:

- (a) Seventy (70) percent of the lump sum price will be paid when the Supervision certifies that such system has been acceptable installed and has become operational, and
- (b) The remaining thirty (30) percent of the lump sum price will be paid when the Supervision issues the Provisional Reception Certificate under Clause II.2.11 the General Dispositions.

All costs incurred from the operation and maintenance of such internal telecommunication system and the VHF radio communication system during the Contract period shall be deemed to be included in the lump sum price for the Item 1./04 in the Bill of Quantities.

A.4.7 Temporary Construction Roads

- (1) The Contractor shall provide, maintain and subsequently demolish the temporary construction roads for approaching to the construction sites, plants, spoil banks and other temporary facilities, including associated drainage and stream crossing facilities in the Site and around the working sites. Such roads shall be planned, designed and built by the Contractor as may be considered necessary for the efficient execution of the Works.

Construction of the temporary construction road shall also comply with the corresponding provisions in Section G, Road Works the Technical of Specifications.

The Contractor shall submit his plans and drawings showing the alignments and roadway structures to the Supervision for his approval and shall not commence the construction of such construction roads without the Supervision's approval. The temporary roads shall be kept in good condition by watering and/or grading.

- (2) Payment for the temporary construction roads will be made to the Contractor by the lump sum price for Item 1./05 in the Bill of Quantities in the followings manner:
 - (a) Seventy (70) percent of the lump sum price will be paid when the Supervision certifies that such construction roads have been acceptably constructed and have become trafficable, and
 - (b) The remaining thirty (30) percent of the lump sum price will be paid when the Supervision issues the Provisional Reception Certificate under Clause II.2.11 of the General Dispositions.

No separate payment for the costs incurred from repairing, maintaining and subsequently removing of the temporary construction roads will be made and such costs shall be deemed to be included in the lump sum price for the Item 1./05 in the Bill of Quantities

The CRM has the right, with agreement of the Supervision, to request the Contractor to leave all or a part of the temporary construction roads in the places for his use during the period of operation and maintenance without any cost to the CRM,

A.4.8 First Aid Station and Ambulance

- (1) The Contractor shall provide and maintain a suitably furnished and equipped first-aid station at the Site by his own expense, and shall provide one (1) motor ambulance with a driver and an attendant, to be kept in a convenient location to be approved by the Supervision. The Contractor shall in all respects be fully responsible for ensuring necessary first-aid services to his staff and all workmen including transport of injured personnel to clinics or hospitals in Pichincha or other places depending upon the Contractor's decision as and when required. The road distance from the Site to Pichincha will be about 15 km.

The Contractor may need to provide registered/licensed nurses at the first aid station at his option. The Contractor shall pay all first-aid charges for his laborers and employees due to diseases and accidents incurred on the Works. The Contractor shall also ensure the timely and promptly medical services from the clinics and/or hospitals which he intends to consult with.

The first-aid service shall also be made available to all of the CRM's staff, the Supervision's staff and other persons who may be designated by the Supervision in case of emergency needs. Rendering of the first-aid service to the public is not within the scope of this Contract, but depending on the circumstances it may be considered on mutual agreement between the CRM and the Contractor.

The Contractor shall, upon completion of the Works or at such other time as the Supervision may direct, dismantle and remove the first-aid station including its equipment.

The first-aid service shall be fully operational within one hundred and twenty (120) days from the date of issuance of the order to commence the Works.

- (2) The lump sum price from Item 1./01 in the Bill of Quantities shall cover the costs for construction of the first aid station and provision, supply, installation and subsequent disposal of all furniture, equipment, medicines and other consumable medical goods required for the first-aid station, and for provision of the ambulance. All costs to be incurred to obtain cooperation of the clinics and hospitals in Pichincha or other places shall also be included in the Item 1./01 in the Bill of Quantities.

Payment to the Contractor will be made in accordance with provisions stipulated in Sub-paragraph A.4.3, Temporary Buildings.

Costs for providing all staff, nurses if any, driver and attendant employed for the operation of the first aid station, and cost for operation and maintenance of furniture, equipment and an ambulance shall be deemed to be included in the lump sum price for the Item 1./01 tendered in the Bill of Quantities.

A.4.9 Sewerage and Pollution Control

- (1) The Contractor shall supply, install, operate, maintain and subsequently remove the adequate treatment facilities for sewerage disposal from all temporary building including warehouses, offices, camps, laboratories, etc. to be constructed by the Contractor. The Contractor shall construct, operate and maintain the temporary toilet facilities fully equipped with adequate water closets, urinals and hand-basins, septic tanks, and other sewerage disposal installations, for all of his personnel. The temporary toilet facilities shall meet the requirements of the Government of the Republic of Ecuador. The location of these facilities and their construction shall be subject to approval by the Supervision. Sewerage from temporary facilities shall be disposal of in hygienic manner as approved.

The Contractor shall take all reasonable precautions to prevent silting, erosion of beds and banks and pollution of reservoirs, rivers, streams and watercourses without interference against supply to or obstruction from underground water sources and without polluting the river water and underground water.

The Contractor shall provide and maintain settling lagoons and other facilities to avoid pollution caused by the Contractor's operations such as but not limited to aggregate washing, concrete mixing and grouting.

- (2) No separate payment will be made for the sewerage and pollution control, and all costs shall be deemed to be included in the unit rates and lump sum prices in the Bill of Quantities

A.4.10 Other Temporary Facilities

- (1) Other temporary facilities such as temporary gangways, ladders, stagings on and about the site and bridges and/or river crossing facilities, if any, necessary for execution of the Works shall be constructed, operated, maintained and subsequently removed by the Contractor. The Contractor shall submit to the Supervision for his approval the details of such temporary facilities.
- (2) No separate payment will be made for other temporary facilities, and all cost shall be deemed to be included in the corresponding unit prices or lump sum prices stated in the Bill of Quantities.

A.4.11 Soil Conservation

- (1) All precautions shall be taken by the Contractor to prevent the erosion of soil from any lands used or occupied by the Contractor for the purpose of the Temporary Works and of the bed or banks of any reservoir, river or stream and the deposition of excavated or eroded materials in any reservoir, river or stream that may result from the execution of the Works.

If in the opinion of the Supervision, the Contractor's operations in areas other than the Permanent Works, cause erosion hazards after removal of such works or reinstatement to the original, the Contractor shall undertake soil conservation measures in these areas to the satisfaction of the Supervision. The method of soil conservation measures shall be submitted by the Contractor to the Supervision for his approval prior to the execution of the said works.

- (2) No separate payment will be made for the soil conservation, and such costs shall be deemed to be included in the corresponding unit prices or lump sum prices in the Bill of Quantities.

A.4.12 Supplemental Site Investigation

- (1) Exploratory boreholes, exploratory excavations, tests and other investigations may be required to supplement the existing knowledges of subsurface conditions prior to and during the course of construction works in the Contract period. The Contractor shall undertake to perform the supplemental site investigation as directed by the Supervision provided that the extent and order of the works will be instructed by the Supervision.

The Contractor will be instructed to build a core shed at the Site designated by the Supervision to store the recovered core specimens and others in a manner to be specified by the Supervision.

- (2) Payment for the supplemental site investigations will be made by Provisional Sum for Item 1./07 in the Bill of Quantities.

A.5 TESTING LABORATORY EQUIPMENT

A.5.1 General

- (1) The Contractor shall provide, operate and maintain a testing laboratory which is fully furnished with testing equipment, instruments and all consumable for testing cement, aggregates, concrete, soils and other construction materials.

The Contractor shall employ sufficient number of qualified supervisors and laboratory assistants who are capable of executing all the tests specified in the Contract and/or as directed by the Supervision.

The Contractor will be requested to submit to the Supervision for his approval a testing schedule specified by the Supervision.

The testing laboratory shall be operated in accordance with the approved testing schedule. The Supervision will instruct the Contractor to modify the testing schedule depending on the work progress and site conditions.

The Contractor shall, when requested by the Supervision, carry out any test in the presence of the Supervision, or shall furnish all testing staff, labourers and consumable goods to the Supervision free of charge in case the CRM and/or the Supervision carry out by themselves any test required to complete the Contract.

- (2) Payment for provision of the testing equipment and instruments, and testing will be made by Provisional Sum for Item 1./06 in the Bill of Quantities.

The costs of operation and maintenance of the laboratory and all equipment and instruments including the staff, laborer, supply of water, fuel, electric power, spare parts and the consumable materials required for the tests shall be deemed to be included in the Provisional Sum for the Item 1./06 in the Bill of Quantities.

A.5.2 Testing Laboratory

The testing laboratory shall be composed of:

- (1) A room for concrete and soil testing equipped with electric and water supply, work benches, tool cabinets, shelves, sinks; store rooms,
- (2) A locker room equipped with toilet facilities,
- (3) An office room equipped with desks, chairs and supply cabinets, and
- (4) A water pool for curing of concrete specimens.

The floor space of the testing laboratory shall be large enough to occupy all the equipment and working staff under proper working condition, and be at least 150 m². The floor of the laboratory shall be of concrete, and the mechanical testing equipment shall be installed on the concrete bases which have sufficient bearing capacity.

A.6 CONSTRUCTION AND MAINTENANCE OF CRM'S BRANCH OFFICES AND PROVISION OF OFFICE EQUIPMENT, ETC.

A.6.1 General

The Contractor shall design, construct and maintain in good conditions the permanent or temporary facilities required for the construction of the Works, including offices for the CRM and the Supervision. The Contractor shall supply the CRM's facilities and services required for the smooth operation of the Works.

Payment, as outlined herein, will be made only for the following works and services:

- Construction and maintenance of branch offices and housing for the CRM and the Supervision
- Water supply system and, sewage and drainage system for the buildings
- Electric power supply system for the buildings
- Telecommunication system for the buildings
- Provision of the office furnitures and equipment

A.6.2 Branch Offices

The Contractor shall built, supply, equip and maintain, and eventually remove, if so requested by the CRM, the following branch offices for exclusive use of the CRM and the Supervision;

Branch Office	Minimum Office Space
At Membrillo	100 m ²
At Conguillo	50 m ²

The said branch offices and housing shall be located at the places where shown on the Drawings. The final location shall be approved by the Supervision and the CRM.

All buildings and housing shall be provided with electric power 110~220 V, water supply, sanitary facilities and air conditioning system, and also provided necessary furnitures and equipment as specified herein.

Within sixty (60) days after the Contract signing, the Contractor shall submit to the Supervision for his approval the detailed design drawings and specifications for the branch offices and housing. The Contractor shall not construct the said buildings without the approval of the Supervision.

The minimum quality required shall be as follows

- Reinforced concrete structure
- Brick closure of minimum 10 cm thick, with plaster coat finish
- Concrete floor with tile finish of granite type
- Slab deck of reinforced concrete
- Exterior aluminum carpentry
- Interior wooden carpentry

A.6.3 VHF Radio Communication System

The Contractor shall provide, install and maintain a VHF radio communication system of the Kachina type, model KC-100 or similar, for the communication between the CRM's main office to be constructed by the Package 2 contractor at the Severino pumping station site, and the Membrillo branch office (about 17 km) and the Conguillo branch office (about 25 km), each one station.

All equipment shall be properly operating and must be commissioned within a period not more than six (6) months.

A.6.4 Provision of Office Equipment and Furniture

The Contractor will be requested to supply the following items of furniture and equipment for the CRM's Membrillo and Conguillo branch offices and which will become the property of the CRM.

(1) Office Furniture

- Desk and chair set
- Conference table and chairs set
- Filing cabinet
- Cabinets for book and stationery
- Drawing cabinet
- Drawing stand with tables and chairs
- Cupboard
- Office sofa set
- Plain board
- Refrigerator of 0.35 m³ capacity

(2) Office Equipment

- Computer and printer
- Stabilizer
- Latest model of software
- Blue printer, (A0 size)
- Xerox copy machine

(3) Topographic Survey Equipment

- Telemeter
- Theodolite level with tripod, box and battery power for lighting
- Theodolite with tripod, box and battery power for lighting
- Automatic Wild type level with tripod and box
- Metric aluminum staffs with minimum length of 4 m
- Metallic metric tapes with a minimum length of 100 m
- Metallic metric tapes with a minimum length of 25 m
- Level rod with a minimum length of 2 m

The details thereof will be designated by the CRM at a later date.

A.6.5 Measurement and Payment

(1) CRM's Branch Offices and Utility Facilities

Payment for construction and maintenance of the CRM's branch offices and utility facilities including VHF radio system will be made by the lump sum price for Item 1/09 in the Bill of Quantities in the following manner:

- (a) Seventy (70) percent of the lump sum price will be paid when the Supervision certifies that these buildings have been acceptably furnished and have become accommodative,

(b) The remaining thirty (30) percent of the lump sum price will be paid when the Provisional Reception Certificate is issued by the Supervision according with Clause II.2.11 of the General Dispositions, and

(c) No separate payment for the costs incurred from repairing and maintaining of the buildings and utility facilities will be made and such costs shall be deemed to be included in the lump sum price for the Item 1/09 in the Bill of Quantities.

(2) **Provision of Office Equipment and Furniture**

Payment for provision of the office equipment and furniture will be made by Provisional Sum for Item 1/10 in the Bill of Quantities.

A.7 MAINTENANCE OF EXISTING PUBLIC ROAD AND PERMANENT AND TEMPORARY ACCESS ROADS NEWLY CONSTRUCTED

The Contractor shall improve sections of the existing public road between Canuto town and Buenaventura village, the total length of the road is approximately 20 km. The Contractor shall then maintain the said public road.

In addition, following construction by the Contractor of the Conguillo access road (permanent), about 22 km long, the El Guasmo access road (temporary), about 1.5 km long, and the Membrillo outlet access road (temporary), about 0.8 km long, he shall maintain these roads.

Maintenance means to protect against damage and to repair the roads during the period of the Contract so that their conditions at the Date of Completion are the same as they were at the dates of acceptance by the Supervision of the improvement works on the public road and the construction work on the permanent and temporary access road.

In maintaining the public road, and permanent and temporary access roads, the Contractor shall:

- keep clear and in good working order at all times all road structures, bridges, culverts, drains and other waterways;
- patch potholes with approved materials, keep the road surface in good repair and perform any grading and necessary resurfacing;
- maintain all fender posts, guide posts, guard posts, fencing, signs, signposts and other roadside structures;
- keep the road surfaces and shoulders free from all rocks, fallen timber, rubbish and other debris and materials removed from the drains and drainage structures;
- maintain slope batters; and

- maintain adequate low soil banks along the top edge on all fill slopes of the roads to prevent drainage from passing down the fill slope, except in drains properly constructed with stone pitching, pipe or half-round lining.

Maintenance work on the existing public road shall be carried out in a manner and at times which will cause minimum inconvenience and delay to the travelling public.

Payment for maintenance of the existing public road, and the permanent and temporary access roads will be made at the lump sum price tendered for Item //05 in the Bill of Quantities, in accordance with the provisions stipulated in Sub-paragraph A.4.7. If, in the opinion of the Supervision, adequate maintenance work is not being carried out, payment will be withheld until the extent of maintenance work is increased to a satisfactory level.

A.8 MONUMENT AND MEMORIAL

A.8.1 General

The Contractor shall construct the project information boards at locations in the vicinity of the Works, and a monument and memorials on completion of the Works. The details thereof will be supplied by the CRM at a later date.

A.8.2 Measurement and Payment

Payment for construction of the project information boards, monument and memorials will be made by Provisional Sum for Item 1/08 in the Bill of Quantities.

CONSTRUCTION OF CIVIL WORKS

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DAULE-PERIPA~LA ESPERANZA TRANSBASIN

VOLUME III - GENERAL AND TECHNICAL SPECIFICATIONS

SECTION B

**DIVERSION AND CARE OF THE RIVER
AND
CONTROL AND REMOVAL OF WATER**

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SECTION B

DIVERSION AND CARE OF THE RIVER AND CONTROL AND REMOVAL OF WATER

B.1 DIVERSION AND CARE OF THE RIVER

B.1.1 General

The Work specified in this Paragraph consists of;

- coffering around the Conguilto inlet structures to be constructed in the Daule-Peripa reservoir, and
- diversion of streams as required for the construction of permanent or temporary structures or stockpiling or disposal of excavated materials.

The Contractor shall furnish all materials, labour and equipment required for the construction and maintenance of work necessary in regard to the diversion and care of the river.

After it has served its purpose, the temporary diversion works constructed by the Contractor shall, with prior approval of the Supervision, be removed from the Site or leveled to give a slightly appearance, so as not to interfere in any way with the operation or usefulness of the reservoir or streams.

The Contractor shall not interrupt or interfere with the natural flow of the river or of any other reservoirs or streams in the area of the Project for any purpose without the approval of the Supervision.

B.1.2 Plan for Drainage and Care of the Water during Construction

All drainage systems and cofferdams as well as the method of execution of the work shall be designed in detail by the Contractor and subject to approval of the Supervision. Approval shall not relieve the Contractor from full responsibility for the adequacy of the drainage and coffering works.

The Contractor shall be fully responsible for the design, construction, maintenance and removal of the coffering systems to ensure that all work on permanent structures and temporary structures shall be performed in areas free of water, unless otherwise specified or authorized by the Supervision.

Permanent relocation of streams required for disposal/stockpile areas shall be designed as permanent structures, having a capacity and a resistance to erosion and damage against the largest stream flows to be expected.

The Contractor shall ensure that all diverted or drained water will be disposed of without causing any damage to his own or any other properties.

At least thirty (30) days prior to beginning any work under these Specifications concerning the drainage and coffering, the Contractor shall submit, for approval by the Supervision, a water control plan showing his proposed method for drainage and care of water during the construction period. These documents shall include the general design drawings, working procedures and time schedule with explanatory notes.

The Contractor shall be totally responsible for furnishing labour, equipment and materials needed in regard to the drainage and care of water for the Conguillo inlet during the period such work is necessary. Work pertaining to the drainage and care of water for the Conguillo inlet shall be performed in accordance with the Contractor's plan and all applicable Specifications, Drawings, procedures, safety programmes, etc.

The reservoir water levels of the Daule-Peripa dam which are attached to this Section are only for general information to be used by the Contractor in regard to timing his construction operations. The CRM will not be responsible for any deductions, conclusions or interpretations which may be made by the Contractor from these data.

B.1.3 Cofferdams

The Contractor shall construct cofferdams at the most suitable locations in the construction area.

The type of materials to be used in constructing the cofferdams, their crest elevation, width, side slopes and exact location shall be established by the Contractor using acceptable design standards, but such design must be approved by the Supervision. The Contractor shall be responsible to maintain adequately the cofferdams during the period they are being used, and shall, if so directed by the Supervision, remove all part of them after these are no longer needed.

B.1.4 Payment for Drainage and Care of Water

Payment for the construction and maintenance of the cofferdams and the drainage and care of water shall be made at the lump sum price tendered therefor in the Bill of Quantities. The lump sum price shall constitute full compensation for the cost of all labor, tools, equipment and materials including design, furnishing, construction, installation, operation, maintenance and subsequently removal of cofferdams and other items necessary to complete the works.

Payment for drainage and care of water during construction will be made in the following manner:

- (i) Seventy (70) percent of the lump sum price will be paid when the Supervision certifies that the construction area has been satisfactorily dried up, and

- (ii) The remaining thirty (30) percent of the lump sum price will be paid when the Supervision certifies that the removal of the temporary drain channels and cofferdams are completed.

No additional payment will be made for any damage or loss due to floods.

No separate payment will be made for diversion of small streams for the construction of permanent or temporary structures other than the coffering required for the Conguillo inlet structure, or around areas used for stockpiling or disposal of excavated materials. All such costs shall be deemed to be included in the unit and lump sum prices tendered in the Bill of Quantities for the various items of work.

B.2 CONTROL AND REMOVAL OF WATER FROM THE WORKS

B.2.1 General

Although explorations to date indicate that control and removal of water during excavation work may not be a significant problem, it will be necessary for the Contractor to be fully prepared to control and remove any water which will be encountered, and in such cases the following provisions shall be complied with.

The Contractor shall furnish, install, maintain and operate all pumping and other equipment or methods which may be required for dewatering the various parts of the Works on the surface, in open-cut excavations or in underground excavations and for keeping the foundations and other parts of the work free from water as necessary for constructing each part of the Works, and as may be required after any part of the Works is completed for such acts as inspection and safety control by the CRM, or for any reason determined to be necessary by the Supervision.

The Contractor shall pump out all water from the working areas and shall keep them free of water while excavating, preparing foundations, placing embankment materials, placing concrete or as may otherwise be required for completing the Works. The Contractor shall be responsible for, and shall repair at this own expense any damage to foundations, excavated slopes, structures or any other parts of the Works caused by water including flooding. No pumping equipment installed by the Contractor for dewatering shall be removed without the prior written approval of the Supervision.

The Contractor shall prepare a method for removal of water from all foundations and excavations and submit it to the Supervision for approval at least two (2) weeks prior to such plan being implemented. The Contractor's plan for the works shall include general drawings and working procedures with explanatory notes showing quantity, type, capacity, arrangement, location, etc. of the proposed system. After approval by the Supervision, the Contractor shall be fully responsible for the implementation and operation of the plan. If the excavation should extend below the water table, the water table shall be lowered in advance of the excavation. The dewatering shall be accomplished in such a manner as to maintain the stability of the underground excavation and the slopes, and to result in all construction

operations being performed in the dry, where "in the dry" means that the construction operation will not be performed in an appreciable amount of free or standing water.

The Contractor is required to control springs (if any) and seepage along the bottom of the excavation for the structural foundations.

B.2.2 Control and Removal of Water in Surface Construction Sites

The Work for care of water in surface construction sites will include construction of dikes, ditches, channels, trenches, sump pits, pump station, installation of water sumps, drainage pipe lines and electric power supply lines and providing protective measures against erosion due to seepage water and precipitation.

During the placing and compacting of the earthfill for the embankment, the water level at every point shall be maintained below the bottom of the embankment until the compacted embankment has reached a depth of three (3) meters, after which the water (if any) shall be kept at least one point five (1.5) meters below the top of the compacted embankment.

The Contractor shall also control the groundwater level and surface water, to the satisfaction of the Supervision, during the placing and compacting the embankment (such as for the permanent access roads) and backfill material.

B.2.3 Control and Removal of Water During Underground Construction

The Contractor shall construct and maintain such intercepting works as may be necessary to prevent surface water from entering the tunnels and shaft.

If, in the opinion of the Supervision, joints, seams or broken ground in sections of the tunnels yield a considerable quantity of water, the Supervision may direct that such joints, seams or broken ground be sealed to reduce the flow of water into the underground working area to a tolerable amount or to basically eliminate the flow as based on the Supervision's judgment. The Contractor shall not be entitled to any additional compensation or extension of time on account of such a direction.

The Contractor shall construct and maintain all necessary temporary diversion conduits, flumes, drains, sumps and other diversion and intercepting works which may be required in the tunnels and shall furnish all materials therefor.

B.2.4 Payment for Control and Removal of Water

(1) Care of Water in Surface Construction Sites

Measurement and payment for care of water in surface construction sites will be made at the respective lump sum prices tendered therefor in the Bill of Quantities, which prices shall constitute full compensation for the cost of all labour, tools, equipment and materials including construction and backfilling and/or removing of ditches, trenches, channels, dikes

and sump pits, and/or installing and removing pump station and drain pipe lines and other items necessary to complete the work.

(2) Care of Water in Underground Construction Sites

No separate payment will be made for the care of water in underground construction sites. The cost for the care of water in underground construction sites shall be included in the respective unit prices tendered in the Bill of Quantities to which the work is incidental.

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PACKAGE 1

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SECTION C

EARTH WORKS

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SECTION C EARTH WORKS

C.1 GENERAL

C.1.1 Definition

As used in these Specifications, the term "earth works" denotes the following operations:

- Clearing and stripping
- Open-cut excavations and trench excavations
- Underground excavations
- Backfilling, bedding and surfacing work
- Embankment
- Disposal or use of excavated materials
- Other excavation, backfilling, embankment and slope protection works as directed by the Supervision

C.1.2 Contractor's Responsibility

- (1) A plan specifying how the Contractor will perform excavation, backfilling, embankment, slope protection and dredging for each particular type of activity such as for the diversion works, inlet and outlet works, tunnel and work adits, buildings and access roads shall be submitted to the Supervision for approval at least twenty-eight (28) calendar days prior to starting such works. The unit prices for performing all types of excavation as well as backfilling, bedding, surfacing work, embankment and dredging for the various activities shall be as tendered in the Bill of Quantities.
- (2) Excavation of the structures shall be operated so that the majority of its materials can be used for the backfilling and embankment for the associated permanent structures.

Although the results of geological investigations to date indicate that a large part of the materials to be excavated from areas at the tunnels, inlet and outlet works, etc. will not be suitable for use in embankment work, except backfilling and will therefore be disposed of in the spoil bank at the locations shown on the Drawings, some of the excavated material may be of high enough quality that it can be used in permanent construction and therefore the Contractor's blasting and other operations in excavations shall be such that the materials excavated will provide as much suitable materials as practicable. If the Supervision decides that the excavated materials are suitable for use, they shall be stockpiled in appropriate areas for later use or hauled to and directly placed in permanent construction, as determined by the Supervision. The detailed Specifications relating to the disposal or use of excavated material, as listed in Paragraph C.17, shall be applied.

C.2 CLEARING AND STRIPPING

C.2.1 Clearing

- (1) All areas to be cleared will be designated on the Drawings or directed by the Supervision. This work shall basically consist of clearing all trees, vegetation, stumps, roots, brush, rubbish and other objectionable matter from the specified area to the satisfaction of the Supervision. The materials obtained from the clearing operations shall be burned or otherwise disposed of as approved by the Supervision. No trees shall be cut outside of the areas mentioned above without special approval. All merchantable timber cleared in the area shall remain the property of the CRM.
- (2) All materials to be burned shall be piled neatly and, when in suitable condition, shall be burned completely. Burning shall be done in such a manner as to minimize fire risk and at the time and date approved by the Supervision in accordance with the applicable laws. All burning shall be so thorough that the materials are reduced to ashes. The Contractor shall take special precautions to prevent fire from spreading to areas beyond the limits of the cleared areas and shall have available, at all times, suitable equipment and supplies for use in extinguishing fire.

C.2.2 Stripping

This work shall basically consist of removing the topsoil, boulders, underground roots, grass cover and other undesirable substances to a depth of 15 cm or as otherwise directed by the Supervision, and stockpiling the material for subsequent use for soil conservation measures, etc. All areas from which topsoil is to be stripped will be as shown on the Drawings and/or as directed by the Supervision.

Materials obtained from stripping work shall be stockpiled or deposited in places as shown on the Drawings or other places as approved by the Supervision. Stockpiled material shall be levelled and smoothed to a measurable outline and shall not be higher than that specified by the Supervision. Exposed surfaces shall be fertilized and seeded with an approved grass mix, and drains and settling ponds installed to protect the stockpiles from wind, rain and stream erosion.

C.2.3 Measurement and Payment

- (1) Measurement, for payment, for clearing work shall be made of the designated surface areas which have been cleared as shown on the Drawings or as approved by the Supervision.

Payment for clearing will be made at the respective unit prices per square meter tendered therefor in the Bill of Quantities, which unit prices shall include the cost of all labor, materials and equipment required to perform the work.

- (2) No separate measurement and payment shall be made for stripping operations, and payment for this work shall be included in the respective unit prices for excavation, common in open-cut.

C.3 EXPLOSIVES AND BLASTING

C.3.1 General

When handling explosives and carrying out blasting operations, the Contractor shall take all proper precautions for protection of persons, the Works and property. The location setting and design of powder magazines, methods of transporting explosives, use of explosives, and the precautions taken to prevent accidents shall be made in accordance with the laws and regulations of the Republic of Ecuador as well as instructions from the Supervision; nevertheless, the Contractor shall assume all liabilities which may be incurred from injuries to, or deaths of persons, or damage to property caused by any form of blasting or explosions.

The use of ammonium nitrate fuel oil (ANFO) as an explosive for underground excavation will not be permitted.

Other stipulations concerning explosives shall comply with Section A of the General Specifications. All blasting operations shall be carried out carefully and only by approved experts.

All costs pertaining to blasting and handling of explosives shall be estimated by the Contractor and included in the applicable unit prices tendered in the Bill of Quantities for work involving the usage of explosives and blasting.

C.3.2 Handling of Explosives

The Contractor shall provide adequate protective facilities to store safely and to prevent the loss or burglary of explosives. Overnight storage of explosives and detonators outside of the magazines will not be permitted.

The Contractor shall maintain an inventory record of storage and withdrawal of all explosives including detonators. This record shall always be available to the Supervision, and the Supervision shall be promptly notified of any loss or theft of explosives.

Caps and detonators or fuses shall in no case be stored, transported or kept in the same places in which dynamite or other explosives are stored or transported.

C.3.3 Blasting

All blasting operations, the depth and size of hole and the size and characteristics of the charges shall be well planned and be subject to approval by the Supervision. The explosives for each blast shall be of such quantity and power and shall be used at such locations that they will neither open seams nor crack the rock outside of the limit of excavation.

As an excavation approaches its final line, the depth of holes for blasting and the amount of explosives used per hole shall be reduced progressively.

Blasting will be permitted only after adequate provision has been made for the protection of persons, the Works, and public or private property. Approval by the Supervision of any of the Contractor's blasting operation shall not relieve the Contractor of his responsibility for the safety of persons, the Works and property.

Blasting that might damage any part of the Works will not be approved by the Supervision. Any damage done to the Works by blasting, including the shattering or loosening of the material beyond the required excavation lines, shall be repaired at the expense of and by the Contractor. Slopes shattered or loosened by blasting shall be taken down at the expense of the Contractor.

The Contractor shall treat, with the pre-splitting blasting technique the required final excavation line of the permanent slopes which is steeper than or equal to slope of 45 degrees for the structures designated by the Supervision prior to its blasting. The pre-splitting blasting, which will form fracture planes along the required design excavation line prior to final blasting, is required to minimize damage to or excess excavation of the rock beyond the specified excavation surface.

The Contractor shall submit to the Supervision for approval, at least twenty-eight (28) days prior to starting excavation in any section of the work requiring the use of the pre-splitting blasting, a detailed description of his proposed method and procedures of excavation. The spacing and diameter of pre-splitting holes and the arrangement of the explosives in each hole shall be varied to suit the rock conditions and shall be chosen to provide the best practical excavated surface line after blasting.

The Contractor shall establish, by field trials in an approved area, his pre-splitting blasting technique which enables to minimize excess breakage and fracture of the rock beyond the excavation lines of the areas to be pre-split. These trials shall be performed by varying the drill size and hole pattern, hole depth, explosive type and quantity. The cost of developing this technique shall be included in the unit prices tendered in the Bill of Quantities for excavation in rock in the areas where such pre-splitting will be required.

When blasting, the Contractor shall exercise special care to avoid damage to concrete already completed. No blasting will be permitted in any case within areas less than 25 m from this pertinent area unless otherwise directed by the Supervision.

Other Specifications pertaining to blasting for underground excavation are stipulated in Paragraph C.13 and shall be applied.

C.3.4 Safety Program for Handling Explosives and Blasting

A detailed safety program covering all aspects of handling explosives and carrying out blasting operations shall be prepared and submitted by the Contractor to the Supervision for approval at least fifty-six (56) calendar days prior to the time the Contractor brings any

explosive to the Site. This shall include but is not limited to the location and design of powder magazines, methods of transporting explosives, use of explosives, and detailed precautions taken to prevent accidents relating to explosives and blasting. After being approved, the Contractor will submit twelve (12) copies of the safety program for handling explosives and blasting to the Supervision.

C.4 CLASSIFICATION AND DEFINITION OF EXCAVATION

C.4.1 Classification

Excavation works are classified into three types in terms of location and technical requirements, and each type is further classified for measurement and payment in terms of method of excavation and material to be excavated as set out below:

- (1) Open-Cut Excavation ;
 - 1) Excavation in Common
 - 2) Excavation in Weathered Rock
 - 3) Excavation in Rock

- (2) Open-Cut Trench Excavation ;
 - 1) Trench Excavation in All Classes (mixed with common, weathered rock and rock)

- (3) Underground Excavation (Tunnel and shaft excavation) ;
 - 1) All Classes

C.4.2 Definition

(1) Open-Cut Excavation

The class of open-cut excavation for measurement and payment will be defined as set out below:

(a) Excavation in Common

Excavation in common is the open-cut excavation of all materials including, but not limited to, soil, clay, silt, sand and gravel, loose boulders, etc. that is not rock or weathered rock, as determined by the Supervision.

(b) Excavation in Weathered Rock

Excavation in weathered rock is the open-cut excavation of disintegrated rocky material (usually caused by weathering) which requires loosening by ripping or the use of power tools (without drilling and blasting) before it can be efficiently excavated, as determined by the Supervision.

(c) **Excavation in Rock**

Excavation in rock is the open-cut excavation of all in-place, sound and intact rock that cannot be excavated without drilling and blasting to break and loosen the rock, as determined by the Supervision.

(2) **Open-Cut Trench Excavation**

Open-cut trench excavation applies for all classes of materials.

(3) **Underground Excavation**

Underground excavation is the required excavation, other than of the types specified above in (1) and (2) of this Paragraph, for all classes of underground materials inside the outlines shown for the water transbasin tunnel, inlet structure, work adits or other underground excavations which may be directed by the Supervision.

C.5 OPEN-CUT EXCAVATION

C.5.1 General

All open-cut excavation required for the permanent construction shall be made to the lines, grades, and dimensions as shown on the Drawings or as directed by the Supervision. During the progress of the work, the Supervision may find it necessary or desirable to vary the slopes, grades or the dimensions of the excavations from those specified herein and the Contractor shall not be entitled to any additional allowance above the unit prices tendered in the Bill of Quantities for excavation by reason of such changes. Any other open-cut excavation, performed at the option of the Contractor such as to secure access to the required work, for disposal of material excavated, or for any other purpose, shall be kept within the limits approved by the Supervision and shall be at the expense of the Contractor with no costs being charged to the CRM.

All necessary precautions shall be taken to preserve the material below and beyond the established lines of all excavation in the soundest possible condition. Unless otherwise determined by the Supervision, any and all over-excavation performed by the Contractor for any purpose or reason, except as may be ordered in writing by the Supervision, is deemed to be unauthorized excavation and shall be at the expense of the Contractor with no costs for such over-excavation being charged to the CRM.

All unauthorized excavation including over-excavation shall be backfilled with concrete or other material, as directed by the Supervision, at the expense of and by the Contractor; however, the CRM will pay the Contractor for such backfill to refill any over-excavation in overbreak due to the specific nature of the rock, and not due to the Contractor's performance or fault, as determined by the Supervision. Payment for such backfill will be made at the applicable unit prices tendered in the Bill of Quantities.

All excavations for structure foundations shall be performed in the dry (where "in the dry" is to be construed as defined in Paragraph B.2 of Section B. No additional allowance above the unit prices tendered in the Bill of Quantities for excavation will be made on account of any of the materials being wet.

All blasting and the handling of explosive shall conform to the Specifications provided in Paragraph C.3 of this Section.

Excavation shall be made to the full dimensions required and shall be finished to the prescribed lines and grades, except that individual sharp points of undisturbed ledge rock will be permitted to extend within the prescribed lines not more than twenty (20) centimeters where the surface is not to be covered with concrete. If the surface is to be covered by concrete, it must be level in principle or as determined by the Supervision.

C.5.2 Slope Requirement for Open-Cut Excavation

Unless definitely shown on the Drawings or directed by the Supervision slope of the open-cut excavation shall be made as specified below regardless of under water or above water:

Material of Formation	Slope Protection	Slope Requirement	
		Permanent	Temporary *
Rock	with	1 : 0.5	-
	without	1 : 0.5	1 : 0.3
Weathered Rock	with	1 : 0.5	-
	without	1 : 0.5	1 : 0.5
Earth (Common)			
a) Excavation height of less than or equal to 5 m			
	with	1 : 1.0	-
	without	1 : 1.0	1 : 0.5
b) Excavation height of more than 5 m but not higher than 10 m			
	with	1 : 1.0	-
	without	1 : 1.0	1 : 1.0

Remark: * denotes temporary slopes, or excavation which are permanently backfilled or refilled and are not exposed directly to open air or water.

The slope of the open-cut excavation in common shall be directed by the Supervision if its excavation higher than 10 m.

The exposed slopes of the required excavations shall be protected by the Contractor. A berm of two point five (2.5) m in width shall be provided at seven point five (7.5) m high interval in cut slope of all classes for the major structures and that of one point five (1.5) m in width and eight (8.0) m high interval for the open channel and the access roads.

Where required and when directed by the Supervision, the Contractor shall excavate open, unlined drains to divert surface water away from open-cut. The entire cost of this work shall be at the expense of the Contractor except where such drains form part of the permanent works. In such case payment for excavation will be made at the applicable unit prices tendered in the Bill of Quantities.

In all work related to open-cut excavation, the Contractor shall carry out soil conservation measures to the satisfaction of the Supervision and the costs for such work shall be included in the unit prices of excavation as tendered in the Bill of Quantities.

C.5.3 Seams and Other Defects

The exploratory investigations of the foundations and excavation slopes would not completely disclose all seams and other defects which may exist. It is anticipated that there may be depressions, faults, seams, and bands of soft rock, including disintegrating rock, running in various directions in the foundations and excavation slopes.

Where such defects occur below the general surface of excavation, they shall be corrected by local excavation to the lines, depths and dimensions as directed by the Supervision. These local excavations shall be solidly backfilled with appropriate concrete or other material as directed by the Supervision. Payment for such excavations and backfill will be made at the applicable unit prices tendered in the Bill of Quantities for excavation in open-cut, concrete, etc.

C.5.4 Excavations upon which Concrete is to be Placed

The bottom and side slopes of excavations for foundations upon or against which concrete is to be placed shall be excavated to the required grades, lines and dimensions shown on the Drawings or directed by the Supervision. No material will be permitted to extend within the neat lines of the concrete structure. If at any point in the excavation, material is excavated upon written orders from the Supervision beyond the limits required to receive the structure, the additional excavation shall be filled solidly with appropriate concrete.

Payment for such additional excavation will be made at the applicable unit price per cubic meter tendered in the Bill of Quantities for excavation for the structure involved and payment for the appropriate concrete placed in such additional excavation will be made at the applicable unit price tendered in the Bill of Quantities.

C.5.5 Measurement and Payment for Open-Cut Excavation

- (1) Measurement, for payment, of each class of material of open-cut excavation will be made to the lines, grades and dimensions shown on the Drawings, to the slope

specified in Sub-paragraph C.5.2 or as directed by the Supervision, and such measurement shall be based on the original ground surface before excavation and the actually excavated surface, as approved by the Supervision. The class of the excavated material will be determined based solely on the Supervision's analysis and judgment.

Before commencing excavation and immediately after completion of the excavation for which payment is to be made by the quantities to be measured by the survey method, the Contractor shall execute the survey measurement, which is sufficient to define the dimensions and elevation of the original and final surfaces. This measurement will be checked independently by the Supervision. Not less than seven (7) days before commencing such survey measurements, the Contractor shall submit to the Supervision for approval, a plan showing the proposed layout of reference lines, cross-sections and methods of survey to be used. Reference lines and points are to be set out on the ground and related to permanent survey stations. At least 24 hours before commencing this survey work, the Contractor shall notify it to the Supervision. Original field notes of the setting out of these reference lines are to be submitted to the Supervision along with the notes on the actual quantity measurements.

Any measurement which may be the basis of quantities for claims for payment shall be taken only in the presence of the Supervision. The Contractor shall notify the Supervision of his intentions to take such measurement.

- (2) Payment for the various items of open-cut excavation will be made at the unit prices per cubic meter tendered for each class of material of open-cut excavation as listed in the Bill of Quantities. These unit prices shall include the cost of all labor, equipment, and materials required for excavation including blasting, slide prevention, erosion control and other work necessary to maintain the excavation in good order during construction. The unit prices tendered in the Bill of Quantities for each class of material for open-cut excavation shall also include the entire cost relating to moving these materials from the excavation site and placing them at the designated spoil bank; however, as stipulated in Paragraph C.17, material removed from open-cut excavations which has found to be suitable by the Supervision for use in permanent construction will be placed in a designated stockpile shown on the Drawings for use at a later time or hauled to and directly placed in permanent construction, as determined by the Supervision.

Payment for such additional excavation stipulated in Sub-paragraphs C.5.3 and C.5.4 will be made at the applicable unit price per cubic meter tendered in the Bill of Quantities for excavation for the structure involved, and payment for the concrete placed in such additional excavation will be made at the applicable unit price tendered in the Bill of Quantities.

Excess excavation and over-excavation made by the Contractor for any purpose or reason without written orders or approval of the Supervision, shall be refilled with approved concrete furnished and placed at the expense of and by the Contractor, except that the CRM will pay the Contractor with approval by the Supervision for such backfill or re-fill any over-excavation in overbreak due to the specific nature of the rock

as specified in Sub-paragraph C.5.1. Payment for such backfill will be made at the applicable unit prices tendered in the Bill of Quantities.

C.6 OPEN-CUT EXCAVATION FOR TRENCHES

C.6.1 General

- (1) The items in the Bill of Quantities for the open-cut excavation of trenches in all classes of material shall include excavation for all types of trenches as shown on the Drawings or as directed by the Supervision including the following items.
 - (a) Trenches for concrete pipe, cross drains, drain pits and side drain ditches for permanent access roads,
 - (b) Trenches as may be shown elsewhere on the Drawings or as directed by the Supervision.
- (2) The Contractor shall submit his proposed method of open-cut trench excavation for the said structures, for approval of the Supervision, at least three (3) weeks prior to starting its excavation.

Open-cut trench excavation shall be performed by the use of hand tools and/or approved mechanical equipment, in principle, in such a manner as to prevent shattering of the sides and bottom of the excavation. At the option and risk of the Contractor, and with the approval of the Supervision, line drilled holes and light blasting may be employed in approved locations, in which case the Specifications provide in Paragraph C.3 shall be applied.

All planking, strutting and supports necessary to retain the sides of the open-cut trench excavation shall be provided, erected and maintained in a safe condition by the Contractor.

Open-cut trench excavation shall conform to the applicable stipulations of Paragraph C.5.

C.6.2 Measurement and Payment

Measurement, for payment, of all classes of material of open-cut trench excavation shall be made to the lines, grades and dimensions shown on the Drawings or as directed by the Supervision, in accordance with the provisions of Sub-paragraph C.5.5.

Payment for the various types of open-cut trench excavation will be made at the respective unit prices per cubic meter tendered therefor in the Bill of Quantities, in accordance with the provisions stipulated in Sub-paragraph C.5.5.

C.7 BACKFILL, BEDDING AND SURFACING WORK

C.7.1 General

The Contractor shall obtain and place various types of backfill, bedding and surfacing materials at the locations shown on the Drawings, and elsewhere as directed by the Supervision. The quality of such materials shall be approved by the Supervision and shall not include any organic matter or other objectionable material.

C.7.2 Free Draining and Selected Sandy Soil Backfills

Free draining backfill and selected sandy soil backfill shall be placed to the lines and dimensions shown on the Drawings for the following items:

- (1) Backfill around the various structures for the access roads, and
- (2) Elsewhere as shown on the Drawings or as directed by the Supervision.

The material to be used for free draining backfill shall be selected pervious material which is well graded with a maximum rock size of fifteen (15) cm and shall not contain more than five (5) percent, by weight, of material passing the 0.074 millimeter mesh sieve as stipulated in JIS Z 8801 or approved equivalent. Fragments larger than fifteen (15) centimeters may be used if approved by the Supervision, provided that such fragments shall be evenly distributed in the backfill.

The material to be used for selected backfill shall be selected sandy soil material which is well graded with a maximum rock size of fifteen (15) cm and shall not contain more than five (5) percent, by weight, of material passing the 0.074 millimeter mesh sieve.

The materials shall be handled and placed in such a manner as to prevent segregation. The method of placing free draining backfill and selected sandy soil backfill shall be subject to approval by the Supervision. Free draining backfill shall be placed in approximately horizontal layers not more than thirty (30) centimeters before compaction and thoroughly compacted by an approved method to sixty (60) percent of relative density or to the satisfaction of the Supervision.

C.7.3 Random Backfill

The materials to be used for random backfill shall be all classes of disposed or excavated materials available in any place. The quality of such materials shall be approved by the Supervision, and all materials shall be free from any organic matter obtained from stripping operation.

The material shall be handled and placed in such a manner as to achieve favorable compaction and density and shall be placed to the line and dimensions shown on the Drawings. The method of placing, moisture controlling and compacting random backfill shall be subject to approval by the Supervision.

C.7.4 Stone Bedding and Gravel Surfacing

Stone bedding for the non-drainage structures which are not covered by the Specifications for the drainage structures in Section F, Drainage, shall be placed to the lines and dimensions shown on the Drawings or as directed by the Supervision.

Gravel surfacing shall be placed to the lines, grades, and dimensions shown on the Drawings or as directed by the Supervision.

The material for stone bedding shall be crushed fresh rock from the approved quarry or selected gravels with approved compressive strength.

The material for gravel surfacing shall be selected gravels from the borrow site approved by the Supervision.

The maximum size and gradation of crushed rocks and gravels shall meet the requirement specified on the Drawings or the direction by the Supervision.

The Contractor shall handle and place the bedding and surfacing materials in such a manner as to prevent segregation. The method of placing the stone bedding for non-drainage structures and gravel surfacing shall be approved by the Supervision. The materials shall be compacted by approved means to the satisfaction of the Supervision.

C.7.5 Stone Pitching, if any

Stone pitching shall be provided to protect excavated or fill surfaces elsewhere as shown on the Drawings or as directed by the Supervision. Such stone pitching shall be made with sound, durable rock not less than fifteen (15) cm thick, properly bedded to a uniform surface. The exposed surface of each stone shall be approximately flat having an area of about 300 cm².

C.7.6 Measurement and Payment

Measurement, for payment, for the free draining backfill, selected material backfill, random backfill, stone bedding for non-drainage structures, gravel surfacing and bedding will be made for the materials in place to the lines, grades and dimensions shown on the Drawings or established by the Supervision.

Payment for the free draining backfill, selected material backfill, random backfill, stone bedding for non-drainage structures, gravel surfacing and bedding will be made at the respective unit prices per cubic meter tendered therefor in the Bill of Quantities. The unit prices shall include the cost of all labor, equipment and materials required for excavating or obtaining these materials from their natural sources or elsewhere as directed by the Supervision, processing at the crushing/classifying plant if required, transporting them to the locations where they are to be placed, spreading and compacting as required, and all other work directly relating thereto.

C.8 EMBANKMENT (NOT APPLICATION)

C.9 TEST ON EMBANKMENT MATERIALS FOR ACCESS ROADS

C.9.1 General

The Contractor shall establish, operate and maintain a testing laboratory which is fully furnished with testing equipment, instruments and all consumable as stipulated in Paragraph A.5 Laboratory, Laboratory Equipment, etc. of Section A. The Contractor shall also provide a trained staff to the satisfaction of the Supervision, and shall assist the Supervision to perform all tests necessary to ensure that the embankment comply with all the requirements of these Specifications. The test items and corresponding testing frequencies of the routine and non-routine tests for quality control of embankment will be directed by the Supervision.

Except as otherwise provided for in this Paragraph, the field and laboratory tests on embankment materials shall be in accordance with Japanese Industrial Standards (JIS), Standards of the American Society for Testing and Materials (ASTM), Practices of the United States Bureau of Reclamation (USBR), or other approved standards.

- (1) Samples of earth material shall be prepared for testing in accordance with ASTM Designation D2217, Procedure B, except that reduction of moisture content of the samples shall be at temperatures not exceeding 50°C.
- (2) The maximum dry density and optimum moisture content of earth material as well as embankment and sub-grade materials for permanent access roads shall be determined according to JIS A-1210 or ASTM D698, providing that:
 - (a) Fresh test material shall be prepared for each specimen to be compacted. Re-use of material compacted in a test will not be allowed.
 - (b) Test material subsamples for specimens to be compacted drier than fill moisture content may be individually airdried to the desired test moisture content for each specimen.
- (3) The gradation of samples of earth material shall be determined according to JIS 1204 or ASTM D422, except that mechanical stirrers shall not be used for the dispersion of the samples. The samples shall be dispersed using an air-jet dispersion cup similar in principle to those shown in ASTM D422.
- (4) For earth material, as routine control of placement, field density is to be measured at the embankment site according to ASTM D 1556 and the balance of field water content and the optimum water content, and the ratio of the field dry density and maximum dry density are to be determined according to the principles set out in ASTM Special Technical Publication 479, 5th Edition, in the "Suggested Method of Test for Rapid Compaction Control" by J.W. Hilf. A concise test procedure based on these principles will be provided by the Supervision. When using this procedure, the mechanical

mixing of test materials shall not be used, and all of the operations during the preparation, mixing and compaction of test materials shall be performed in a humidified atmosphere.

C.9.2 Payment for Tests

No separate payment will be made for the tests on earth material required by this Paragraph. The Contractor's costs for performing such tests shall be included in the applicable unit prices for construction of the embankment for the permanent access roads as tendered in the Bill of Quantities.

C.10 BORROW AREA (NOT APPLICABLE)

C.11 QUARRY SITE

C.11.1 General

The operation of quarry sites, if any, and excavation sites shall be the responsibility of the Contractor under the Supervision's direction.

The rock material shall be obtained from the quarry sites in Picoazá area about 10 km west of Portoviejo or other quarry sites specified by the Supervision.

Rock material to be used for producing aggregates for concrete and base course for the permanent access roads will be procured from the said quarry site and transported to the crushing plant, if required, at the Site for further processing and stockpiling. After processing, the said material will be transported to the access road site for placing and compacting, and the aggregates will be used as required for concrete works.

C.11.2 Measurement and Payment

The cost of all works for procurement of rock materials shall be included in the respective unit prices for applicable work items, such as concrete (aggregates), graded crushed stone subbase course and surface course for roads, etc., tendered in the Bill of Quantities.

C.12 OPERATION OF CRUSHING PLANT, IF ANY

C.12.1 General

Crushing plants of the type approved by the Supervision are to be erected and maintained at the specified location, if required. Material procured from the Picoazá quarry site will be hauled to the crushing plants for further processing it to produce coarse and fine aggregates for concrete, sand for grout/mortar, graded material for the base and surface courses of the permanent access roads, etc. After the materials from the quarry have been processed by the crushing plants, they will be stockpiled nearby in a suitable manner so as to prevent segregation.

The entire area around the crushing plant will be graded for drainage and suitably maintained to the satisfaction of the Supervision.

C.12.2 Measurement and Payment

No separate measurement and payment shall be made for the operation and maintenance cost of the crushing plants.

The operations and maintenance cost of the crushing plant, if required, in regard to further processing the materials for base and surface course for the permanent access roads, concrete aggregates, sand for grouting and mortar, and other drainage materials shall be included in the applicable unit prices tendered in the Bill of Quantities.

C.13 UNDERGROUND EXCAVATION

C.13:1 General

The underground excavation shall be carried out in accordance with the principles of the New Austrian Tunneling Method (NATM).

The Contractor shall retain on site an expert experienced in NATM tunneling practice and controlled blasting techniques for the duration of the underground excavation to provide construction advice on smooth blasting and rock reinforcement support methods required by these Specifications. The Contractor shall submit a work resume of the expert he proposes to employ, which expert shall have had at least ten years relevant experience, including measurement of rock stresses, settlement and convergence, etc.

The term "underground excavation" means approved excavation performed by methods other than open-cut excavation for all tunnel and shafts including work adits and the inlet structure.

Prior to starting any underground excavation, the Contractor shall make a detailed construction plan including the arrangement of machines, equipment and facilities, the system of excavation and disposal, the method of supporting the crown of tunnel (steel and/or rock bolt support) and the surface of shaft, the progress schedule and other pertinent data necessary to plan and perform the work in due consideration of all applicable conditions such as geology, climate and the prescribed construction period. The plan so laid down shall be submitted to the Supervision for his approval at least twenty-eight (28) days prior to the commencement of any underground work.

Should the use of a tunnelling machine for tunnel excavation be proposed, accurate and reliable documentation of the successful performance of the proposed tunnelling machine for excavation of tunnels of similar size in similar geological conditions shall be submitted to the Supervision.

A complete description of the proposed equipment, and shop drawings shall be submitted showing the design specifications, method of operation and other pertinent data of the machine.

Use of a tunnelling machine for tunnel excavation shall be subject to the approval of the Supervision. Approval by the Supervision of the use of a tunnelling machine shall not relieve the Contractor of his responsibility to perform the work of his Contract safely and satisfactorily.

The Contractor shall develop a contingency plan for completion of the work in the event of failure of the tunnelling machine to perform in a satisfactory manner.

The Contractor shall perform the work efficiently and safely, taking into consideration such items as proper drainage, the control and removal of water, ventilation and lighting systems, the method and sequence of placing supports, grouting, concreting, etc. The Contractor shall pay particular attention concerning air pollution caused by the type of equipment to be used in underground excavation. All such equipment shall be subject to approval by the Supervision.

Even if the construction method which has been actually adopted by the Contractor for the tunnel excavation differs from that originally planned by him and approved by the Supervision, the Contractor shall not be entitled to additional compensation on account of such changes. Any damages caused by careless execution of the Contractor shall be repaired by him at his own expense in a manner satisfactory to the Supervision.

During the underground excavation work, the Contractor shall, at his full responsibility, maintain the lines and grades shown on the Drawings by accurate surveying and/or other suitable means and methods approved by the Supervision. If seams or similar defects are encountered during underground excavation the applicable parts of Sub-paragraph C.5.3 shall be applied.

The Contractor shall use a blasting technique which will produce a minimum of overbreak and a minimum of stressing or fracturing of the rock beyond the excavation lines. The perimeter holes shall be drilled accurately to the tunnel alignment, shall be lightly loaded and shall be fired simultaneously as far as practicable. The use of ammonium nitrate fuel oil explosives (ANFO) will not be permitted.

At least twenty eight (28) days prior to starting underground excavation, the Contractor shall advise the Supervision of details of his proposed blasting technique, which technique shall comply with all applicable Specifications including those listed in Paragraph C.3. During the progress of the excavation, this blasting technique shall be varied as necessary to suit the encountered rock conditions and to obtain the best practicable excavation surface after blasting. Any blasting technique to be used shall at all times be subject to the approval of the Supervision.

Blasting that might damage the work will not be permitted, and any damage to or displacement of supports, and any damage to any part of the works caused by blasting or

any other operations of the Contractor, shall be repaired by and at the expense of the Contractor and in a manner satisfactory to the Supervision.

Immediately following blasting, during the final clean-up prior to placing concrete, and at any other time in the duration of the work, all loosened material either inside or outside the "B" line that is likely to fall shall be removed.

Unless otherwise determined by the Supervision, all excavation beyond the pay lines prescribed in Sub-paragraph C.13.2 shall be completely filled with concrete at the Contractor's expense.

The drill holes shall be exactly located by scaling accurately the design section on the heading face. Completed sections of the underground excavation shall be inspected for acceptance by the Supervision before the concrete lining is placed.

Excavated materials shall be deposited in the designated spoil bank, or shall be placed in the designated stockpile for use or hauled to and directly placed in the permanent construction as directed by the Supervision, if they are assessed to be suitable for use in the permanent construction by the Supervision, as stipulated in Paragraph C.17.

The use of permanent steel supports, rock bolt support, shotcrete and temporary timbering for the underground excavation work shall be in accordance with Paragraphs C.14, C.15, and Sub-paragraph C.13.5, respectively.

The control and removal of water relating to underground excavation work shall be in accordance with the applicable stipulations in Paragraph B.2 of Section B of these Specifications.

If, after any part of the underground excavation has been made to the prescribed section, the Supervision directs that enlargement be carried out, the Contractor shall perform the additional excavation at the same unit price per cubic meter of underground excavation as tendered therefor in the Bill of Quantities.

C.13.2 Design Section

The "A" lines shown on the typical sections of the Drawings are the lines within which no unexcavated material of any kind and no supports shall be permitted to remain. In the use of permanent structural steel supports, the inside face of the supports will be allowed to project from the "A" line equal to or less than 7.5 cm. Prior to placing of concrete, any materials projecting within the "A" line excluding the permanent steel support shall be removed by the Contractor.

The "B" lines are the outside limits to which measurement for payment of excavation will be made. Measurement for payment will in all cases be made to the "B" lines regardless of whether the limits of the actual excavation fall inside or outside of the "B" lines. The Contractor shall take every precaution to avoid excavation beyond lines to which measurement for payment is made.

The application of the various typical sections shown on the Drawings for underground excavation is provisional and will be determined by the Supervision according to the geological conditions at the site during the progress of work.

C.13.3 Drilling Feeler or Pilot Holes ahead of Underground Excavation

When directed by the Supervision, feeler or pilot holes shall be drilled ahead of underground excavation, to capture in advance the nature of the materials to be excavated, the existence of possible water-bearing seams or strata, and/or the requirement of grouting. The minimum length of feeler or pilot holes will be five (5) m and a maximum of ten (10) m may be required. The diameter of each hole shall be not less than thirty-five (35) mm. The location, direction, length and number of holes shall be as directed by the Supervision.

When feeler or pilot holes are required to be drilled in the excavations, other operations shall be suspended or modified as may be necessary to permit such drilling and the Contractor shall not be entitled to any additional compensation or extension of time on account of such requirement.

Nothing contained in this Sub-paragraph shall prevent the Contractor at his own expense from drilling feeler or pilot holes ahead of the underground excavation as he may consider necessary.

Where directed by the Supervision, feeler or pilot holes shall be grouted with approved mix proportion of grout under pressure.

C.13.4 Lighting and Ventilating Underground Excavation Works

During construction, the Contractor shall properly light and ventilate the tunnels and shafts to the satisfaction of the Supervision. All lighting systems in the tunnels and shafts shall be operated at a voltage to be approved by the Supervision.

The cost of all works required by this Sub-paragraph shall be included in the unit prices per cubic meter of underground excavation as tendered in the Bill of Quantities.

C.13.5 Temporary Timbering for Underground Excavation

Suitable temporary timbering, including lagging, may be used where such temporary timbering is necessary to support the roof and sides of the underground excavation work. Wooden supports, instead of steel supports may be used for temporary supporting, providing that thorough investigations by the Contractor and the Supervision on the safety aspects related thereto are favorable.

Temporary timber supports which include such items as timber lagging, cribbing, blocking, wedging, spreaders, foot blocks, etc. shall be of sound timber having a rectangular cross-section. The dimensions of the support timber shall be as approved by the Supervision but foot blocks shall not exceed ten (10) cm in height.

Timber lagging is defined as the first layer of timber pieces which bears directly or indirectly against the outer faces of two or more adjacent steel ribs and which are usually held in place by timber blocking, cribbing, wedges, etc. Timber spreaders are defined as those pieces of timber placed between the outer face of the support and the minimum excavation line (Line "A").

In supported sections of underground excavations, support timber shall not be used over greater areas than necessary and except where the lagging is closely spaced. It shall be removed completely before concrete for lining is placed, unless otherwise directed by the Supervision. The Contractor shall securely brace the supports with the minimum practicable amount of blocking and wedges. Where closely spaced lagging is required, the Contractor shall fill at his own expense, as completely and compactly as practicable, all remaining spaces outside the lagging.

The material for use as temporary timbering shall always be stocked in adequate amounts, as determined by the Contractor and approved by the Supervision, to meet an emergency demand such as in the event an accident occur, etc.

The total cost for furnishing, erecting and removing (if necessary) temporary timbering shall be included in the unit prices per cubic meter for underground excavation as tendered in the Bill of Quantities.

C.13.6 Measurement and Payment

Measurement, for payment, of underground excavation will be made based on the typical sections actually made at the Site, and will be limited to the specified sectional dimensions within the pay line ("B" lines) as prescribed in Sub-paragraph C.13.2.

Payment for underground excavation will be made at the unit prices per cubic meter tendered therefor in the Bill of Quantities, which unit prices shall include the cost of all labor, materials and equipment required by Paragraph C.13 and other applicable Specifications including the cost of blasting, drilling feeler or pilot holes, lighting, ventilating, temporary timbering, disposal of excavated materials, and of maintaining the excavation in a satisfactory condition until the concrete lining is placed.

Payment for control and removal of water during underground excavation shall be included in the unit prices or the lump sum prices for the corresponding items therefor in the Bill of Quantities.

The Contractor shall not be entitled to the following additional costs or compensation:

- (a) repair cost for any damages caused by the Contractor's fault,
- (b) any cost incurred in the change of excavation method regardless of the Supervision's approval, and
- (c) the cost of the concrete placed in the excess excavation beyond the pay line.

Payment for use of permanent steel supports shall be as stipulated in Paragraph C.14.

C.14 PERMANENT STEEL SUPPORTS FOR UNDERGROUND EXCAVATION WORK

C.14.1 General

Permanent steel supports shall be used to support the roof and sides of the underground excavation, as required or as determined by the Supervision. The type of lagging will be dependent upon geological conditions. Nothing contained in this Paragraph shall prevent the Contractor at his own expense from erecting such amounts of supports as he may consider necessary or from using heavier supports than directed or approved by the Supervision, nor shall it be construed to relieve the Contractor from sole responsibility for the safety of the underground workings, nor for liability for injuries to or deaths of persons or damage to property, nor of any of his obligations under the Contract.

Permanent steel supports, complete with ribs, lagging, bolts, tie rods, foot plates and other accessories required for assembling the supports and for supporting them until the concrete lining is placed, shall be furnished by the Contractor.

Type and sizes of steel supports, their miscellaneous details, location and spacing shall be subject to the approval of the Supervision. The clear distance between the installed steel supports shall not be less than eighty (80) centimeters unless otherwise approved by the Supervision, and shall be subject to approval of the Supervision if it is planned to be more than one and a half (1.5) meters.

Upon request by the Contractor in writing to the Supervision with sufficient particulars to substantiate, the rock bolt support combined with steel mesh reinforcement and shotcrete stipulated in Paragraph C.15 may be substituted for permanent steel support if the Supervision approves to do so as the best substitute to secure the safety of construction and to comply with the Time for Completion and the Contractual Construction Programme in the Contract, without any additional cost.

C.14.2 Installation of Permanent Steel Supports

The steel supports shall be installed to the proper lines and grades as shown on the Drawings and shall be maintained by the Contractor in the proper condition and alignment until the concrete lining is placed around them. The Contractor shall securely brace the supports with tie rods and collar braces and the minimum practicable amount of blocking and wedges. Any improperly installed steel supports shall be immediately adjusted to the satisfaction of the Supervision after the Contractor is notified to effect such adjustment.

Except as authorized in specific instances, steel lagging and blocking shall be arranged to permit the ready flow of concrete through and around the lagging and blocking, so that the concrete lining will be in contact with the excavated surface area. Timber collar braces, braces, lagging, blocking and wedging can be used for supporting where required and shall

be removed before placement of concrete lining unless such removal is judged impracticable by the Supervision.

Steel lagging, cribbing, blocking and wedging shall be steel plates or steel sections, the dimensions of which shall be as approved by the Supervision.

Steel lagging, cribbing, blocking and wedging shall be secured by welding in such a way as to take advantage of its greater structural strength and to minimize the number of members used, to the satisfaction of the Supervision.

The Contractor may, to facilitate his operations, place structural steel supports with sufficient space from the finished surface of concrete lining shown on the Drawings or as prescribed by the Supervision, provided that any increase in the quantity of steel supports and any excavation and concrete lining outside the "B" lines described in Sub-paragraph C.13.2 which is required thereby, shall be at the Contractor's expense.

Permanent steel supports required for any sections not shown on the Drawings shall be in accordance with the design submitted by the Contractor, as approved by the Supervision.

C.14.3 Measurement and Payment

Measurement, for payment, of permanent steel supports will be made by the weight in metric tons of the main steel supports, including steel lagging, and steel accessories placed permanently as approved by the Supervision, but only for the necessary quantities for satisfactory construction, in the judgement of the Supervision.

The amount of permanent steel supports numerated in the Bill of Quantities is only for bidding purpose, and will vary depending on the geological conditions. The Contractor shall estimate and provide the necessary quantity of the same at his own risk to comply with the Time for Completion and the Contractual Construction Programme stipulated in the Contract.

The variation of the quantity of the same is not subject to any adjustment of the unit price for the same.

Payment for furnishing and installing permanent steel supports will be made at the respective unit prices per metric ton tendered therefor in the Bill of Quantities, which unit prices shall be for the cost of all labour, equipment and materials including the cutting, bending, assembly and installation of the steel supports, supporting them in place and other similar work until the concrete lining is placed.

C.15 ROCK BOLT SUPPORT

C.15.1 General

The Contractor shall furnish and install rock bolt support in underground excavation where shown on the Drawings or approved by the Supervision. Rock bolt support required for

any section not shown on the Drawings shall be in accordance with the design submitted by the Contractor, as approved by the Supervision.

The type of rock bolt support shall be either point anchorage type (wedge type or expansion type) or overall plane anchorage type depending on the geological conditions encountered. The overall plane anchorage type shall be of rock bolt support anchored with resin or cement mortar.

The type, length and arrangement of rock bolt support shall be determined in association with or combination with shotcrete and steel mesh reinforcement to minimize the construction cost and to secure safety of construction taking into account the actual geological conditions encountered or captured by the pilot holes at the face of the tunnel.

The Contractor shall submit his proposed construction plan for the same to the Supervision for his approval prior to the commencement of the said work.

The application of rock bolt support and/or shotcrete with steel mesh reinforcement shall not be construed as relieving the Contractor of his responsibility to maintain all portions of the work in a safe conditions.

C.15.2 Installation of Rock Bolt Support

The rock bolts and method of installation of the rock bolts, including the details of the equipment necessary to drill the hole, effectively seat and tighten the anchorage in the hole and tighten the bolt to the required tension after installation shall be subject to the approval of the Supervision. Where rock bolt support is required at any location in the tunnel excavation, such support shall be installed as soon as practicable after the rock has been excavated.

The Contractor shall so plan his equipment and operations that routine installation of rock bolts can be carried out within 10 m of the face of tunnel excavation. In the event that the bolts placed at a distance of less than 10 m from the face are damaged by subsequent blasting at the face, they will be subject to payment notwithstanding such damage, provided that payment will not be made for such damaged bolts that are readily repairable until they have been repaired to the satisfaction of the Supervision.

Rock bolts of the point anchored type shall be D. 25 (25 mm nominal diameter) steel rounds threaded with a cold rolled thread at least 150 mm in length at one end and fitted at the other end with a wedge and an expansion shell or such other type of anchor as may be approved by the Supervision.

The Contractor shall furnish with each rock bolt and all accessories including expansion anchors, steel bearing plates, washers, machine washers, hexagonal nuts, wedges and taper washers if used. All steel for rock bolt shanks shall conform to JIS G 3112, SR D 25 except in respect of chemical composition, or equivalent standard as approved by the Supervision. All steel for bearing plates and rolled steel sections shall conform to JIS G 3101, Class I or equivalent standard as approved by the Supervision.

Rock bolts anchored with resin or cement mortar (the overall plane anchorage type) shall be of deformed bar. The material of rock bolts shall be of SD 35 (JIS G 3112) or SD 30 or approved equivalent one depending on the geological conditions.

The diameter and length of the holes drilled in rock for the installation of rock bolts shall be as directed by the Supervision to suit the type of anchor and shall be drilled in locations and in directions approved or directed by the Supervision. The standard length of rock bolts will be 2.0 m.

Each hole shall be cleaned of all drill cuttings, slug and debris by the Contractor before a rock bolt is inserted in the hole. The installation procedure shall be subject to the approval of the Supervision and shall cause no ending of the bolt shank or damage to the thread on the projecting end of the rock bolt.

After initial installation, the Contractor shall ensure that the rock bolts act as effective supports by periodically testing rock bolts and retightening, if necessary, to the directed torque. The installations shall be tested and the bolts retightened as and when directed by the Supervision.

C.15.3 Shotcrete and Steel Mesh Reinforcement

Shotcrete and steel mesh reinforcement, when required to be used together with rock bolt support, shall be used to protect and to support the sides and roof of both the tunnel and inlet structure and work adits carried out in underground excavation, as shown on the Drawings or as directed by the Supervision.

The materials to be used for and the method to be applied to the shotcrete shall comply with the Specifications prescribed in Paragraph E.16 of Section E, Concrete Works. The materials to be used in and the method to be applied to the steel mesh reinforcement shall conform to the Specifications stipulated in Sub-paragraph E.16.2 of Section E, Concrete Works.

C.15.4 Measurement and Payment

- (1) Measurement, for payment, of rock bolt support to be used for the underground excavation will be made on the basis of installed length of rock bolts with grouting or ungrouting in linear meters indicated on the Drawings or as directed by the Supervision according to the actual geological condition, and only for the quantities which, in the judgement of the Supervision, are installed effectively for satisfactory construction.

The amount and type of rock bolt support and shotcrete numerated in the Bill of Quantities is only for bidding purpose, and will vary depending on the geological conditions. The Contractor shall estimate and provide the necessary quantity and type of the same at this own responsibility to comply with the Time for Completion and the Contractual Construction Programme stipulated in the Contract. The variations of the quantity of the same is not subject to any adjustment of the unit prices for the same.

Payment of rock bolt support will be made at the unit price per linear meter measured as provide above, tendered therefor in the Bill of Quantities, which unit price shall be for the costs of all labor, materials and equipment including all works such as drilling holes, removal of water, disposal of loose materials, cleaning rock, grouting (or injecting resin or cement mortal), retightening of the rock bolts as necessary to maintain the required strength in the bolt and other items necessary to complete the works.

- (2) Measurement and payment of shotcrete and steel mesh reinforcement for the underground excavation shall be made according to the provisions stipulated in Sub-paragraph E.17.6 of Section E, Concrete Works.

C.16 SHOTCRETE FOR UNDERGROUND EXCAVATION

C.16.1 General

Shotcrete shall be furnished to protect the sides and roof of tunnel in underground excavation where shown on the Drawings or directed by the Supervision.

The materials to be used for and the method to be applied to the shotcrete for underground excavation shall conform to the Specifications provided in Paragraph E.16 of Section E, Concrete Woks. Shotcrete required for any section not shown on the Drawings shall be in accordance with the design submitted by the Contractor, as approved by the Supervision.

The application of shotcrete shall not be construed as relieving the Contractor of his responsibility to maintain all portions of the Work in a safe condition.

C.16.2 Measurement and Payment

Measurement and payment of shotcrete furnished in underground excavation shall be made according to the provisions stipulated in Sub-paragraph E.17.6.

C.17 DISPOSAL OR USE OF EXCAVATED MATERIAL

C.17.1 General

As noted in Paragraph C.1 of this Section, it is estimated that the quality of the materials to be excavated from the various types of excavation will be such that much of it may have to be hauled to the designated spoil bank shown on the Drawings for disposal. However, if the Supervision determines that certain quantities of the excavated materials will be temporarily stockpiled in appropriate location shown on the Drawings for use at a later time or hauled to and directly placed in permanent construction, as determined by the Supervision.

C.17.2 Disposal of Excavated Materials to be Wasted

Unsuitable excavated material shall be hauled to the designated spoil bank shown on the Drawings.

Waste piles at the spoil bank shall be located where they will not interfere with the natural flow of the rivers and streams, with the operation of the reservoirs, and where they will neither interfere with the accessibility to the structures for operation nor detract from the appearance of the completed Project. Where required, as determined by the Supervision, waste piles shall be levelled, graded for drainage, protected against erosion and trimmed to reasonably regular lines.

Location changes, or additions, to the disposal area for the Contractor's own convenience shall be subject to approval of the Supervision and shall be made at the Contractor's expense.

The Contractor shall submit proposals to the Supervision for approval for disposing of materials at any area other than previously approved areas and for the protection of these materials from erosion, at least twenty-eight (28) calendar days prior to the commencement of hauling material to the area.

The cost of hauling unsuitable material to the spoil bank and for maintaining the disposal area as specified herein shall be included in the unit prices per cubic meter for various classes of excavation material as tendered in the Bill of Quantities.

C.18 GABION MATTRESS

C.18.1 General

Where shown on the Drawings or directed by the Supervision, the Contractor shall excavate for, trim to line and level, provide and erect gabions including providing selected rock, crushed if necessary, packed and compacted inside the gabions.

Gabions shall be matters with diaphragms at 1 m centers fabricated with hot-dip galvanized wire and conform to the Ecuadorian standard or approved equivalent. The maximum mesh size shall be 80 mm x 100 mm for gabion matters. The standard gabion shall have the following dimensions:

Length : 2.0 m

Width : 1.0 m

Height : 0.5 m

The wire used for the construction of gabion mattress shall unless otherwise instructed by the Supervision comply with the requirements of the followings;

	Diameter (mm)	Galvanizing (g/m ²)
Mesh	2.4	260
Binder	2.2	240
Selvedge	3.0	275

Gabions shall be constructed to the shapes and dimensions as shown on the Drawings or as directed by the Supervision. Gabions as constructed shall be within a tolerance of $\pm 5\%$ on the height or width instructed and $\pm 3\%$ on the length instructed.

The alignment of the gabion shall be connect within a tolerance of 100 mm of the instructed alignment and the level of any course of gabion shall be corrected to within a tolerance of 50 mm of the instructed level. In addition adjacent gabions shall not vary by more than 25 mm in line and/or level from each other.

The surface upon which gabions are to be laid shall be compacted to a minimum dry density of 95 % (AASHTO T99) and trimmed to the specified level or shape.

Joints in gabions shall be stitched together with 600 mm minimum lengths of binder wire, with at least one stitch per 50 mm, and each end of the wire shall be fixed with at least two turns upon itself. Adjacent gabion shall be stitched together with binder wire along all touching edges.

Gabions shall be laid with broken bond throughout to avoid continuous joints both horizontally and vertically.

Gabions shall be handpacked with broken rock of 150 mm minimum dimension and 300 mm maximum dimension. The sides shall be packed first in the form of a wall, using the largest pieces, with the majority placed as headers with broken joints to present a neat outside face. The interior of the gabion shall be hand packed with smaller pieces and the top layers shall be finished off with larger pieces. The whole interior and top layers shall be packed tight and hammered into piece.

At the back face and ends of completed gabion work or where shown on the Drawings or instructed by the Supervision, the existing soil shall be backfilled, thoroughly compacted against the sides of the gabions and finished flush with the top surface of the gabion.

C.18.2 Measurement and Payment

Measurement, for payment, of gabions shall be made on the basis of the placed volume of gabions determined by designed line and dimension as shown on the Drawings or as directed by the Supervision.

Payment for gabions will be made at the unit price per cubic meter tendered therefor in the Bill of Quantities. The unit price for gabions shall include for the cost of excavation to any depth, compaction of the surfaces to receive the gabions, backfilling with the excavated material or removing the excavated material to spoil if surplus to requirements, providing

and fixing the mesh, and providing, hauling and placing the rock and all other work directly relating thereto.

C.19 WET RUBBLE MASONRY WALLS

C.19.1 General

The Contractor shall construct wet rubble masonry walls for slope protection as shown on the Drawings or elsewhere as directed by the Supervision. The stone for wet rubble masonry walls shall be natural or crushed stone having sufficient strength and durability required for its use. The maximum size shall not be exceeded at 20 cm.

The rubble stone shall be moistened and hand-placed with uncoursed close joints to the line, and grades shown on the Drawings or as approved by the Supervision onto a bedding of backfill concrete placed on a compacted layer of free draining backfill material. The spaces between the stones shall be filled with a 1 : 3 cement sand mortar. Surface joints shall be finished struck.

The walls shall be provided with expansion joints as shown on the Drawings or as approved by the Supervision.

Drain holes of 50 mm dia. P.V.C. pipe shall be installed on wall surface as shown on the Drawings. The upper surface of the walls shall be finished smooth with a trowelled layer of 10 cm thick capping concrete.

After completion of a section of wet rubble masonry wall, it shall be cured with water for a minimum of seventy two (72) hours or as approved by the Supervision.

C.19.2 Measurement and Payment

Measurement, for payment, for wet rubble masonry walls shall be made for the volume of walls constructed to the prescribed lines and dimensions as shown on the Drawings or as established by the Supervision.

Payment for wet rubble masonry walls will be made at the respective unit prices per cubic meter tendered therefor in the Bill of Quantities, which unit prices shall include the cost of all labor, equipment and materials required for obtaining the materials, transporting them to the locations where they are to be placed, constructing the walls as required, and all other work directly relating thereto.

Payment for free draining backfill, gravel bedding, backfill concrete, 50 mm dia. P.V.C. drain pipes, foundation concrete and capping concrete will be made separately in the appropriate work items stated in the Bill of Quantities.

C.20 SOD FACING

C.20.1 General

The Contractor shall carry out sod facing using the methods shown on the Drawings or directed or approved by the Supervision.

The Supervision may direct the Contractor to carry out sod facing in successive stages at any time during the execution of the Works when weather conditions are suitable for the establishment of grasses.

Sod facing shall be carried out to establish a protective cover of grass over erodible surfaces by using 200 x 200 mm sods of dense, well-rooted grass cut to a depth of not less than 40 mm. The sods shall be well bedded onto a 100 mm layer of topsoil, pegged to the ground with bamboo or timber skewers, and kept watered until the sods have rooted. The Contractor shall replace any sods which die or fail to take root.

On completion of the work, the Contractor shall maintain and water the sodded areas. Any areas subsequently killed or damaged before completion of the Works shall be restored, re-sodded and watered by the Contractor at his expense.

After initial watering, the Contractor shall water the grassed area when necessary, as determined by the Supervision, to the equivalent of 25 mm of rain per week. The method of watering shall be subject to approval and shall be carried out during normal working hours.

C.20.2 Measurement and Payment

Measurement, for payment, of sod facing shall be made on the basis of placed area in square meters determined by the lines and grades as shown on the Drawings or as directed by the Supervision.

Payment will be made for the number of square meters measured as provided above at the unit price per square meter tendered therefor in the Bill of Quantities, which unit price for sod facing shall constitute full compensation for the cost of all labor, tools, equipment, and materials including supplying and placing topsoil; supplying, cutting, handling, loading, hauling, unloading, placing, the sods; maintaining and watering up to the end of construction period; and all incidental work connected thereto.

CONSTRUCTION OF CIVIL WORKS

PACKAGE 1

DAULE-PERIPA-LA ESPERANZA TRANSBASIN

VOLUME III - GENERAL AND TECHNICAL SPECIFICATIONS

SECTION D

DRILLING AND GROUTING

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SECTION D DRILLING AND GROUTING

D.1 GENERAL

D.1.1 Contractor's Responsibility

- (1) The items under this works shall comprise (a) the supply of all labour, construction equipment and materials, and the performance of all work necessary for drilling through concrete or soil or rock, washing holes and supplying, transporting, mixing and injecting grout materials; (b) supply and installation of grouting pipes; and shall be all performed as shown on the Drawings or as directed by the Supervision and as specified herein.
- (2) The Contractor shall employ an approved specialist to carry out the grouting works unless he can perform the works to the satisfaction of the Supervision including possession of necessary equipment and skilled staff. The Contractor shall be entirely responsible for the workmanship and proper execution of the drilling and grouting works.
- (3) All materials and equipment which are provided by the Contractor shall be subject to the Supervision's approval before work commences.
- (4) The Contractor shall submit to the Supervision for approval a detailed programme stating the method of works which he proposes to take. The Contractor shall provide the Supervision each day, an approved form, with accurate daily records in duplicate of the grouting operation carried out in the previous day.
- (5) After the work has been completed, the Contractor shall clean the work site to the satisfaction of the Supervision.

D.1.2 Classification and Definition

(1) Classification

The drilling and grouting works are classified as follows:

- (a) Backfill grouting in tunnel and inlet structure
- (b) Contact grouting
- (c) Core drilling for holes, if required
- (d) Drilling drainage holes

(2) Definition

- (a) Backfill grouting shall be performed for the purpose of filling up openings between the lining concrete of the tunnel and the excavated rock surface to unite

the lining concrete and the surrounding rock behind the lining by means of injecting mortar grout.

- (b) Contact grouting shall be performed for filling up any shrinkage gaps between the surrounding rock and the lining concrete, or between any backfill concrete (including plug concrete) and the initial lining concrete by means of injecting cement grout into the gaps. This grouting shall be undertaken after backfill grouting operations have been completed in those locations.
- (c) Core drilling of holes, if required, shall be performed for the purpose of investigating geological conditions of foundation rock and rock around the underground structures and tunnels.
- (d) Drilling of drainage holes shall be made without requirement of taking core samples.

D.2 GROUT MATERIAL

- (1) Grout shall consist of a mixture of Portland cement Type I and water, plus approved admixtures. The mixture will be designed by the Contractor and approved by the Supervision. The use of sand or any other additives must be approved by the Supervision.
- (2) Mixing water for grout shall be fresh, clean and free from injurious amounts of oil, acid, alkali, salts, organic matter or other deleterious substances.
- (3) All cement for grout shall have a quality equivalent to that of Type I Portland cement (ASTM Designation C150 and/or as approved by the Supervision). Cement shall contain no hardened lumps.
- (4) Whenever sand is added to the grout, it shall consist of clean, durable stone particles, free from lumps of clay and objectionable foreign matters, and shall be of the grain size distribution as approved by the Supervision.
- (5) Mineral filler for grouting shall be used when directed by the Supervision. Procedures for mixing the mineral filler will be governed by field conditions and shall be as directed by the Supervision.
- (6) Requirements for any type of accelerating agent in grout mixes shall be governed by the Supervision.

D.3 DRILLING EQUIPMENT

All equipment necessary for performing the work shall be provided by the Contractor and is specified thereunder.

- (1) For core drilling of holes, if required, standard rotary drilling equipment capable of drilling to the depth of 50 m shall be used. Core barrels shall be "double tube swivel type bottom discharge" or "triple tube type". The Contractor shall submit details of drilling diameter he proposes to use to ensure the maximum core recovery.
- (2) Drainage holes shall be drilled with percussion drilling equipment with hole diameter of 45 mm.

D.4 CORE DRILLING OF HOLES, IF REQUIRED

- (1) The Supervision may require the Contractor to drill holes to recover core sample for the purpose of investigating geological conditions. The diameter of the such holes shall be not less than 65 mm nor greater than 87 mm, unless otherwise directed by the Supervision. This prescription does not mean to reject a drilling in larger diameter for the purpose of casing the hole when it is necessary.
- (2) The Contractor shall keep a driller's log, available to the Supervision, of each hole drilled, on which shall be recorded coordinates, locations, elevation and final depth of the hole, the nature of the rock drilled and other pertinent data usually recorded in logs of drill holes, such as core recovery percentages, etc.
- (3) Core samples shall be placed in suitable wooden boxes with hinged covers to be furnished by the Contractor. The core samples in each run shall be separated in the box by a divider and shall be identified by means of a wooden tag inserted at the end of the run, upon which the depth of the run shall be marked. All core boxes shall be clearly marked with the number of the hole from which the core is taken. After core inspection and the logging work have been completed, those core boxes shall be delivered by the Contractor to the place of storage at the Project site as designated by the Supervision. Before the core boxes are stocked all core samples shall be photographed in colour at a reduced scale of 1:7 so that details marked on the inside of the box are visible in the photo. A linear scale shall be include in the photo. The Contractor shall supply to the Supervision the negative and two positives of each photo. The core samples shall be washed before photographing and shall be still damp when photographing, so as to bring out the nature and characteristics of the rock.
- (4) If the core recovery is less than 70% for a continuous section of more than 3 m in length, without any appropriate geological reason which is acceptable to the Supervision, the drilling length of that section shall not be subject to payment. If the core recovery of less than 70%, without acceptable reason, continues for more than 10 m, the Supervision can order the Contractor to drill a new core hole to the depth of the said section near the hole in question.

D.5 BACKFILL GROUTING

(1) Location and Size of Holes

The backfill grouting shall be done for filling openings between rock and lining concrete of the water transbasin diversion tunnel and inlet structure.

Holes through the concrete linings shall be prepared at the time of concrete placing by embedding steel grout pipes (50 mm in diameter) in the lining concrete. Arrangement of the holes will be as shown on the Drawings or as directed by the Supervision.

(2) Grout Pipe

Steel pipes, 50 mm in diameter and with a length depending on distance to rock from the lining concrete, shall be set in the concrete lining. The upper ends of the pipes shall not be flush against the rock but the lower ends shall be made flush with the inner surface of the concrete lining.

Any obstacle choking the pipe shall be removed by the Contractor.

(3) Backfill Grouting Procedures

Cement or mortar grout shall be injected through the grout pipes. The mix proportion of mortar will be determined at the site by the Supervision. The approximate ratio of cement/sand/water will be 1/2/1 by weight.

The maximum allowable pressure shall be 2 kgf/cm² (0.2 MPa) or as directed by the Supervision. Grouting shall be continued until the injection rate decreases to zero under the maximum allowable pressure, unless otherwise directed by the Supervision.

In case that injected grout flows out of the other holes, those holes shall be plugged and re-drilled afterwards by the use of drift for further grouting.

D.6 CONTACT GROUTING

(1) Locations of Contact Grouting

The Contractor shall fill with grout the gaps between the concrete lining or surrounding rock and the backfill concrete (plug concrete) in the inlet tunnel, and elsewhere as shown on the Drawings or directed by the Supervision.

(2) Tubing and Grout Outlets

The grout pipe system for contact grouting for backfill concrete (plug concrete) shall consist of, as shown on the Drawings, supply headers, return headers, vent return headers, 40 mm

diameter steel pipes for grout supply, return and vent, and 25 mm diameter grout riser pipes. Valves shall be attached at the end of all headers.

Grout outlets shall be of a type approved by the Supervision.

(3) Grouting

Before the pipes are embedded in concrete, they shall be cleaned inside and outside, and proven to be unobstructed, and any obstructed pipes shall be repaired or replaced by the Contractor at his own expense. The pipes shall be carefully laid and kept in position when concrete is being placed.

Before grout is injected, all pipes and joints shall be thoroughly washed with clean water under a pressure of not more than the allowable maximum pressure. Immediately prior to grouting, the water shall be drained. All accessible leaks discovered at the washing or all leaks occurring during the grouting operation shall be caulked or stopped in a manner approved by the Supervision.

The grout concentration to be used shall be within the range of 1:6 to 1:0.7 in cement-water ratio by weight. The changing concentration shall be as directed by the Supervision. The maximum allowable grouting pressure will be determined on site by the Supervision, and shall not exceed 5 kgf/cm² (0.5 MPa).

Grout shall be injected through the supply headers. When the maximum allowable pressure has been attained and the grout take has decreased to zero, the valves at the supply headers shall be closed and then grout shall be injected through the vent headers under the allowable maximum pressure until the grout take becomes zero. The maximum allowable pressure shall be maintained at least 30 minutes after the grout take has become zero. The valves of headers shall not be opened until grout is set sufficiently to be retained in the pipes.

The program of grouting, the time when each joint is grouted, the grout mixture used, the pressure applied, and all other details of the grouting operation shall be subject at all times to approval of the Supervision.

D.7 DRILLING DRAINAGE HOLES

The drainage hole shall be provided in the water transbasin diversion tunnel and inlet structure and shall be 45 mm in diameter as shown on the Drawings and/or as directed by the Supervision.

After completion of the drilling, every drainage hole shall be washed with pressured clean water.