JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

PEOPLE'S COMMITTEE OF HO CHI MINH CITY (PCHCMC)
MINISTRY OF PLANNING AND INVESTMENT (MPI)
THE SOCIALIST REPUBLIC OF VIET NAM

THE DETAILED DESIGN STUDY
ON
HO CHI MINH CITY
WATER ENVIRONMENT IMPROVEMENT PROJECT
IN
THE SOCIALIST REPUBLIC OF VIET NAM

FINAL REPORT

DRAFT BIDDING DOCUMENTS

PACKAGE D :
CONVEYANCE SEWER CONSTRUCTION,
EXISTING COMBINED SEWER IMPROVEMENT

VOLUME 2

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PACIFIC CONSULTANTS INTERNATIONAL

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SECTION 1. GENERAL SPECIFICATION

1.1 DESCRIPTION OF THE PROJECT

1.1.1 Overview of the Project

Ho Chi Minh City has been rapidly urbanized and expanded over the last 20 years without development of city infrastructure, particularly urban drainage and sewerage systems. Water pollution in canals and rivers, caused by direct discharge of domestic and industrial sewage, has resulted in an unsanitary, unhealthy environment. Solid waste dumping, housing development along canals and sludge accumulation have led to obstruction of waterway transportation. Low ground level combined with inadequate drainage systems result in periodic flooding of certain areas.

The Ho Chi Minh City Water Environment Improvement Project, in addressing the above problems, aims to contribute to the improvement of urban drainage and sewerage system of Ho Chi Minh City.

The project area covers an area of 3,065 ha which includes the central part of the city as well as the outlying areas of Thanh Da and Ben Me Coc. Certain elements of the overall project have been deferred to a future phase which, in the case of sewerage development, will integrate with works to be completed under the present project.

The main elements of the project are:

- Tau Hu - Ben Nghe canal improvement of 7.3 km
- Pump drainage improvement at Thanh Da (15.4 ha) , Ben Me Coc (1) (70.9 ha) and Ben Me Coc (2) (46.0 ha)
- Existing combined sewer improvement of 9.5 km
- Interceptor sewer of 12.2 km
- Conveyance sewer of 3.5 km
- Intermediate wastewater pumping station with a total pumping capacity of 133 m^3/min
- Wastewater treatment plant with a capacity of 141,000 m^3/day

1.1.2 Contract Packages

The project has been divided into packages for the purposes of implementation as follows:

Package A:	Tau Hu - Ben Nghe Canal Improvement
Package B:	Pump Drainage Improvement
Package C:	Interceptor Sewer Construction, Intermediate Wastewater Pumping Station Construction and Procurement of Sewer Cleaning Equipment
Package D:	Conveyance Sewer Construction and Existing Combined Sewer Improvement
Package E:	Construction of Wastewater Treatment Plant

1.1.3 Interfaces with Other Packages

The Works for Package D has interfaces with those of other packages in the project as follows:

(i) At three locations with the works for Package C where sewer lines cross the main interceptor sewer, run parallel with secondary interceptor sewers then have physical connections at diversion chambers constructed under Package C.

(ii) At the defined interface shown on the Drawings with that portion of the conveyance sewer constructed under Package C.

(iii) At the defined interface as shown on the Drawings with that portion of the inspection and maintenance road constructed under package C;

(iv) At four locations where sewer lines and their outlet structures constructed under this package join into the revetments in the bank of the Tau Hu Canal constructed under Package A

(v) Where the access road meets the northern abutment of the bridge across the Tac Ben Ro canal constructed under Package E

(vi) At the defined interface shown on the Drawings with that portion of the conveyance sewer constructed under Package E.

1.1.4 Scope of Work for Package D

The main elements of the works to be completed under this package include, but are not limited to, the following:

Component	Main Elements of Scope of Work
Conveyance Sewer Construction	(a) Conveyance sewer construction comprising the construction of approximately 3.0 km of a double-cell (each 1200 mm x 1300 mm) reinforced concrete sewer supported on timber piles and concrete piles between interfaces with those portions of the conveyance sewer constructed by others; (b) Construction of approximately 3 km of road works comprising an inspection and maintenance road along the route of the sewer and a road for inspection and maintenance but also serving as an access road to the proposed waste water treatment plant;
Existing Combined Sewer Improvement	(a) Construction of approximately 7,127 m of additional sewers comprising 3,889 m of concrete pipe sewers of diameters 1,000 mm to 2,000 and 3,238 m of reinforced concrete box culvert section sewers with sizes ranging from 2000 mm x 2000 mm to 2500 mm x 2000 mm. (b) replacement of approximately 2,396 m of reinforced concrete box culvert sewers with sizes ranging from 2,000 mm x 2,000 mm to 2,500 mm x 2,000 mm.

Complete descriptions of the requirement are included in the Drawings, the Specification, the Bill of Quantities and other documents comprising the Contract.

1.2 GENERAL INFORMATION

1.2.1 Site Conditions

(a) Conveyance Sewer and Road Construction

The site of the conveyance sewer and road is low-lying and swampy, relatively undeveloped and involves construction in the through water courses. The general surface level of the existing ground is around 0 to 1.4 m above datum.

(b) Existing Combined Sewer Improvement

The site of the works is built-up with high traffic volumes. The general surface level varies between 1.6 and 5.9 m above datum.

1.2.2 Climate

Ho Chi Minh City is located in the tropical monsoon zone and its climatic characteristics are almost uniform temperature, high humidity, and heavy precipitation. Meteorological observation has been carried out at Tan Son Nhat station since 1915.

Meteorological characteristics as recorded at the Tan Son Nhat Station from 1976 to 1977 station are s follows:

- The annual average temperature and relative humidity are 27.4 °C and 77.2 % respectively;
- Annual sunshine hours are 2,508 hours,

Annual average rainfall is 1,929 mm, of which about 93 % (1,788 mm) occurs during the rainy season starting from May to November with maximum monthly rainfall of 308 mm occurring in the month of August. Only about 7% (141 mm) of annual rainfall occurs during the dry season from December to April.

1.2.3 Access to the Site

1.2.3.1 Location of Site

The Site of the Works is located in Ho Chi Minh City in the Socialist Republic of Vietnam. The site of the Combined Sewer Improvement portion of the Works in located in districts 5, 10 and 11 of the city and that of the Conveyance Sewer portion is located in district 8 and the adjacent rural District of Binh Chanh.

1.2.3.2 Existing Roads

The existing combined sewer improvement works are to be constructed under existing city roads. The conveyance sewer site is accessible by existing roads and bridges across the Tau Hu and Doi Te Canals. There are no existing roads along the route of the majority of the conveyance sewer route.

The Contractor shall fully inform himself of the conditions of roads, traffic conditions, traffic regulations, waterway conditions and regulations governing navigation with respect to gaining access to the Site for the purposes of performing the Works and shall take all necessary actions to ensure availability of access to the Site as required.

1.2.3.3 Load Limits

(a) The public roads and bridges have various load limits and the Contractor shall be responsible for determining the load limits existing at the time and ensuring that his Equipment does not exceed such limits. Before moving any heavy construction equipment into public roads and bridges, the Contractor shall make suitable arrangements with the appropriate Government authorities and obtain their approval for the passage of such traffic.

(b) The Contractor shall use every possible means to prevent any public roads or bridges connecting with or on the road to the Site from being damaged by any traffic of the Contractor or his subcontractors.

1.2.3.4 Tracked Vehicles

The Contractor shall not travel tracked vehicles on any bituminous sealed road surface or bridge. Rubber tired vehicles conforming to applicable load restrictions will be permitted to use bituminous sealed roads and bridges.

1.2.3.5 Safety

The Contractor shall take necessary care at all times to ensure the convenience and safety or residents along or nearby the roads and streets used to access the Site.

1.2.3.6 Construction of Additional Access Roads

All additional roads required by the Contractor as temporary road on the Site shall be provided by the Contractor at his expense.

1.2.3.7 Maintenance

All damage caused to the public roads or bridges used by the Contractor for access to the Site shall be promptly repaired by the Contractor at his expense.

1.2.4 Sources of Materials

The following sources of materials are listed for information only. The Contractor shall satisfy himself as to the suitability of such sources.

Material	Source	Approx. Distance from Site
Sand and Gravel	Long Thanh District, Dong Nai Province	60 km
Sand Fill	Dong Nai River	40 km
Concrete Aggregate	Bien Hoa City, Dong Nai Province	30 km
Cement	Thu Duc District, HCMC	15 km
Concrete Reinforcement	Long Thanh District, Dong Nai Province	60 km
Precast Concrete Piles	Thuan An District, Binh Duong Province	25 km
Precast Concrete Pipes	Thu Duc District, HCMC	15 km

1.2.5 Spoil Disposal Area

Excavated material unsuitable for reuse as fill or surplus to requirements shall be disposed of in the area designated as a spoil disposal areas shown on the Drawings.

1.2.6 Water Supply, Power and Telephone Facilities

The above utilities are readily available in the vicinity of the site of the Existing Combined Sewer Improvement portion of the Works. Utilities are not readily available for the Conveyance Sewer portion of the Works. The Contractor shall make his own arrangements for procurement of such utilities.

1.3 CONTRACT DOCUMENTS AND DRAWINGS

1.3.3 Contract Documents

The Contractor will be provided with a maximum of five (5) sets of Contract Documents for his own use. Bid Documents in the Contractor's possession shall be marked superseded or returned to the Employer after issue of the Contract Documents and will not be recognised in the administration of the Contract. Further instructions issued by the Engineer shall be kept at all times on the Site by the Contractor and shall be available to the Engineer and his staff.

1.3.4 Bid Drawings

The Drawings included in the Bidding Documents are to be used for bidding purposes only. The Drawings show the work to be carried out in accordance with the Contract as definitely and in as much detail as is possible at the time of bidding. The Contractor may use the Bid Drawings for placing preliminary orders for materials or for preparing Drawings of Temporary Works. However, the Bid Drawings shall not be used as a basis for fabrication of equipment or for construction of the Works.

1.3.5 Construction Drawings

Bid Drawings will be supplemented or superseded by such Construction Drawings as necessary for the purpose of the proper and adequate execution of the Works. Two (2) full size prints of such Construction Drawings will be issued by the Engineer to the Contractor in accordance with the construction programme required under the provisions of Clause 1.4. On receipt of the Construction Drawings, the Contractor shall check them carefully and advise the Engineer in writing of any discrepancies, errors or omissions and full instructions will be furnished to the Contractor should any discrepancies, errors or omissions be found. The Contractor shall be required to perform the Work in accordance with such Construction Drawings at the applicable rates bid in the Bill of Quantities for such work or work of a similar nature. Although the Drawings are prepared to scale, work shall be based upon dimensions shown on the Drawings and not on dimensions scaled from the Drawings.

The Engineer may, from time to time during the construction, issue further Drawings to supplement or amend the Construction Drawings, if deemed necessary. Such further Drawings shall become part of the Construction Drawings.

The Contractor shall be governed by figure dimensions as given on the Drawings. Where the required dimensions are not shown in figures, the Contractor shall obtain such dimensions from the Engineer before proceeding with the construction of the portion of the Works to which they refer. In every case, detailed Drawings shall take precedence over general Drawings.

When additional information regarding foundation or other conditions becomes available as a result of excavation work, further testing or otherwise, and if it is found desirable to make changes in the alignment, cross section, dimensions or design of the Works to conform to such conditions, the Employer reserves the right to make such changes as in the opinion of the Engineer are necessary or desirable, and the Contractor shall forthwith comply with any such direction of the Engineer.

Bid drawing may be used as construction Drawings, as defined above, when authorised, in writing, by the Engineer.

1.3.6 Drawings to be furnished by the Contractor

1.3.6.1 General

All of the various types of Drawings as stated hereinafter shall be prepared in a form approved by the Engineer and submitted in advance to give the Engineer sufficient time to review and approve them without causing any delay to the field works. The Contractor shall provide qualified staff and a sufficient number of draftsmen/CAD operators and assistants capable of producing all Drawings required.

All Drawings and supporting computations to be submitted by the Contractor for the Engineer's approval shall be in English. All dimensions shall be given in the metric system. The Drawings shall be in JIS A1 size (594 mm by 841 mm) unless otherwise specified or approved by the Engineer.

The Contractor shall be held responsible for all Drawings and documents not submitted within the time limits stipulated in Clause 1.3.5. and for all costs involved for delays and damages consequent thereto. Contractor's Drawings approved by the Engineer are to be used for construction.

1.3.6.2 Working Drawings

The Contractor shall prepare the working Drawings for all items of the Permanent Works on the basis of the Construction Drawings issued by the Engineer. The working Drawings shall show sufficient details of the structure of the works or the construction methods or procedures such as, but not limited to, and as applicable, excavation and embankment fillings, concrete reinforcement bar arrangement including bending/cutting schedule and bar list, expansion joints, contraction joints, construction joints, concrete placement details, waterstop layout, equipment installation, etc., by which the Contractor will proceed with the field construction and operation. Further, Drawings presenting full details of items not to be incorporated into the Permanent Works but which affect the quality of work such as concrete forms, supports, etc., shall also be included in the working Drawings. All the working Drawings related to any section on the Works shall be approved by the Engineer prior to the time the Contractor plans to perform such section of work.

1.3.6.3 Shop Drawings

Shop Drawings, shall be prepared by the Contractor, or the Contractor's materials/equipment supplier on behalf of the Contractor, to show the outline, dimensions, type of material, etc., of particular items indicated in the Drawings and/or Specifications and as directed by the Engineer. Such shop Drawings shall be submitted by the Contractor to the Engineer for approval.

1.3.6.4 Drawings of the Temporary Works

Thirty (30) days before starting any section of the temporary facilities specified in Clause 1.8 hereof, the Contractor shall submit to the Engineer for approval Drawings showing details of such facilities.

The Drawings for temporary facilities shall show the locations and other pertinent details of the principal components of the Contractor's Equipment, offices, quarters, warehouses, storage areas, workshops, labour camps and other temporary buildings and facilities which the Contractor proposes to construct in the Works area.

If any change is made in the items mentioned above during erection or after the items become operational, the Contractor shall submit revised Drawings showing such changes to the Engineer for approval.

1.3.6.5 As-Built Drawings

Throughout the period of construction, the Contractor shall maintain an up-to-date set of as-built Drawings for the various items of work completed. Such Drawings shall show all authorised changes to the Construction Drawings and Shop Drawings to the extent that they correctly portray the true "as-built" condition of each item of the Permanent Works. The format of the as-built Drawings shall be as approve by the Engineer.

The up-to-date set of as-built Drawings shall be subject to periodical inspection at the Site by the Engineer and if the Drawings are found unsatisfactory or not up-to-date the Contractor shall bring them up-to-date within fourteen (14) days after inspection. If any part of the permanent Works delineated on the Drawings is complete, the pertinent as-built Drawings, after approval by the Engineer, shall be signed by both the Engineer and the Contractor, or their representatives, and three (3) copies shall be kept by the Engineer.

The as-built Drawings shall be made on high quality reproducible paper so that clearly readable copies can be made. The finished set of as-built Drawings shall be submitted by the Contractor to the Engineer for his approval and transmittal to the Employer in the manner specified in Clause 1.3.5.

1.3.6.6 Other Drawings

Drawings other than those mentioned above, which are of a general nature, such as the proposed construction methods, temporary works for construction purposes, schematic diagrams and outlines of how various types of work are to be performed shall, as directed by the Engineer or as stipulated in the Contract Conditions and Specification, be submitted to the Engineer for approval.

1.3.6.7 Form and Presentation of Drawings

(a) General

All shop Drawings and Working Drawings produced by the Contractor or his subcontractors for this Contract shall use a common system of sizes, title blocks and numbers in accordance with this Clause, regardless of who produces the Drawings.

(b) Drawing Sizes and Standards

All Drawings shall be drawn in the accordance with Clause 1.3.4.7.

(c) Title Blocks

(vii) The Contractor shall submit a sample of the title block he proposes to use for approval by the Engineer. The general format of the title blocks shall follow those of this Specification.

(viii) The Contractor or his subcontractor's title blocks shall show the Contractor's and subcontractor's name, the date, the title, and number of the drawing and each new issue of the drawing shall be identified by a revision letter as a part of the number. In addition each drawing shall show the following details in the lower right hand corner:

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DRAWING NO. .....

(d) Numbering System

(i) Primary reference to drawing numbers on all Drawings, correspondence, operation, and maintenance instructions and elsewhere, shall be the number from the Engineer's numbering system, which system will be notified to the Contractor.

(ii) The Contractor may, if he desires, insert his own reference number in the appropriate place on the title block.

(iii) Drawing number shall be as allocated by the Engineer.

(e) Quality

The quality of working Drawings, shop Drawings, "as-built' Drawings and Drawings for temporary works shall be in accordance with Clause 1.3.5.

(f) Drawing Index

The Contractor shall compile a drawing index for all Drawings produced by himself and his subcontractors. The Contractor shall submit an up-to-date copy of each sheet of the index to the Engineer at three monthly intervals or on request.

(g) Drawings on Site

Copies of the latest revisions of all Drawings shall be sent to the Contractor's site office as soon as possible after they are approved. The Drawings shall be available at all reasonable time for inspection by the Engineer.

1.3.7 Submittal and Approval of Contractor's Drawings

1.3.7.1 General

(a) It is to the Contractor's advantage to prepare his Drawings and submit them to the Engineer at the earliest possible time to avoid delay in the fieldwork due to lack of approved Drawings on hand for the construction crew.

(b) Any work done prior to the Engineer's approval of the Drawings shall be at the Contractor's risk. Approval by the Engineer of the Contractor's Drawings shall not relieve the Contractor from any of his obligations in the complying with the provisions of the Contract.

1.3.7.2 Procedure for Submittal and Approval

(a) Unless otherwise specified the Contractor shall submit his working drawing, shop Drawings and other required Drawings to the Engineer for approval at least twenty eight (28) days prior to the commencement of construction of any particular item of work. Shop Drawings for any particular item which has to be fabricated outside of the Site shall be submitted early enough to allow adequate time for review, approval, fabrication, transportation and receipt at the Site.

(b) Four (4) clearly readable print copies of each drawing shall be submitted to the Engineer by means of a standard transmittal sheet. The format of the transmittal sheet shall be as approved by the Engineer.

(c) The Engineer shall have the right to direct the Contractor to provide additional details and change in the Drawings if they are necessary to ensure compliance with the provisions and intent of the Specifications. Within thirty (30) days after the receipt of the Drawings submitted by the Contractor, the Engineer shall return one (1) copy thereof to the Contractor marked "Approved for Construction", "Approved for Construction-Except as Noted", or "Not Approved Resubmit".

(d) The return and receipt of any approved drawing shall be deemed to authorise the Contractor to proceed with the work covered by such drawing, but before proceeding with the work the Contractor shall first submit to the Engineer by logged transmittal sheet two (2) prints of each drawing. When requested by the Engineer, one (1) transparency of working Drawings and shop Drawings shall also be submitted together with two (2) prints. Copies of all approved Drawings shall be maintained at the Contractor's site office in proper order.

(e) When correction or revision is directed on the Contractor's submitted Drawings, the Contractor shall make the necessary corrections and/or revisions in a timely manner and shall resubmit them in two (2) copies to the Engineer in the same manner as for new drawing. This procedure shall continue until the Drawings have been finally approved.

1.3.7.3 Other Information

All applicable requirements of this Clause shall apply equally to other submittals described in Clause 1.4.

1.3.7.4 As-Built Drawings

Within one (1) month following the issue of the Certificate of Completion of the Works, the Contractor shall furnish to the Engineer, for his approval; and transmittal to the Employer, the final version of as-built Drawings. These as-built Drawings shall consist of:

(a) Two (2) sets of transparent polyethylene sheets ;

(b) Three (3) sets of full-sized (A1 size) bound copy ; and

(c) Ten (10) sets of reduced size (A3 size) bound copy.

(d) Two (2) sets of CD ROM of all Drawings prepared by CAD

1.3.8 Language and Units

The English language shall be used for all Drawings, specifications and other submissions by the Contractor except that Operation and Maintenance Manuals shall be prepared in both English and Vietnamese.

SI Units shall be used on in all Drawings, specifications and other submissions by the Contractor. Where printed information uses other units the equivalent SI units shall be shown.

1.3.9 Payment

1.3.9.1 Working Drawings and Shop Drawings

Payment for shall be made at the Lump Sum price entered in the Bill of Quantities.

For the purposes of monthly progress payments the amount completed, expressed as a percentage of the total number of Working and Shop Drawings required to be completed by the Contractor, shall be determined. Payment shall be calculated by multiplying the percentage completed by the lump sum entered in Bill of Quantities. Payment for Drawings shall never exceed the lump sum entered in the Bill of Quantities.

1.3.9.2 As-Built Drawings

Payment for shall be made at the Lump Sum price entered in the Bill of Quantities.

For the purposes of monthly progress payments the amount completed, expressed as a percentage of the total number of As-Built Drawings required to be completed by the Contractor, shall be determined. Payment shall be calculated by multiplying the percentage completed by the lump sum entered in Bill of Quantities. Payment for Drawings shall never exceed the lump sum entered in the Bill of Quantities.

1.3.9.3 Other Drawings

No separate payment shall be made for other categories of Drawings describe in this Clause 1.3 and the cost of preparing such Drawings shall be deemed to be included in the lump sum price for Working Drawings and Shop Drawings.

1.4 CONSTRUCTION PROGRAMME, CONSTRUCTION PLAN, PROGRESS REPORTS AND OTHER SUBMITTALS

1.4.1 General

The Contractor shall prepare and submit a construction programme, a construction plan, progress reports and other required documents in the manner specified herein.

1.4.2 Construction Programme

1.4.2.1 General

The Contractor shall prepare a construction programme in accordance with Conditions of Contract, Part II, Sub-Clause 14.1.

1.4.2.2 Revision of Programme

If in the course of execution the rate of progress of the Works or any section thereof falls behind the Contractual Construction Programme the Contractor shall prepare a revised programme in accordance with Conditions of Contract, Part II, Sub-Clause 14.2.

1.4.3 Construction Plan

1.4.3.1 General

Within twenty eight days of receiving the notice to proceed in accordance with Sub-Clause 41.1 of the Conditions of Contract, the Contractor shall submit a revised general construction plan including a detailed list of equipment to be mobilised, particulars of Temporary Works and method statements for major items of work to the Engineer for approval. The plan shall be prepared on the basis of the Construction Schedule and Method Statement submitted by the Contractor with his Bid. Any instructions given by the Employer and/or the Engineer on and after award of the Contract shall be incorporated.

1.4.4 Weekly Schedule

The Contractor shall, at the end of each week, submit to the Engineer for his review and comments two (2) copies of a weekly schedule for the succeeding week in a form approved by the Engineer. The schedule shall contain appropriate comments with regard to the work to be performed on each major item as well as other construction work related to the execution of the Works including procurement of materials, transportation of materials and equipment, preparation of Drawings and other items required by the Engineer.

1.4.5 Monthly Progress Report

1.4.5.1 Written Report

The Contractor shall submit, before the tenth (10^{th}) day of each month or at any time designated by the Engineer, five (5) copies of a monthly progress report in a form acceptable to the Engineer detailing the progress of the Works during the preceding month. The report shall contain, but not be limited to, the following items:

(a) A brief but detailed description of all works executed during the reporting month together with a cumulative summary of progress to date for each main activity.

(b) Total overall percentage of work completed up to the end of reporting month as well as the total overall schedule percentage completed and the forecast completion date computed by the critical path method (or other method previously approved by the Engineer) as of the end of the reporting month with appropriate comments on progress.

(c) Actual percentage of each main work item completed, as well as their schedule percentage, with appropriate comments on their progress. The percentages shall be provided for each month and cumulatively.

(d) Schedule of activities to be started within the succeeding two (2) months with the forecast starting and completion dates. If the dates are different from those shown on the approved Construction Programme on explanation shall be given.

(e) List of manpower by trade, and supervisory personnel by position, employed during the reporting month.

(f) List of Construction Equipment and materials on Site used in the execution of the Works including those that arrived at or were removed from the Site. The records shall include duration for which Equipment was not in working order.

(g) General description of the weather conditions during the reporting month including records of each rainfall duration.

(h) List of each accident involving, lost time, and/or death of any person, damage suffered by Works, properties and equipment.

(i) Occurrence of any event or condition that might delay or prevent completion of the Works in accordance with the current, approved Construction Programme and the steps taken by the Contractor to correct the situation.

(j) Schedule of the amount of payments received to date and the amount of any monthly invoice submitted but not yet paid.

(k) Estimated amount of payment from the Employer to the Contractor for the succeeding month.

(l) Colour photographs (not smaller than 8 cm x 12 cm) of the work progress of all major components of the Works from start to completion taken at locations directed by the Engineer. A brief description and date of each photograph shall be stated. The date shall be imprinted in each negative and photograph. A minimum of two photographs shall be taken of each major component under construction in the month including temporary works.

(m) Any other matters which may be required under the Contract or statement concerning any matter arising from or relating to the execution of the Works during the reporting month.

1.4.5.2 Video Report

The Contractor shall make a video tape recording of the progress of the Works on a monthly basis and shall engage a professional recording company approved by the Engineer to carry out the work.

The monthly recording shall be of 10 minutes duration and shall be carried out throughout the duration of the Contract or as directed. Additional recordings may be necessary to record significant milestone events.

A copy of each monthly recording shall be submitted to the Engineer. The recording shall be accompanied with dialogue, in English, describing the events recorded.

At the completion of the Works the monthly recordings shall be compiled and edited into a single recording of one hours duration, or as directed, complete with approved dialogue and soundtrack and submitted to the Engineer.

1.4.6 Daily Report

The Contractor shall prepare daily and periodical reports in a form approved by the Engineer. The following items:

(a) Weather conditions;
(b) Staff and labour force employed on the work;
(c) Materials and Equipment on Site;
(d) Work in progress including locations and estimates of daily production;
(e) Work in preparation;
(f) Accident or any other reason causing a suspension of the work;
(g) Occurrence of any event or condition that might delay the progress of work; and
(h) All other information relevant to the progress of the Works.

1.4.7 Other Submittals

During the course of the Works the Contractor shall submit to the Engineer for approval construction programmes, design computations, financial schedules, construction plans, various plans of work, survey, tests and operation, reports on the results of survey, test and inspection, written description of equipment to be used, pamphlets, brochures and samples of materials and equipment, and other required documents and goods as prescribed in this Specification and as directed by the Engineer. Such submittal of documents and goods shall be made in advance to avoid causing any delay to the field works. The procedure for submittal and approval shall be in the same manner as specified in Clause 1.3.5.

1.4.8 Payment

Except as otherwise specified, separate payment will not be made for complying with the requirements of Clause 1.4 and all costs shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities.

1.5 PROGRESS MEETINGS

1.5.1 General

A regular meeting between key personnel of the Engineer and the Contractor's authorised representative shall be held once a week at a time agreed upon by both parties to discuss the progress being made, the work proposed for the forthcoming week and any problem having a direct bearing on the immediate or near term work activities.

1.5.2 Payment

Except as otherwise specified, separate payment will not be made for complying with the requirements of Clause 1.5 and all costs shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities.

1.6 STANDARDS AND TESTS

1.6.1 Standards and Specifications

All materials and equipment to be furnished and installed for the Works and all construction works to be executed under the Contract shall conform to the respective standards and specifications stated in the Specification. Where applicable standards and specifications for any material, equipment and construction are not stated in the Specification, they shall conform to the latest edition of the relevant standards of the following organizations:

JIS	:	Japanese Industrial Standard
ISO	:	International Standards Organization
AASHTO	:	American Association of State Highways and Transportation Officials
ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standards
TCVN	:	Vietnamese Codes
JEC	:	Japanese Electro-Technical Committee Standard

If the Contractor proposes equivalent standards or specifications for materials and equipment, he shall state the exact nature of the proposed change and shall submit complete standards and specifications in English, including information and data on such materials and equipment, for approval of the Engineer. Such submittal shall be made in sufficient time for approval by the Engineer and failure to do so the purchase of any proposed equivalent materials and equipment prior to the approval of the Engineer shall be at the Contractor's risk.

The Contractor shall have available in his site office at all times at least one (1) copy of every standard referred to in this Specification or necessary for the execution of the Works.

In the event of a Vietnamese standard being more stringent than the specified standard, the Vietnamese standard shall govern.

1.6.2 Inspection, Examination and Testing of Materials and Equipment

Materials and equipment furnished by the Contractor, which will be incorporated in the Permanent Works, shall be subject to inspection, examination and test as provided in the Contract. To allow sufficient time to provide for inspection, examination and testing, the Contractor shall submit to the Engineer at the time of issue, copies in duplicate of all orders, including Drawings and other pertinent information covering the materials and equipment to be furnished by the Contractor, or shall submit other evidence in the event of such orders being issued verbally or by letter. The inspection, examination and testing of materials and equipment or the waiving of inspection, examination and testing thereof shall in no way relieve the Contractor of the responsibility for furnishing materials and equipment meeting the requirements of this Specification.

All examinations and tests shall be carried out by the Contractor in the presence of the Engineer in accordance with the normal practice for such examination and tests. The Contractor may carry out the examinations and tests with his staff and equipment available at the Site. Examinations and tests carried out off the site shall be made at a laboratory approved by the Engineer.

The Engineer shall be at liberty to reject any material or item of Plant that does not comply with the requirements of the Contract notwithstanding any previous approval thereof. The Contractor shall not be entitled to any extra payment or extension of time for completion of the Works on account of the rejection of materials due to their non-compliance with the requirements of the Contract, or of the waiting time required for carrying out the examinations and tests.

The Contractor shall furnish test samples as requested and shall provide reasonable assistance and co-operation as necessary to permit tests to be performed on materials or work in place, including reasonable stoppage of work during testing.

1.6.3 Tests and Testing Laboratory

The Contractor shall provide a site laboratory equipped with sufficient apparatus and staffed by qualified personnel for the control of concrete placement and compaction of fill materials. Other testing, such as concrete cylinder testing, shall be carried out at a laboratory approved by the Engineer at the Contractor's expense.

The Contractor shall carry out all field tests such as compaction tests, concrete workability tests and so on in accordance with the manner and frequency prescribed in the Specification and shall provide the testing equipment and apparatus, testing staff, labour and consumables necessary for carrying out his field testing. The Contractor shall prepare schedules of his field and laboratory testings taking into account the work progress schedule and shall submit them to the Engineer for approval.

The Engineer will supervise the Contractor's testing for the purpose of adequate and sufficient quality control of the Works during its execution. The cost of all testing shall be borne by the Contractor.

All test reports shall be submitted to the Engineer as soon as possible and within 24 hours of their completion.

1.6.4 Payment

Separate payment will not be made for complying with the requirements of this Clause 1.6 and all costs shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities for the items to which the standards and tests apply.

1.7 MOBILISATION AND DEMOBILISATION

1.7.1 General

Mobilisation shall refer to the transportation of Contractor's Equipment, based on the construction programme submitted by the Contractor in accordance with Clause 14 of the Conditions of Contract, from the place of origin to the Site where they are to be used. When the mobilisation has been

substantially completed to the extent the Works can be effectively performed and obtain the scheduled progress, the Contractor shall submit the required documentation for the Engineer's approval and certification. Subject to the authorisation of the Engineer the Contractor may at any time during the execution of the Works, make alteration, reduction and/or improvement to the Equipment.

Demobilisation shall be made after the written approval of the Engineer and shall include the removal of the Contractor's Equipment from the Site.

1.7.2 Equipment

The Contractor shall furnish the necessary Contractor's Equipment, as defined in Clause 1 of the Conditions of Contract, required for the execution of the Works. The Engineer may, if he consider it necessary for the execution of the Works in accordance with the Contract, instruct the Contractor to furnish additional Equipment. All equipment to be furnished by the Contractor shall be complete with all spare parts and the Contractor shall maintain a sufficient stock of such spare parts to ensure the efficient execution of the Works.

1.7.3 Programme and Notice of Transportation

Concurrently with the submittal of the programme in accordance with Clause 14 of the Conditions of Contract, the Contractor shall furnish the Engineer with a complete transportation programme for Equipment, showing, in detail, the sequence of transportation and delivery on the Site to comply with his proposed construction programme.

The Contractor shall keep the Engineer informed of the arrival of Contractor's Equipment and materials at the Site.

1.7.4 Payment

Payment for mobilisation and demobilisation will be made at the lump sum price tendered therefore in the Bill of Quantities. Progress payment will be made in the following manner :

(a) Seventy percent (70 %) of each approved Sub-item of the lump sum price tendered in the Bill of Quantities will be paid upon certification by the Engineer that mobilisation has been substantially completed for each item of equipment shown in the Contractor's breakdown submitted with his bid.

(b) The remaining thirty percent (30 %) of each approved Sub-item of the lump sum price tendered in the Bill of Quantities will be paid upon certification by the Engineer that the demobilisation of concerned equipment has been completed for each of the items of plant or equipment mentioned above.

Monthly estimates of progress for payments of mobilisation and demobilisation shall be supported with appropriate records and documents showing that mobilisation or demobilisation for each item of equipment as mentioned above has been completed during the month for which the estimate is prepared.

1.8 TEMPORARY FACILITIES

1.8.1 General

1.8.1.1 Extent of Temporary Facilities

For the purposes of this Clause temporary facilities shall mean those parts of the Temporary Works required for the purposes of the establishment, gaining and maintaining access to the site and continuing obligations for managing the site as described hereunder. Other Temporary Works which are associated with the executions of the Works such as shoring, formwork, etc. are addressed elsewhere.

All Temporary Facilities shall be provided, installed, operated, maintained and subsequently removed by the Contractor, except as otherwise provided in the Contract.

1.8.1.2 Approval of Temporary Facilities

The Contractor's proposal for the erection of all Temporary Facilities shall be in accordance with the proposals submitted with his Bid or with such modifications as approved by the Engineer from time to time.

The Contractor shall submit to the Engineer for approval, twenty eight (28) days from the receipt of the notice to proceed, the revised general plan of Temporary Works, based on the proposals in the Bid, layout, dimension, installation programme and schedule. The Engineer may direct the Contractor to modify or change the proposals, if in the opinion of the Engineer it is deemed necessary. Such direction of the Engineer shall not relieve the Contractor from any of his obligations and responsibilities under the Contract.

Before starting any part of Temporary Facilities the Contractor shall, at least twenty eight (28) days before starting construction, submit to the Engineer for the approval the detailed proposal for such part of the Temporary Works including plans, Drawings, schedules, and other information as specified in Clauses 1.3 and 1.4 of the General Specification which will supplement or modify the general plan of the Temporary Works already submitted by him.

1.8.1.3 Removal of Temporary Facilities

Unless otherwise directed or approved by the Engineer, all Temporary Works constructed by the Contractor shall be removed and the area made safe, vegetation and natural drainage reinstated all to the satisfaction of the Engineer prior to the end of the Defects Liability Period.

1.8.1.4 Payment

Separate payment will not be made for Temporary Facilities and all the costs thereof shall be deemed to be included in the lump sum prices entered in the Bill of Quantities for Establishment.

1.8.2 Use of Construction Facilities and Work Areas

1.8.2.1 Location of Temporary Facilities

The Contractor shall, as far as practicable, lay out the Temporary Works within the Site.

1.8.2.2 Restoration of Temporary Facilities Areas

Before acceptance of the Works by the Employer the Contractor shall restore the land occupied by the Temporary Works as nearly as practicable to its original condition or to a condition to the satisfaction of the Engineer.

1.8.2.3 Rights of Others to Use Construction Facilities

Other contractors employed by the Employer and their workmen and workmen of the Employer and of other Government authorities who will be carrying out work on or near the Site of the Works shall have the right to use, without charge, the access facilities, including bridges and roads, of which the Employer has given possession to the Contractor or which have been constructed or acquired by the Contractor for use in constructing the Works. Other contractors requiring to use such facilities shall be required to make application to and receive the approval of the Engineer before use.

1.8.3 Establishment

1.8.3.1 General

An item has been included in the Bill of Quantities for Establishment which item shall be deemed to include the cost of provision, erection and removal if required, of all Temporary Works at the Site including the Engineer's site office, the Contractor's site office, buildings, temporary fences, sanitary facilities, medical facilities, fixed construction facilities including but not limited to workshops, electric power supply, water supply, telecommunications, temporary roads, bridges and jetties, traffic control (including waterway traffic) and other temporary facilities required for the execution of the works and cleaning-up and restoration of the Site on completion.

1.8.3.2 Payment

The Contractor shall provide a breakdown of the lump sum for Establishment in accordance with Sub-Clause 57.2 of the General Conditions of Contract. The breakdown shall be arranged such that it includes not more than ten (10) sub-items which can be readily recognised and measured for payment purposes.

Payment for Establishment will be made at the lump sum price entered in the Bill of Quantities. Progress payments for work under each sub-item will be made as follows:

(a) Sixty percent upon certification by the Engineer that work under each sub-item is substantially complete.

(b) Ten percent upon certification by the Engineer that the facility under each sub-item has been removed.

(c) Thirty percent to be distributed uniformly over the duration of the Contract.

1.8.4 Utilities

1.8.4.1 Water Supply System

The Contractor shall ensure that there is an adequate supply of water to the Engineer's Site Office as specified in Sub-Clause 1.8.7, his offices,

laboratory, labour quarters, workshops, batching plant and other places on the Site where water is required in accordance with the Contractor's proposal in his Bid and approved in the Letter of Acceptance or as otherwise approved by the Engineer. Water for the human use shall be of a standard equal to the domestic town water supply in Ho Chi Minh City.

The Contractor shall supply to the Engineer's Site Office and Facilities, and to all work areas, an adequate supply of purified, bottled water

1.8.4.2 Electric Power Supply

The Contractor shall be responsible for providing at the Site, all electric power required for his construction activities, his site office, his labour camps, the Engineer's site office and any other areas where electric power is required.

The method of supplying such electrical power to the various parts of the Site shall be as proposed by the Contractor in his Bid and approved in the Letter of Acceptance or as otherwise approved by the Engineer.

The Contractor shall design and install the electrical power supply system in accordance with the requirements of the relevant Vietnamese codes of practice and the requirements of the power supply authority.

1.8.4.3 Telecommunication System

(a) General

The contractor shall supply, install and maintain telephone (fixed line and mobile) and facsimile facilities for the purposes of communication between the Engineer and the Contractor and in the various parts of the site.

(b) Telephone Requirements for Engineer's Office

Three external lines shall be provided to the Engineer's site office for the exclusive use of the Engineer. All external lines shall be capable of international direct dialling.

Separate metering shall be provided for the external lines and the Contractor may charge the Employer for international calls but not for calls made within Vietnam.

(c) Telephone Requirements for the Contractor's Site Office

The Contractor shall provide the quantity and type of communications facilities he deems necessary for the execution of the Works which shall not be less than two external telephone lines.

(d) Payment

Separate payment will not be made for complying with the requirements of this Sub-Clause and all costs shall be deemed to be included in the lump sum price for Establishment in the Bill of Quantities.

1.8.5 Temporary Roads and Bridges

1.8.5.1 General

The Contractor shall construct and maintain temporary access facilities, including haul and access roads, bridges, jetties and the associated drainage and watercourse crossing facilities necessary for the execution of the Works.

The Contractor shall make the necessary arrangements with the appropriate Local Government Authorities and private landowners where new temporary access and haul roads are required through private land.

Not less than thirty (30) days before the Contractor intends to commence construction of any part of the temporary construction roads, the Contractor shall submit to the Engineer for approval a detailed construction plan including:

(a) The location and design of the temporary construction roads, including the associated drainage; and

(b) The construction method and construction time schedule of such temporary construction roads,

The location of these roads shall be in accordance with the Contractor's proposals submitted with his Bid and approved in the Letter of Acceptance or as otherwise approved by the Engineer.

1.8.5.2 Design Requirements for Temporary Roads and Bridges

The temporary construction roads shall be designed so as to generally have a driveway width of not less than 6.0 m

The Contractor shall provide a gravel pavement or other measures in stretches where trafficability is in the opinion of the Engineer, not sufficient for the efficient transportation of Contractor's Equipment and materials.

Where the temporary construction roads cross existing watercourses, the Constructor shall provide an appropriate section of concrete or steel pipe or other means to allow water discharge. The Contractor shall be responsible for the repair at his own expense of any damage to the temporary construction roads caused by the passage of heavy equipment and trucks used by the Contractor or his subcontractors for the execution of the Works. On the completion of the Works, such temporary construction roads shall be removed and the land restored to its original condition to the satisfaction of the Engineer.

1.8.6 Contractor's Site Office and Facilities

1.8.6.1 General

The Contractor shall provide, maintain and operate the Contractor's Site office and construction facilities which include, among other things, staff quarters, warehouse, workshop, laboratory, labour camp and other temporary buildings and facilities necessary for the execution of the Works, and shall remove them upon the completion of the Works except as otherwise specified in the Contract or directed by the Engineer. The Contractor shall be solely responsible for providing the land for his site office and facilities.

The Contractor shall submit revised Drawings showing the site, layout plans and general particulars of such temporary buildings and facilities to the Engineer for his approval. The construction of any buildings or facility shall not be started until the Contractor's proposals have been finally approved by the Engineer.

1.8.6.2 Construction Camp

The Contractors shall construct his construction camp as proposed in his Bid and approved in the Letter of Acceptance. It shall include housing camps and other facilities and amenities for his employees and for the employees of his subcontractors.

The Contractor's staff quarters and labour camp shall be provided with all the necessary services for drainage, electricity, lighting, roads, paths, parking spaces, fencing, sanitation including sewage treatment, water supply, kitchen, fire prevention and fire fighting equipment.

1.8.6.3 Contractor's Site Office

The Contractor shall provide the Site office as soon as the preparatory work at the Site takes place. The Site office shall be constructed with all the necessary facilities for drainage, lighting, sanitation, parking spaces, etc.

1.8.6.4 Completion of Contractor's Site Office and Construction Facilities

The Contractor shall notify the Engineer in writing as soon as the temporary buildings and facilities have been constructed and are ready for operation. The Engineer shall certify that such buildings and facilities have been constructed in accordance with the approved plans.

1.8.7 Engineer's Site Office

1.8.7.1 General

The Contractor shall design, construct, operate, maintain and demolish after completion of the Works, the Engineer's site office.

The office shall have a gross floor area of not less than 220 m^2

The Engineer's site office shall be constructed at a location in close proximity to the Contractor's office and shall comply with the general design requirements included or referred to in the Appendix to the General Specification.

The buildings shall be fully air conditioned and provided with the utility services as specified in Sub-Clause 1.8.4. and with the furniture and office equipment listed in the Appendix to the General Specification

1.8.7.2 Technical Requirements and Standards

The Engineers Office shall be constructed to a good quality standard and shall be fit for its intended purpose. All work shall comply with Vietnamese Codes, Standard and local Authority requirements.

1.8.7.3 Submissions

The Contractor shall make detailed proposals for the provision of the facilities included in Sub-Clause 1.8.7 in the form of detailed design Drawings, schedules of finishes, materials lists, construction programme and specifications, all of which shall be subject to the Engineers approval. Procedures shall be in accordance with Sub-Clause 1.3.

1.8.7.4 Time for Completion

The Engineer's Site Office shall be completed within 3 months of the Commencement Date

1.8.7.5 Maintenance and Operation

The Contractor shall ensure that the Engineer's Site Office and Facilities are at all times maintained in good order and provided with the utility services specified in Sub-Clause 1.9.4.

1.8.7.6 Removal and Hand-over

At the conclusion of the Contract the Contractor shall remove all of the buildings and facilities provided under this Clause and reinstate the area to the satisfaction of the Engineer and all items of furniture and equipment shall be handed over to the Employer.

1.8.7.7 Alternative Option of Rented Office Space

As an alternative to the above, the Contractor may propose to provide equivalent rented office space in a modern, air conditioned building in Ben Me Coc, Ho Chi Minh City. Acceptance of an alternative option is at the sole discretion of the Engineer.

1.8.7.8 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.8.7 and all costs shall be deemed to be included in the lump sum price for Establishment in the Bill of Quantities.

1.8.8 Transport Facilities for the Engineer

1.8.8.1 General

The Contractor shall provide transport facilities as specified hereunder for the exclusive use by the Engineer and his staff for the purpose of construction supervision throughout the duration of the Contract commencing within 56 days of the issue of the Letter of Acceptance.

The transport facilities shall include the following:

(a) One (1) New, four-door four- wheel drive, Toyota Land Cruiser or equivalent including driver;
(b) One (1) New two-wheel drive Toyota Previa van or equivalent
(c) Two (2) New Honda Dream motor cycles or equivalent.

The Contractor shall arrange for payment of all vehicle registration and comprehensive insurance fees for each vehicle.

All vehicles shall be registered and ownership shall be vested with the Employer.

In the event that the above facilities cannot be provided within the said 56 days, the Contractor shall arrange temporary vehicles for the Engineer's use for interim period until the specified facilities have been provided.

Following completion of the Contract the vehicles shall be handed over to the Employer in good condition.

1.8.8.2 Maintenance of the Engineer's Transport Facilities

The Contractor shall arrange to service and repair vehicles at regular intervals in accordance with the manufacturers' recommendations and provide all necessary spare parts to maintain the vehicles in a proper and safe running condition.

All consumables, including fuel, oil, filters, etc., required for the vehicles shall be provided by the Contractor.

If any vehicle requires maintenance for a period exceeding 2 days, the Contractor shall provide an alternative vehicle to the vehicle being repaired for the use of the Engineer.

1.8.8.3 Measurement and Payment

Payment for the provision of transport of the Engineer shall be made at the Lump Sum Price entered in the Bill of Quantities and shall include full compensation for the cost of providing the vehicles, drivers, maintenance, insurance, consumables and any other incidental costs.

Payment shall be made as follows:

60 % of the lump sum shall be paid upon delivery of all of the specified vehicles

The remaining 30 %, representing operation cost, shall be made in uniform monthly payments over the duration of the Contract.

1.8.9 Engineer's Accommodation

1.8.9.1 General

The Contractor shall provide accommodation for the Engineer commencing 28 days after the date of the Letter of Acceptance and extending to the date of Completion plus 1 month in accordance with the following requirements.

Type of Accommodation:	One (1) two-bedroom, fully-furnished, air conditioned, serviced apartment
Location:	Located in a modern apartment building situated in District 1, 2 or 3 of Ho Chi Minh City

1.8.9.2 Payment

Payment shall be made at the monthly rate entered in the Bill of Quantities which shall be full compensation for all cost of providing the said accommodation.

1.8.10 Garbage Disposal

1.8.10.1 Scope

The Contractor shall undertake the collection of and disposal of all garbage from within the Contractor's Site office, the Contractor's Temporary Facilities, the Engineer's Site office and other areas used in connection with the Works. Garbage collections shall be made at least twice each week and shall continue until completion of the Works.

Garbage shall be disposed of in a manner acceptable to the relevant local authority.

1.8.10.2 Payment

Separate payment will not be made for the provision for garbage disposal and the cost of this work shall be deemed to be included in the lump sum price entered in the Bill of Quantities for Establishment.

1.8.11 Maintenance of Existing Public Roads

1.8.11.1 General

The Contractor shall maintain all roads within the vicinity which he uses for purposes of carrying out the Works required by this Contract

1.8.11.2 Contractor's Operations

If the Contractor's operations obstruct or hinder the passage of traffic on the roads described in Sub-Clause 1.8.11, the Contractor shall provide and maintain for the duration of such disruption an alternative route, approved by the Engineer, of a standard not less than that of the road so affected.

Existing roads and bridges have load limits which the Contractor shall be responsible for determining. Before moving any heavy construction traffic into highways, roads, and bridges, the Contractor shall make suitable arrangements with the relevant authorities and obtain their approval for the passage of such traffic.

The Contractor shall not travel tracked vehicles or equipment on any bituminous sealed road surface. Rubber-tired vehicles conforming to applicable load restrictions will be permitted to use bituminous sealed road surfaces.

All the work of improvements or modifications on the existing public roads made by the Contractor for his own convenience shall be at the Contractor's own risk and expense.

1.8.11.3 Maintenance of Roads

The Contractor shall nominate public roads to be used by him during the execution of the Works in his construction plan. Prior to the commencement of the use of such roads, a joint inspection shall be carried out by the Engineer and the Contractor to document their conditions.

All damage caused by the Contractor's operations to the nominated roads shall be promptly repaired by the Contractor. At the end of the use by the Contractor of any particular section of public road, or completion of the Contract, whichever is the earlier, the Contractor shall ensure that the nominated roads used by him are reinstated to a condition equal to or better than the condition documented in the pre-commencement joint inspection referred to above. All expenses relating to the maintenance of public roads shall be borne by the Contractor.

In fulfilling his obligation for maintaining roads the Contractor shall:

(i) reinforce to pass his traffic, if necessary, and keep in good working condition at all times all road structures, bridges, culverts, drains and other waterways;

(ii) patch potholes with approved materials, keep the road surfaces in good repair, and perform all grading and necessary resurfacing;

(iii) maintain all fenders, posts, guideposts, guard posts, rails, fencing, signs, signposts and other roadside structures;

(iv) keep road surfaces and shoulders free from all earth, mud, stones, timber, rubbish, and other debris and materials removed from the Works;

(v) adequately maintain cut-slopes and fill-slopes of the roads and appurtenant drainage ditches; and

(vi) keep the road surface watered where dust is likely to be a safety or health problem.

1.8.11.4 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.8.11, and the cost of this work shall be deemed to be included in the various rates and lump sum prices entered in the Bill of Quantities.

1.9 UTILITY SERVICES SURVEY

1.9.1 General

The precise location of existing underground utility services is not known. The Contractor shall be responsible for determining the location and protection of all such underground services and shall be responsible for the cost of reinstating any utility service damaged by him during the execution of the Works.

1.9.2 Scope of Work

Prior to commencement of any part of the Works, the Contractor shall consult with the relevant public authorities, utility companies or private owners about existing utility services. With consent, and in the presence, of the pubic authorities, utility companies, private owners and the Engineer, the Contractor shall excavate, by hand, test pits to identify the type, size, level, location, direction and number of underground utility services.

Following determination of the presence and location of such utility services, the Engineer may direct minor relocation of the Permanent Works.

All exploratory pits or trenches shall be backfilled in accordance with the requirements of Section 3, Earthworks, and a temporary pavement comprising 200 mm gravel and 30 mm asphalt concrete shall be constructed to the approval of the Engineer.

1.9.3 Measurement and Payment

1.9.3.1 Test Pits

Measurement shall be made of the volume of test pits excavated and subsequently backfilled.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for consulting with public utility authorities and private owners, excavating test pits and their backfilling on completion and shall include the cost of all materials, labour and equipment and all other things necessary to complete the work.

1.9.3.2 Reinstatement of Road

Measurement shall be made of the area of road reinstated.

Payment shall be made at the rate entered in the Bill of Quantities which shall include the cost of all material, labour and equipment to construct the temporary pavement.

1.10 SOIL INVESTIGATION

1.10.1 General

The Contractor shall, when directed by the Engineer, carry out test drilling with core recovery and in situ testing for the purpose of determining sub-surface geological conditions at piling sites or elsewhere within the Site. The locations, directions and depth of each test drilling shall be as directed by the Engineer.

1.10.2 Soil Tests Required

In situ and laboratory testing and the relevant standards to which tests shall be performed shall be in accordance with the following:

TEST	TESTING FREQUENCY
Standard Penetration (ASTM D 1586) 2m	every 1 m
Vane Shear Test (ASTM D 2573)	every 5 m
Specific Gravity (ASTM D 854)	every 5 m
Natural Water Content (ASTM D 2216)	every 5 m
Grain Size Analysis (ASTM D 422)	every 5 m
Liquid Limit Test (ASTM D 423)	every 5 m
Plastic Limit Test (ASTM D 424)	every 5 m
Wet Density Test (Calliper method)	every 5 m
Unconfined Compression (ASTM D 2166)	every 5 m
Consolidation Test (ASTM D 2435)	every 5 m

1.10.3 Reporting

Upon completion of testing, the Contractor of shall prepare and submit to the Engineer five (5) copies of a Soil Testing Report in a format to the Engineer's approval.

1.10.4 Measurement and Payment

Payment test drilling will be made at the unit rate per metre depth of bore hole entered in the Bill of Quantities, which rate shall constitute full compensation for the cost of all labour, tools, equipment and materials for the test drilling, performing standard penetration tests, vane tests, recovering cores, laboratory testing, analysis, preparation of report, and all other items necessary to complete the work.

1.11 SAFETY, HEALTH CONTROL AND SECURITY

1.11.1 General

The Contractor shall be responsible for all safety, health controls and security and shall submit to the Engineer details of the organization and regulations for these purposes.

1.11.2 Safety Precautions

1.11.2.1 General

The Contractor shall comply with any safety instruction given by the Engineer. In the performance of the Works, the Contractor shall exercise every reasonable precaution to protect from injury persons or property. The Contractor shall erect and maintain all necessary temporary fencing, barricades, barriers, signs and lights and provide fire alarm, fire extinguishing and fire fighting services at strategic points on the Site and adequate ventilation, lighting and safe working conditions for his workmen engaged in the performance of the Works. The Contractor shall adopt and enforce such rules and regulations as may be necessary and desirable in the work and in its supervision. Safety measures shall include but shall not be limited to those measures mentioned in this Clause.

1.11.2.2 Safety Officer

In amplification of the requirements of the General Conditions of Contract Part II, Sub-Clause 34.10, the Contractor shall constantly employ during the progress of the Works an employee qualified in safety, and familiar with the type of work being performed, whose assignment shall include initiation of measures for the protection of health and the prevention of accidents and who shall see, by personal inspection, that all safety rules and regulations are enforced. The Contractor shall hold regularly scheduled safety meetings at least once each month with his engineers, supervisors and foremen and, when directed, with the Engineer. The Contractor shall keep the Engineer advised as to when these meetings are to be held and shall provide the Engineer with a copy of the proposed agenda.

1.11.2.3 Temporary Fencing

The Contractor shall erect, maintain and remove suitable and approved temporary fencing to enclose such areas of the Permanent Works and areas of land occupied by the Contractor within the Site as may be necessary to implement his obligations under the Contract in approved manner. Where any temporary fence has to be erected, it shall be of the type required by and shall be erected to the satisfaction of, the Government authority concerned.

1.11.2.4 Lighting

(a) In the event of night work being carried out, the Contractor shall provide sufficient lighting to ensure that in all places where work is in progress :

  (i) safe working conditions are provided for the Contractor's personnel and the Engineer;

  (ii) the Works can be constructed in complete compliance with the Contract; and

  (iii) a complete inspection of all Works in progress can be made by the Engineer.

(b) Unless otherwise directed by the Engineer, the minimum illuminance on ground or working surfaces to be provided for the various operations or work areas shall be as tabulated below :

ILLUMINANCE		
OPERATION OR AREA	**Design Value (Lux)**	**Minimum Measured Value (Lux)**
Construction Site in General	50	20
Concrete placing	100	50
Maintenance shops and Auxiliary Buildings	300	200
Maintenance shops and Auxiliary Buildings	300	200
Underground Works	100	50

(c) All moving equipment or plant used during night operations shall be equipped with sufficient lights and reflectors.

(d) Not less than fourteen (14) days before the start of any night operations, the Contractor shall submit to the Engineer his proposals for lighting in the areas in which he proposes to work at night. The Contractor shall modify the proposals if directed and shall not begin operations at night, until the proposals for lighting have been approved.

(e) The submission to or approval by the Engineer of the Contractor's proposals for lighting shall not relieve the Contractor of any of his liabilities or obligations under the Contract.

1.11.2.5 Signs

(a) The Contractor shall provide all necessary signs for the Works. These shall include, but not be limited to

- standard road signs;
- warning signs;
- danger signs;
- control signs;
- safety signs; and
- direction signs.

(b) Wording on all signs shall be in the Vietnamese and English languages. The size, colour, lettering and location of all signs will be subject to approval, and attention shall be paid to international system of signs.

(c) The Contractor shall maintain all signs placed by himself as well as those placed by the Employer.

(d) If the Engineer considers 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 Engineer.

1.11.2.6 Other Safety Measures

(a) When working in the vicinity of electrical equipment and in the interest of safety and security, the Contractor shall complete the erection of any

safety fencing around electrical and mechanical equipment by the time that the said apparatus is connected to any electrical supply.

(b) Use of Lasers - The use of lasers on the Site shall be done with due regard to eye hazard and all personnel working on the site shall be warned accordingly.

(c) Safety instructions - Within 56 days of receiving the notice to proceed the Contractor shall, at his own cost, supply and issue to his employees, those of his subcontractors and the Engineer, in English, Vietnamese and in other languages used by his employees at the Site, a booklet containing safety regulations based on good practice. The booklet shall be pocket size and issued to each person employed at the Site. Proof copies of the booklet shall be submitted to the Engineer for approval before printing and amendments shall be made to the booklet to his entire satisfaction. The Contractor shall issue the booklet immediately after printing and ensure that all employees are fully conversant with the instructions. Safety instructions shall deal with all safety including but not limited to the following items where relevant to the Works :

(i) protective clothing, headgear and footwear;
(ii) use of lifting equipment;
(iii) earthmoving;
(iv) formwork and reinforcement erection;
(v) concreting;
(vi) routine for accidents or fires; and
(vii) watchman, warning notices and barriers
(viii) electrical safety;
(ix) welding and painting.

The Contractors shall allow for ten (10) booklets in the English language for the use of the Engineer.

(d) Accident Report - The Contractor shall promptly report to the Engineer, in a form to be prescribed, all accidents involving death or serious injury to staff or workmen, and shall furnish monthly reports of all accidents to staff or workmen involving loss of time, giving such information as may be directed.

1.11.2.7 Provision of Safety Equipment

All persons employed on the Works are to be provided with safety equipment appropriate to the tasks upon which the are engaged such as helmets and safety equipment shall be compulsory as deemed necessary by the Engineer.

1.11.2.8 Payment

Separate payment will not be made for complying with the provisions of Sub-Clause 1.11.2 and all costs shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities.

1.11.3 Sanitary Arrangements

1.11.3.1 Scope of Work

The Contractor shall keep the Site in a clean and hygienic condition, and shall provide and maintain sanitary conveniences for use of the persons employed in the Works to the extent, in the manner and at such places as approved by the Engineer and by any Government health authority concerned. All persons connected with the Works shall be enjoined to use these conveniences. Sewage shall be disposed of in a hygienic manner.

1.11.3.2 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.11.3 and all costs shall be deemed to be included in the item in the Bill of Quantities for Establishment

1.11.4 Fuel Storage

1.11.4.1 General

(a) The Contractor shall make arrangement for the transportation, storage and handling of fuels in a safe manner to protect the public in accordance with the laws and security regulations of the Socialist Republic of Vietnam.

(b) Above-ground gasoline and liquefied petroleum gas storage tanks shall not be located within 100 meters of any building.

1.11.4.2 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.11.4 and all costs shall be deemed to be included in the item in the Bill of Quantities for Establishment.

1.11.5 Fire Prevention

1.11.5.1 General

The Contractor shall take every precaution to prevent fire occurring on or about the Site. The Contractor shall comply with the laws and regulations of the appropriate Government authority relating to fires and shall provide fire fighting equipment, which the Engineer considers to be suitable and adequate, ready to use in all structures, buildings or the works under construction, including his labour camps and ancillary buildings. The Contractor shall maintain such equipment and such additional fire fighting equipment as may be required, in good working condition until the Works are accepted by the Employer.

The Contractor shall extinguish promptly any fire which may occur on the Site wherever the fire may originate. In this regard, he shall employ all requisite equipment and manpower for fire fighting up to the limits of his equipment and manpower employed at the Site including the equipment and manpower of his subcontractors.

1.11.5.2 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.11.5 and all costs shall deemed to be included in the various rates and lump sums entered in the Bill of Quantities.

1.11.6 Earthing

1.11.6.1 General

All appliance and facilities which are possibly subject to lightning strikes shall be electrically grounded and the effectiveness of such grounding shall be periodically checked by the Contractor.

1.11.6.2 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.11.6 and all costs shall deemed to be included in the various lump sums and rates entered in the Bill of Quantities.

1.11.7 Medical and Health Services

1.11.7.1 General

(a) The Contractor shall provide a person qualified in first aid at all working hours on the Site.

(b) The Contractor shall provide a first aid unit on the Site for treatment of casualties in conformity with the requirements of all duly constituted medical and health authorities. The Contractor shall provide such first aid units and shall responsible for and bear all costs in connection with the first aid services including removal by ambulance of injured or sick employees to hospital in Ho Chi Minh City or other places.

(c) The Contractor shall provide first aid services for the Employer's and Engineer's staff working on the Site.

1.11.7.2 Payment

Separate payment will not be made for medical and health facilities provided by the Contractor for his employees, for his subcontractors and the Employer's and Engineer's staff, as required by this Clause, and all costs shall deemed to be included in the various rates and lump sums entered in the Bill of Quantities.

1.11.8 Security

1.11.8.1 Responsibility of the Contractor

(a) The Employer will specify overall security requirements for the project and the Contractor shall perform to such requirements and be responsible for such action of his personnel in respect of such requirements.

(b) The Contractor shall be responsible for the security of the Works and the at Site and shall provide and maintain continuously and adequate security force to fulfil these obligations. The duties of the Contractor's

security force shall include, but not be limited to, maintenance of order on the Site, provision of all lighting, fencing, guards, flagmen, all other measures necessary for the protection of the Works within the Site, all material delivered to the Site, the public, and all persons employed in connection with the Works, continuously throughout working and non-working periods, including nights, Sundays and holidays, for the duration of the Contract.

1.11.8.2 Payment

(a) Separate payment will not be made for the provisions of security services and all costs shall be deemed to be included in the various rates and lump sum prices entered in the Bill of Quantities.

1.12 SURVEY AND MEASUREMENT OF THE WORKS

1.12.1 General

1.12.1.1 Bench Mark and Reference Points

Reference points have been established on the Site by the Employer as shown on the Drawings or as advised by the Engineer. The Contractor shall use the co-ordinates and elevations of such reference points in setting out the Works. Any reference points damaged as the result of action by the Contractor shall be replaced by the Contractor at his own expense.

The Contractor may establish temporary reference points for his own convenience but each point shall be of a design and at a location approved by the Engineer. Each point shall be accurately related to the points established by the Employer.

1.12.1.2 Responsibility for Setting Out

The Contractor shall be solely responsible for the correct setting out of the Works and shall employ experienced and qualified surveyors approved by the Engineer.

The Contractor shall furnish all materials, labour and equipment including stakes, templates, patterns, platforms and special labour that may be required by the Contractor in setting out any part of the Works. The Contractor shall use survey equipment of the type and accuracy to permit correct setting out and control of the Works.

Before performing the pre-construction surveys the Contractor shall give the Engineer at least 7 days notice before commencing such survey in order that the Engineer or his representative can witness and verify levels and other data so determined. The original surface level determined shall be subject to the Engineer's approval.

The Contractor shall co-operate with the Engineer in checking the setting-out and in performing the measurement surveys for record and payment purposes. The Contractor shall render all necessary assistance to the Engineer and shall provide, as required for the use of the Engineer, sufficient quantities of pegs, poles, straight edges, stagings, moulds, templates, profiles, survey assistants, labourers and transport (including boats where required) for checking the Contractor's setting-out and for measurement of the Works.

1.12.2 Survey Data and Calculations

The Contractor shall submit all survey data, information, calculations, results and records to the Engineer as soon as they are available.

1.12.3 Payment

Payment for surveying shall be made at the lump sum entered in the priced Bill of Quantities. Monthly progress payments shall be made in proportion to the progress of the Work.

1.13 OTHER ITEMS

1.13.1 Information Board

The Contractor shall provide three free-standing boards for the purpose of providing information in English and Vietnamese about the project to the public.

The boards shall be not less than 2500 x 2500 and shall be of galvanized steel construction. The lower edge of the board shall be 1200 above adjacent ground level and shall be mounted on suitable posts with struts in concrete footings. The paint to be used shall be sunshine resistant. The Contractor shall be responsible for the repair and maintenance of the boards until completion of the Works.

The information to be dsplayed and the locations shall be directed by the Engineer and the design of the supporting structures shall be subject to the Engineer's approval.

1.13.2 Securities and Insurance

1.13.2.1 Performance Security and Advance Payment Security

The Contractor shall furnish an Advance Payment Security and a Performance Security and in accordance with Sub-Clauses 60.7 and 10.1 of the Conditions of Contract to ensure the refund of the Advance Payment and for the due performance of the Contract respectively.

1.13.2.2 Insurance

The Contractor shall effect certain insurances relating to the Contract in accordance with of the Conditions of Contract.

In handling compensation to workmen under the above Clauses, the Contractor shall arrange that any compensation amount determined shall be paid without delay by the Contractor to the workmen entitled to such compensation irrespective of the time for payment of insured amount from the Insurance company to the Contractor.

1.13.2.3 Payment

Separate payment will not be made for complying with Sub-Clause 1.13.2 and the Conditions of Contract and all costs shall be deemed to be included in the rates and lump sums for the various items entered in the Bill of Quantities.

1.13.3 Audits by the Employer

1.13.3.1 General

The Employer shall be entitled at his discretion to conduct audits as necessary for his own investigation in connection with :

Costs incurred in the event of termination of the Contract as provided in Clause 65 and 66 of the Conditions of Contract;

Other costs that the Contractor may claim to the Employer, which are not specifically covered by the terms of the Contract.

1.13.3.2 Records

The Contractor is obligated to keep accurate and up-to-date accounts and records concerning the above items.

1.13.3.3 Payment

Separate payment will not be made for complying with the requirements of this Clause and all costs shall be deemed to be included in the rates and lump sums entered in the Bill of Quantities.

1.13.4 Liquidated Damages

1.13.4.1 Amount of Liquidated Damages

If the Contractor should fail to complete the Works within the Time of Completion as stated in the Appendix to Bid, the Contractor shall pay to the Employer liquidated damages pursuant to Clause 47 of the Conditions of Contract.

1.13.4.2 Maximum Damages

The maximum amount of liquidated damages payable or allowable to the Employer will be limited to the amount stated in the Appendix to Bid.

1.13.4.3 Other Rights of the Employer

Nothing contained in this Clause shall prejudice or affect any other rights of the Employer under the Contract.

1.13.5 Monthly Statement

1.13.5.1 General

The Contractor shall submit a monthly statement in accordance with the requirements of Clause 60 of the Conditions of Contract. The monthly statement shall be accompanied by copies of all survey notes, records of measurements and calculation which the Engineer has directed to be prepared by the Contractor in support of the amounts claimed for the work executed.

1.13.5.2 Payment

All costs associated with the submission of the monthly statement shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities.

1.13.6 Hours and Days of Working

Before commencement of work on the Contract, the Contractor shall notify the Engineer, in writing, of the days, hours and of the number of shifts that he proposes to work and shall give at least 48 hours notice to the Engineer of any changes to such hours of working and/or number of shifts that may be necessary during the currency of the Contract.

1.13.7 Prevention of Water Pollution

1.13.7.1 Scope

The Contractor's construction activities shall be performed by methods that prevent entrance or accidental spillage of solid matter, contaminants, debris and other objectionable pollutants and wastes into streams, flowing or dry water courses and underground water sources. Such pollutants and wastes include but not restricted to refuse, garbage, cement, concrete, sewage effluent, industrial waste, oil and other petroleum products. The Contractor shall submit his plan showing the location and design of the water pollution prevention systems and facilities to the Engineer for approval.

1.13.7.2 Payment

Separate payment will not be made for complying with the provisions of this Clause, and the costs shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities.

1.14 MEASUREMENT AND PAYMENT (GENERAL)

1.14.1 General

The method of measurement shall be in accordance with the methods and procedures stipulated in the particular Clauses and as set forth herein.
The various unit rates and lump sums for each work item entered in the Bill of Quantities shall be deemed to have included full compensation for supplying all materials, labour, equipment consisting of owning, operation and repair costs, and other expenses necessary to complete the work in accordance with the Drawings, the Specifications, the instructions of the Engineer and compliance with all other obligations, including rectification of defects, as required under the Contract.

1.14.2 Measurement and Tolerances

This Clause explains the tolerance for measuring the dimensions of the work and the method of calculation of the quantity of the work completed in the following categories:

Category - 1 (linear metres, m)

The work item shall be measured to the second decimal place of a metre and be approved by the Engineer at every work stage on an inspection sheet.

The amount of payment will be determined by multiplying the measured length by the unit rate and then rounding the result to the nearest integer.

Category - 2 (square metres, m2)

The work item shall be measured to the second decimal place of a square metre by multiplying the two dimensions, measured to two decimal places,

and rounded off, and approved by the Engineer at every work stage on an inspection sheet.

The amount of payment will be determined by multiplying the measured area by the unit rate and then rounding the result to the nearest integer.

Category - 3 (Hectare, ha)

Not used

Category – 4 (cubic metres, m3)

The work item shall be measured to the second decimal place of a cubic metre by multiplying the three dimensions, measured to two decimal places of a metre, and rounded off and approved by the Engineer at every work stage on an inspection Sheet.

The amount of payment will be determined by multiplying the measured volume by the unit rate and then rounding the result to the nearest integer.

Category - 5 (Lump Sum Item)

The method of measurement and payment shall be as set out in the respective payment Clause for each of the following items for which payment is by lump sum.

Category - 6 (mass)

(a) (Mass in kg)

The work item shall be measured to the second decimal place of a metre and multiplied by the approved mass per metre at every work stage on an inspection sheet.

The amount of payment will be determined by multiplying the calculated quantity by the unit rate and then rounding the result to the nearest integer.

(b) (Mass in tonne, Note: 1 tonne = 1000 kg mass)

The mass shall be determined by reference to delivery notes from the specialised supplier, duly approved by the Engineer or his representative, to the accuracy of the third decimal place of a tonne (1 kg).

The amount of payment will be determined by multiplying the approved quantity by the unit rate and then rounding the result to the nearest integer.

Category - 7 Number (No.)

The work item shall be measured to the exact number of items installed (or item of work performed) and approved by the Engineer at every work stage on an Inspection Sheet.

The amount of payment will be determined by multiplying the number by the unit rate.

Category – 8 Litre

The volume shall be determined by reference to dip sticks before and at the end of spraying work and shall be recorded on an inspection sheet and approval by the Engineer at every stage of the work.

The amount of payment will be determined by multiplying the whole number of litres by the unit rate.

Category – 9 Month

The applicable time shall be measured in months. Fractions of a month shall be calculated on the basis of 1 day equal 1/30 month.

The amount of payment will be determined by multiplying number of months, expressed to 3 decimal places by the unit rate.

APPENDIX: REQUIREMENTS FOR ENGINEER'S OFFICE

Location	For a purpose-built office, in close proximity to the Contractor's office; for rented office space, in District 8 at a location subject to the Engineer's approval
Gross Area (minimum)	220 m^2
Air Conditioning	Required throughout
Utility Rooms	Kitchen fitted with sink and tea and coffee making facilities, Male and female toilets Store room fitted with shelving
External Works	Paving, lighting, car parking area, security fencing
Office Furniture and Equipment, general	All shall be new and of good quality
Office furniture required	Desks with lockable drawers complete with chairs for 20 persons Meeting table with 10 chairs Book shelves (4 units) Filing cabinets (4 units)
Equipment Required	10 Desktop computers (IBM-type, 700 MHz or greater, 128 Mb DRAM, 30 GB Hard disk plus all devices for network operation) 1 Server (complete with all necessary software) and local area network connecting all computers and output devices. Each desktop computer shall be loaded with the following software: • Microsoft Windows latest version. • Microsoft Office latest version • Virus Protection Program latest version • AutoCAD latest version • Any other software necessary for proper network operation 1 Laser Jet Printer capable of printing A3 size, complete with all accessories and consumables 1 Inkjet Plotter capable of plotting A1 size Drawings complete with all accessories and consumables 1 Inkjet Colour Printer capable of printing A3 size 1 Photo copy machine of commercial quality capable of copying A3 size and collating 1 facsimile machine 1 Potable water cooler/dispenser Miscellaneous office equipment including hole punches, scissors, staplers etc.

DIVISION B

TECHNICAL SPECIFICATION

SECTION 2. PREPARATORY WORKS
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SECTION 2. PREPARATORY WORKS

2.1 GENERAL

This section covers the general and specific requirements for preparatory works including care of water, clearing and grubbing and demolition works to be carried out for construction of various works in Package D.

2.2 CARE OF WATER

2.2.1 General

The Contractor shall be responsible for the removal of all water encountered during the execution of the whole of the Works.

The Contractor shall design, construct and maintain all temporary diversion and protective works which are necessary for construction and to prevent surface, drainage and groundwater from entering excavations and shall furnish all materials required therefor.

The Contractor shall be responsible for and shall repair, at his expense, any damage to foundations, excavation slopes or any other parts of the Works caused by water, floods or by his failure to protect the Works in accordance with the requirements of this Clause

2.2.2 Dealing with Water

Where it is required that construction shall proceed with flow of water in rivers, canals, sewers etc. it shall be necessary to isolate the site of the structure to be constructed from the flow of water. Suitable coffer dams, canals, flumes, drains or other temporary diversion and protection works shall be constructed without interruption or interference with the flow of water in the rivers, canals, sewers etc. The Contractor shall construct sufficient temporary works as described above to deal adequately with surface and groundwater sources to enable the construction of the Permanent Works to the satisfaction of the Engineer.

Where it is required to work in an operational sewer or connection to existing sewer, it will be necessary to divert the existing flows in the sewers to isolate the working area. Where gravity diversion is not possible, the Contractor may be required to utilize over pumping at these locations.

The Contractor shall submit for the approval of the Engineer the location, size, diversion flow requirement and other relevant details including materials proposed for the construction of the temporary works described above. In the case of over pumping, the Contractor shall maintain one (1) stand-by pump of capacity at least equal to the largest duty pump available on site at all times. The Contractor shall include provisions for maintaining flows during rainstorms by means of over topping, removal of flow barriers or otherwise to prevent artificial flooding at the upstream locations of the particular site.

The Contractor shall submit Drawings and calculations showing his proposed method, dimensions and sizes of cofferdam construction. Approval of the Drawings and calculations by the Engineer will not in any way relieve the Contractor of the responsibility for the adequacy of the design for strength and stability or for the safety of the people working therein.

The interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction and removal of any required forms and the inspection of the interior and to permit pumping outside the forms.

Cofferdams that tilt or move laterally during construction shall be corrected as necessary at the expense of the Contractor. In case the structure is damaged it shall be repaired as directed by the Engineer at the expense of the Contractor.

Unless otherwise provided, cofferdams shall be removed after the completion of the structure in a manner so as not to disturb or mar the finished work.

2.2.3 Removal of Water

Much of the Works are located below the normal water level in the Saigon River or canals (which are tidal) and removal of water from excavations is required in order to carry out all construction operations under dry conditions. The Contractor's method of removal of water from foundation excavations shall be subjected to the approval of the Engineer.

Subject to approval of the Engineer, water from excavations shall be disposed of by pumping or gravity diversion directly to the canals or river.

Before commencement of excavation for foundation works for the structures of the Works and/or related structures, the Contractor shall submit the method for removal of water, installation and details of the proposed dewatering system he proposes to use.

Any dewatering system adopted by the Contractor shall be operated in such a way that the groundwater level outside the excavation is not reduced to the extent that would cause damage or endanger adjacent structures or property or loss of fines from adjacent ground which could cause adverse effects.

The Contractor shall be required to ensure that the bottom of excavations are free of water prior to placement of concrete or embankment/filling material. Such controls may require supplementary approved dewatering methods by the use of perforated pipe or under drains leading to sumps from which water shall be pumped. The water pumped out from the foundation shall be diverted directly to the river/canals or through existing drains or pipes without allowing it to flow overland causing inundation of properties, etc.

Cofferdams shall be constructed so as to protect newly cast concrete from sudden rising of the water and to prevent damage to the foundation by erosion.

Pumping and dewatering from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through or alongside any concrete being placed. No pumping or dewatering will be permitted during the placing of concrete nor for a period of at least 24 hours thereafter unless it is done from a suitable sump separated from the concrete work by a water tight wall. The wall shall be extended sufficiently far below the bottom of the sump so that no material from the concrete can penetrate into the well. The design of this sump shall be made to the Engineer's satisfaction.

Excavations shall be kept dry down to at least 100 mm below foundation level prior to and during placing concrete. Placing concrete under water will only be permitted if indicated on the Drawings or permitted by the Engineer.

2.3 CLEARING AND GRUBBING

2.3.1 General

The Contractor shall carry out clearing and grubbing of the areas directed by the Engineer in accordance with this Clause.

2.3.2 Definition of Extent

The extent of the area for clearing and grubbing shall be agreed by the Engineer prior to commencement by the Contractor.

2.3.3 Requirements

The Contractor shall remove and dispose of all stumps, veins, brush, grass, roots, vegetation, fences, rocks, masonry, trash, debris, building rubble, building foundations and other objectionable matter within the area to be occupied by the permanent works.

Where directed by the Engineer, the holes resulting from grubbing operations shall be filled with approved materials which shall be placed and compacted to the same density as the adjoining soil.

All waste materials resulting from the clearing and grubbing work shall be transported to the designated spoil disposal area then spread and buried to the approval of the Engineer.

Any combustible material shall be removed from the site and burnt. Burning on site shall not be permitted.

All salvageable materials shall remain the property of the Employer and shall be transported and stacked at locations as directed by the Engineer.

2.4 DEMOLITION WORKS

2.4.1 General

The Contractor shall carry out demolition works in accordance with the requirements of this Clause.

2.4.2 Scope

The work consists of the complete demolition and removal of existing concrete, masonry, brick and timber structures which are required to be removed for the purpose constructing sewers and roads.

2.4.3 Method of Execution

Structures to demolished shall be broken into units of sufficiently small size so as to be safely handled and removed from the site.

All waste materials resulting from the demolition work shall be transported to the designated spoil disposal area then buried to the approval of the Engineer.

Any combustible material shall be removed from the site and burnt. Burning on site shall not be permitted.

All salvageable materials shall remain the property of the Employer and shall be transported and stacked at locations as directed by the Engineer.

2.5 MEASUREMENT AND PAYMENT

2.5.1 Care of Water

The Contractor shall provide a breakdown of the lump sums for Care of Water in accordance with Sub-Clause 57.2 of the General Conditions of Contract. The breakdown shall be arranged such that it includes not more than ten (10) sub-items which can be readily recognised and measured for payment purposes.

Payment for Care of Water will be made at the lump sum price entered in the Bill of Quantities. Progress payments for work under each sub-item will be made as follows:

(a) Coffering and Dewatering

Where the approved breakdown of the lump sum includes a component for coffering and dewatering, payment shall be made for the section of coffering and for the dewatering of the its enclosed area and the subsequent removal of the section of cofferdam and all associated equipment as follows:

- 40 % on completion of the cofferdam
- 30 % on completion of all dewatering following completion of the permanent works protected by the cofferdam
- 30 % on the complete removal of the section of cofferdam to the approval of the Engineer

(b) Other Items

Other items included in the Contractor's breakdown of the lump sum for Care of Water shall be paid in proportion to their completion.

Items to be paid under this Clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.1.1 3.1.1	Care of Water	L.S.

2.5.2 Clearing and Grubbing

Measurement for payment will be made in square metres (m^2) of the area actually cleared and grubbed and approved by the Engineer.

Payment will be made at the rate entered in the Bill of quantities and include the entire cost of completing the work including materials, labour, equipment, transportation and disposal of material and all associated costs. Clearing in excess of the approved area shall not be paid for.

Items to be paid under this Clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.1.2 3.1.2	Clearing and Grubbing	m^2

2.5.3 Demolition Works

Measurement shall be made of the net volume (i.e. excluding internal voids etc.) of obstructions to the Works or other items demolished and removed in accordance with the specification and to the approval of the Engineer. Measurement shall only be made of the volume of those obstructions or items for which the Contractor has received the Engineer's instruction or approval for their demolition.

Payment shall be made at the rate entered in the Bill of Quantities which shall include the entire cost of demolishing obstructions or items consisting of any type of material, including cost of labour, equipment, transportation and disposal of demolished material and all associated costs.

Items to be paid under this Clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.1.3 3.1.3	Demolition: including hauling and disposal in designated area	m^3

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SECTION 3. EARTHWORKS

3.1 GENERAL

This section covers the general and specific requirements for earthworks to be carried out under the Contract which include, but are not limited to, excavation and backfilling of trenches for the existing combined sewer improvement works, the conveyance sewer, sewer outlet and revetment construction and for roadworks.

3.1.1 Character of Strata

The Contractor shall acquaint himself with all available data regarding earthworks and the character of strata and materials to be excavated and used as filling. He shall satisfy himself as to :

- the general circumstances at the Site of the Works
- any obstructions thereon
- his obligations for diversion and care of water
- flow of water in existing sewers
- tidal effects
- springs, subsoil and river water
- the surface of the ground
- possible subsidence of soft ground
- poor materials
- possibility of floods
- slipping clay
- running sand
- trees, brushwood, timber and debris
- floating debris
- obstructions of any kind and material of whatever nature.

Rates entered in the Bill of Quantities shall reflect the Contractor's own assessment of risk and influence that these matters may have on his costs and no subsequent adjustments shall be made to rates for any reason.

3.1.2 Earthworks to Dimensions, Lines and Levels

All earthworks shall be carried out to the dimensions, lines and levels as shown on the Drawings, or to such other dimensions, lines and levels as may be ordered by the Engineer. Dimensions and lines, which are based on or related to ground levels, shall be referred to the Engineer before commencing earthworks at any location.

For the purpose of the Specification the term original surface level shall refer to the ground or road surface as applicable, measured by the Contractor and approved by the Engineer in accordance with Clause 1.12 of the General Specification.

The Contractor shall be completely and solely responsible for setting out the works and establishing an adequate number of bench marks and reference points. Surveys to be performed by the Contractor are described in Clause 1.12 of the General Specification.

3.1.3 Method of Excavation

The Contractor shall carry out excavation in whatever material may be encountered and by any method or combination of methods he considers most suitable subject to any restrictions herein.

The Contractor shall give due consideration to the matters in Clause 3.1.1 (Character of Strata), Clause 2.2 (Care of Water) of Section 2, location and access to soil disposal areas, fill and stock pile areas and all other relevant factors.

3.1.4 Unsuitable Materials

Excavated materials which, in the opinion of the Engineer, do not meet required Specifications for fill, embankment or backfill shall not be used for such purpose and shall be transported to the designated spoil disposal area.

3.1.5 Transportation of Excavated Material

The transportation of excavated material to fill, embankment, backfilling or stockpile site or disposal of excess or unsuitable materials shall be carried out in accordance with the approved schedule of earthworks operations. The Contractor shall transport material by the most appropriate route between excavation and placement or disposal areas. Protective measures shall be made and maintained throughout the duration of the Works for the safety of operations both on-site and off-site.

When hauling by road is done, off-site loads shall be trimmed to prevent spillage. Wet materials to be hauled shall be dried sufficiently prior to loading to prevent spillage by leaking. Any damage or unsightly appearance on the surface of any road caused by the Contractor's hauling operation shall be reinstated by the Contractor at his own expense.

When hauling by barge is carried out it shall be done in accordance with the safety provisions of the General Specification.

3.1.6 Disposal of Excavated Materials

Excavated material which, in the opinion of the Engineer, is suitable for use in filling, embankment or backfill may be transported directly to its final position, stock piled, or placed as otherwise approved by the Engineer.

Unsuitable soil or surplus excavated materials shall be disposed of in the designated spoil disposal area. The Contractor shall trim and grade spoil tips to profiles, heights and levels approved by the Engineer. He shall also maintain without interruption the flow of water courses affected by tips and comply with any other arrangement at the site existing between the Engineer and any other parties involved.

3.1.7 Submittals

Pursuant to Clause 1.4.7 of Section 1 , prior to the commencement of any earthworks operation the Contractor shall submit to the Engineer for his approval method statements. Such method statements shall include, but not be limited to the following:

- Equipment to be used
- Materials to be procured and their sources and properties
- Haul routes
- Stock pile areas
- Safety measures to be taken

- Detailed drawings of all temporary works with particular attention given to the shoring of trenches and deep excavations for sewer line construction.
- Computations to support the design of temporary works
- Dewatering methods
- Lighting and ventilation to be used in deep excavations and confined spaces
- Measures to be taken to ensure that the public can safely pass the works including fencing, barriers, clearance distances for pedestrians and traffic,
- Traffic control measures
- Proposed working hours

3.2 STRIPPING OF TOPSOIL

3.2.1 General

Stripping of topsoil shall consist of the removal of all organic materials such as sod, topsoil and roots from areas where earth fill or embankment are to be constructed.

3.2.2 Method of Execution

Stripping of topsoil shall be to the depth and area limits shown on the Drawings or as directed by the Engineer. All topsoil stripped, except that as may be used or saved in accordance with the Engineer's order, shall be disposed of in the manner described for soil unfit for reuse in Clause 3.1.6. The minimum depth of topsoil stripping shall be 250 mm unless otherwise specified on the Drawings or directed by the Engineer.

3.3 EXCAVATION

3.3.1 Common Excavation

3.3.1.1 General

This Clause 3.3.1 refers to all common excavation to be carried out under the Contract and shall be read in conjunction with Clause 3.1.

Common excavation is the open-cut excavation of all materials including, but not limited to soil, sand, gravel, clay, silt, sediments, etc. excluding rock as determined by the Engineer. Any excavation without a classification of the material generally means common excavation.

The Contractor shall carry out all common excavation in whatever material may be encountered in accordance with these Specifications, Drawings and any directions of the Engineer. The Contractor shall provide and operate all necessary excavating, lifting, hauling, transport and other equipment to deal with any type of material encountered. Excavation for the various works shall be carried out to such widths, lengths, depths and profiles as shown on the Drawings, or to such other dimensions as may be ordered by the Engineer in writing.

3.3.1.2 Support of Excavation

Where necessary the sides of all excavations shall be properly shored up and supported with strutting and planking, and the sides shall be close sheeted where necessary to prevent the entry of running sand, mud and the like. Owing to space restrictions or limited right of way all excavations made for sewer construction works shall be carried out using shoring of a type and design approved by the Engineer. Excavation using battered side slopes shall not be done unless expressly approved in writing by the Engineer.

Where excavation is being carried out in trenches, pits or other confined spaces the Contractor shall give particular care to the safety of workers and shall follow the appropriate recommendations in BS 6031 – Code of Practice for Earthworks.

3.3.1.3 Inspection of Excavation

When any excavation has been completed and trimmed, the Engineer shall be informed so that he may make a formal inspection. No excavation shall be backfilled or covered with concrete until it has been inspected and the Contractor has been authorised to proceed.

3.3.1.4 Ventilation

The Contractor shall provide adequate ventilation and efficient apparatus to keep all excavations, headings and places of work free from all gasses, whether generated in the strata or otherwise, and he shall take precautions to ascertain that they are in a safe condition before allowing workmen to enter.

3.3.1.5 Excavation Beyond True Line

Where any over-excavation occurs for whatever reason or cause, unless as a result of the Engineer's direction, the Contractor shall, at his own expense, make good those excavations to the required line and level with :

a) approved material and in such manner as the Engineer may direct where the excavation is other than for concrete work; or
b) concrete of the same grade as that to be used in the true excavated shape, unless directed otherwise by the Engineer, where the excavation is for concrete work.

3.3.2 Excavation of Trenches for Sewers

3.3.2.1 General Requirements

Excavation of trenches for the purpose of sewer or stormwater pipelines shall be performed in accordance with the requirements of Clause 3.3.1 and this Clause 3.3.2.

Excavation methods and equipment to be used for trenches shall be suitable for the particular work. Trenching shall be to the lines and grades shown on the Drawings and to the required width and depth. Excavation to the final trench bottom shall be done in such a way as to leave the bottom undisturbed. All trench excavation shall be done in the dry.

No excavation of trenches shall be carried out until the Contractor's method statement has been approved by the Engineer. Approval of the Contractor's method statement shall not relieve the Contractor of his obligations or liabilities under the Contract.

3.3.2.2 Removal of Pavement

Pavement to be removed during excavations shall be cut along straight parallel lines before excavating to provide a uniform edge and minimize the amount of pavement disturbed.

Asphalt pavement shall be cut with vertical sides. Settlement and cracks in bituminous pavement are to be restored to the approval of the Engineer.

Concrete curbs shall be sawn with vertical sides in line with the sides of the trench or, in the case of precast block, sufficient blocks shall be removed and stockpiled for future reinstatement.

3.3.2.3 Trench Widths for Sewer Lines

Trenches shall be excavated to the widths shown on the Drawings which shall include the thickness of sheeting, bracing or sheet piling used as temporary works to support the sides of the trench.

3.3.2.4 Protection of Existing Utilities

Existing facilities, including water pipelines, electrical cables, telephone cables and existing sewers shall be supported and protected from damage during all phases or construction, and they shall be kept in full operation during the work of this Contract. Where it is necessary to cut existing sewers for the purposes of connection into manhole structures, the Contractor shall divert water in accordance with his obligations for Care of Water as specified in Section 2.

Trees and their root structures intended to remain must be protected during excavation to the satisfaction of the Engineer.

3.3.3 Excavation of Pits for Manholes and Inlets

Excavation of pits for manholes or inlets for sewers shall be carried out with the same provisions as specified in Clause 3.3.2 and as follows.

The widths of pit shall be constructed to 1m (including the thickness of shoring) beyond the external face of the structure unless otherwise directed or approved by the Engineer.

3.4 FILL

3.4.1 General

The work described in this clause shall consist of the furnishing of necessary materials and selecting, stockpiling and blending if required, transporting, placing, spreading, adjustment of moisture content, compaction, shaping and doing incidental items of work to construct the finished fill to the lines, grades and profiles as shown on the Drawings or as directed by the Engineer.

The Contractor shall make due allowance for consolidation and settlement whether compaction is specified or not, such that the levels, widths and dimensions of the finished surfaces at the end of the Defects Liability Period shall not be less than the levels and dimension shown on the Drawings.

All filling and embankments shall be constructed to the lines and levels shown on the Drawings or established by the Engineer.

Backfilling of trenches and filling adjacent to structures is also included in this category of work.

Accumulation of material at the base of embankment slopes will not be permitted.

3.4.2 Materials

Materials to be used for the various types of fill, backfill or bedding shall conform to the requirements specified herein or as approved by the Engineer.

a) Earth Fill (selected from Common Excavation)

Material to be used shall be extracted and selected from excavated material from common excavation, and shall not contain roots, turf or clod exceeding 75 mm in size or organic matter of any kind and shall be approved by the Engineer.

b) Sandy Soil Fill

Sandy soil fill material (locally known as black sand) shall be clean well graded sand, free of organic or other deleterious matter conforming to the following requirements:

- The percentage, by weight passing the 0.075 mm sieve shall be less than 35%
- The uniformity Coefficient (Uc), defined as D_{60}/D_{10} shall not be less than 4

c) Sand

Sand, for use as sand bedding or sand backfill (locally known as yellow sand) shall consist of natural sand, having clean, hard and durable particles, and it shall be free from clay, organic matter, and other deleterious materials. It shall meet the following grading requirements

Sieve Size (mm)	Cumulative Passing Percentage by Weight
9.5	100
4.75	95 - 100
2.36	80 - 100
1.18	50 - 85
0.600	25 - 60
0.300	10 - 30
0.150	2 - 10

d) Free Draining Gravel

Gravel for use in Free Draining Gravel shall consist natural gravel or crushed stone which shall be hard and durable and which will not break down or deteriorate in service and shall be clean and free from clay, organic matter or other deleterious materials. The maximum particle size shall be 40mm and the minimum particle size shall be 20mm.

3.4.3 Soil Tests

Tests on materials for use as fill or backfill materials shall be performed by the Contractor and shall enable determination of soil characteristics, suitability, dry density/moisture content relationships and the like. A formal report of all tests shall be prepared by the Contractor and approved by the Engineer. Tests shall be performed by the Contractor prior to commencement of earthworks, and every time soil characteristics change. Tests shall include but not be limited to the following :

a) Compaction (AASHTO T 99) (Dry Density)
b) Particle size distribution
c) Specific gravity
d) Moisture content
e) Plastic limit, Liquid limit
f) Direct shear

Test results shall be submitted to the Engineer for approval.

Field compaction tests of compacted filling shall be made on each layer and at a frequency of one test for every 300 m².

For backfilling of trenches, field compaction tests shall be made for every layer in each section of work undertaken or as otherwise directed by the Engineer.

The Contractor shall prepare a soil test programme in conjunction with his earthworks operation schedule and submit it to the Engineer for approval.

3.4.4 Placing, Compaction and Moisture Content of Fill

This clause relates to the earth fill and sandy soil fill as shown on the Drawings.

Prior to commencement of filling, the Contractor shall carry out, under direct supervision and to the satisfaction of the Engineer, a series of field tests to determine optimum conditions and minimum number of passes of each type of equipment required to achieve the specified compaction for each type of fill material.

Fill material shall not be placed when, in the opinion of the Engineer, satisfactory results cannot be achieved due to heavy rain or other adverse conditions.

Fill shall be spread and compacted in approximately horizontal layers of uniform moisture content and uniform compacted thickness not exceeding 200 mm (or to lesser thickness as specified elsewhere). Filling operations shall be such as to ensure that materials will be blended sufficiently to achieve the highest practicable dry density and stability. Where the surface of any layer of filling is too dry or too smooth to bond properly with the next layer of material, it shall be moistened and/or scarified in an approved manner to provide a satisfactory bonding surface before the next layer is placed.

The moisture content of filling shall be carefully controlled, either by natural drying or wetting with a fine spray, to achieve optimum values. Fill material shall be compacted to a density of not less than 90% maximum standard dry density determined in accordance with AASHTO T 99. For portions of fill upon which road pavements are to be constructed the upper 300 mm of fill material directly below the road pavement shall be compacted at optimum moisture content to a compaction of 95% maximum standard dry density in accordance with AASHTO T 99 for the full width of the roadway or for the full width of the trench as the case may be. Where practical, as determined by the Engineer, moistening of the material shall be performed at the site of stockpiles but such moistening shall be supplemented by fine spraying at the time of compaction, if necessary. Where moisture content is beyond the optimum range, the operation shall not proceed except with the specific approval of the Engineer, until the material has been conditioned by wetting or drying to achieve a moisture content in the required range.

All compaction equipment shall be approved by the Engineer in writing before commencement of any filling operations.

3.4.5 Preparation of Surface under Fill

Filling shall not be placed on any portion of embankment foundation until such foundation has been cleared, stripped of topsoil, suitably prepared and has been approved by the Engineer. Tests pits, trenches and cavities resulting from the removal of unsound foundation materials or for inspection of sub-surface conditions shall be filled with selected materials.

Foundation material which does not have a density in the undisturbed condition as specified for the fill material to be placed upon it shall be moistened and compacted to specified dry density or shall be removed, filled and compacted or shall be treated in a manner as directed by the Engineer.

3.4.6 Filling Adjacent to Structures

Filling adjacent to structures shall be placed and compacted to avoid damage to such structures. Compaction adjacent to structures shall be carried out by hand or with suitable hand-operated equipment in horizontal layers not exceeding 150 mm thickness after compaction.

Unless otherwise specified or permitted by the Engineer, filling shall not be placed and compacted adjacent to concrete until at least fourteen (14) days after the placing of the concrete.

3.4.7 Backfilling

Backfill comprising approved materials complying with the specification for filling provided in Clause 3.4.2, shall be placed and compacted adjacent structures or in trenches generally in accordance with Clause 3.4.4, as shown on the Drawings or as directed by the Engineer.

Prior to commencement of backfilling adjacent to structures, the area shall be cleared of all formwork and other temporary works. Compaction shall be carried out by hand or with suitable hand operated equipment so as to achieve specified compaction without damage to structures. Backfilling material shall be wetted or allowed to dry in order to achieve optimum moisture content for compaction.

Backfilling shall be placed and compacted in continuous horizontal layers of not more than 150 mm compacted thickness. Unless otherwise specified, backfilling shall be compacted to 90% of the maximum dry density as determined in the laboratory compaction test referred to in Clause 3.4.3.

Unless otherwise specified or permitted by the Engineer, backfilling shall not be placed and compacted adjacent to concrete until at least fourteen (14) days after the placing of concrete.

Compaction of backfilling material placed above buried concrete, however, shall not be permitted to be carried out with vibrating equipment except with the prior approval of the Engineer.

3.4.8 Backfilling of Trenches and Pits

The backfilling of trenches for sewers, pipes, pits for manholes or other excavations where shoring has been used to support excavation, backfilling shall be done in accordance with Clause 3.4.7 and the following requirements.

For trenches less than 4 m deep and where timber sheeting is used, backfill shall be placed in layers as described in Clause 3.4.7 while trench support being concurrently partly withdrawn to permit compaction of backfill against the sides of the excavation.

For deeper trenches, where sheet piling support has been used, backfilling shall be completed up to the subgrade level before sheet piling is withdrawn.

This clause shall be read in conjunction with Clause 7.6.

3.4.9 Gravel Placement

This clause covers the requirements for placing gravel bedding or free draining gravel in the locations as shown on the Drawings or as directed by the Engineer.

Materials shall comply with the requirements of Clause 3.4.2

Gravel shall be placed and compacted in continuous horizontal layers of not more than 150 mm compacted thickness. Each layer shall be compacted until it is stable and dense and shows no movement under compaction.

Gravel on batter slopes in revetments shall be placed in a single layer and compacted by hand or using a vibrating plate until it is dense and stable.

3.5 RIP RAP

3.5.1 General

This clause refers to the construction of rip rap for protection of around the outlets of sewers as shown on the Drawings or directed by the Engineer.

3.5.2 Material

Stone shall be clean, hard, and durable with a specific gravity not less than 2.5.

Samples of stone proposed for use in rip rap construction shall be submitted to the Engineer for his approval.

3.5.3 Preparation

Where applicable, surfaces on which rip rap is to be placed shall be completed to the satisfaction of the Engineer prior to placing rip rap.

3.5.4 Selection and Placement

Stones of size 250 mm to 300 mm in maximum dimension in accordance with Clause 3.4.2 shall be selected for use.

Stones shall be carefully placed such they are stable, closely interlock with adjacent stones and are arranged such that they comply with the lines, levels and profiles of the stone facing as shown on the Drawings to a tolerance of + or – 100 mm. Particular care shall be taken not to damage other parts of the revetments when placing rip rap. Any such damage caused shall be rectified by the Contractor at his expense.

3.6 GEOTEXTILE CLOTH

3.6.1 General

This clause covers the requirements of geotextile filter cloth for use in sewer outlet and revetment construction or as directed by the Engineer.

3.6.2 Materials

Geotextile filter cloth shall be a polyester, staple fibre, needle punched felt with a minimum mass of 250 g/m^2 and shall comply with AASTHO M 288 'Geotextiles used for Subsurface Drainage Purposes'.

3.6.3 Construction

The surface on which the geotextile filter cloth is to be laid shall be completed to the satisfaction of the Engineer and then the cloth shall be laid out uniformly taking care not to puncture the cloth. Laps shall be a minimum of 300 mm.

Placement of material above the geotextile cloth shall be made carefully so as not to cause puncturing or dislodgement.

3.7 MEASUREMENT AND PAYMENT

3.7.1 Stripping of Topsoil

Measurement shall be made of the area stripped of topsoil in accordance with the requirements of Clause 3.2 of the Specification. No measurement shall be made of stripping in excess of 250 mm depth unless authorised by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities which shall include the entire cost of completing the work including labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid under this clause:

Pay Item No.	Description	Unit of Measurement
2.2.1	Stripping of Topsoil: including hauling to stockpile or disposal in designated area	m^2

3.7.2 Excavation

3.7.2.1 Common Excavation

Measurement of the volume of common excavation will be made using the average end area method.

Measurement for payment shall not be made of over-excavation beyond the lines, levels and profiles shown on the Drawings except as provided for herein.

For common excavation of trenches, the trench width shown on the Drawings, which includes allowance for working space and the thickness of shoring (i.e. sheeting and waling and any other bracing of the trench), shall be used as the basis for measurement. For common excavation for manholes, inlet pits etc the widths shall be as permitted in Clause 3.3.3.

Where the Engineer has permitted open cut excavation without shoring, the volume shall include working space around the structure to be constructed plus battering of the cut slope to an angle approved by the Engineer. The working space around structures in such cases shall be 600 mm unless otherwise approved by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the excavation from the approved original surface levels down to the lines, levels and profiles shown on the Drawings including materials, labour, equipment, transportation and any other associated costs.

No payment shall be made for over-excavation

Payment shall be deemed to include allowance for the cost of:

1) excavation through any material and to any depth
2) trimming to the correct profiles, lines and levels as shown in the Drawings
3) separating and setting aside those excavated materials suitable for re-use for other purposes and transporting to spoil those materials unsuitable for re-use or surplus to requirements
4) transporting excavated materials to the designated spoil disposal areas, stockpiles or to areas to be filled with approved material
5) preparation, clearing and operation of spoil disposal areas
6) designing, furnishing, installing and subsequent removal of all temporary shoring for the support of excavation.

The following pay items shall be measured and paid under this clause:

Pay Item No.	Description	Unit of Measurement
2.2.2	Common Excavation (Depth <= 3 m) for Conveyance Sewer: including shoring, hauling and disposal in designated area	m^3
2.2.3	Common Excavation (3 m < Depth) for Conveyance Sewer: including shoring, hauling and disposal in designated area	m^3
3.2.1	Common Excavation: including shoring, hauling and disposal in designated area	m^3
3.2.2	Common Excavation: including hauling to stockpile in vicinity of the Site	m^3

3.7.3 Fill

3.7.3.1 Earth Backfill

Measurement of the volumes of earth backfill shall be made of the actual volume in cubic meters as determined by the measurement taken before and after filling operation. No measurement and payment shall be made for unauthorised filling outside the lines shown on the Drawings.

For backfilling of trenches, measurement of trench width shall be that permitted for excavation.

For filling, where the Engineer has permitted open cut excavation without shoring, the volume shall include working space around the structure to be constructed plus battering of the cut slope to an angle approved by the Engineer as for excavation.

Payment shall include the cost of hauling from stockpile, placing, watering, levelling, compacting and testing of the materials of in-situ fill. Payment shall also include cost of preparation of surface and trimming of slopes and all labour, materials and equipment necessary to complete the work.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
3.2.5	Earth Backfill: from stockpile including hauling and placement	m^3

3.7.3.2 Sandy Soil Fill or Sandy Soil Backfill

Measurement of the volumes of earth fill shall be made of the actual volume in cubic meters as determined by the measurement taken before and after filling operation. No measurement and payment shall be made for unauthorised filling outside the lines shown on the Drawings.

For backfilling of trenches, measurement of trench width shall be that permitted for excavation.

For backfilling of excavations for manholes, inlet pits or other buried structures, the widths shall be those permitted for excavation.

For filling, where the Engineer has permitted open cut excavation without shoring, the volume shall include working space around the structure to be constructed plus battering of the cut slope to an angle approved by the Engineer as for excavation.

Payment shall include the cost of procurement, hauling, placing, watering, levelling, compacting and testing of the materials of in-situ material. Payment shall also include cost of preparation of surface and trimming of slopes and all labour, materials and equipment necessary to complete the work.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
2.2.4 3.2.4	Sandy Soil Backfill: including supply and placement	m^3

3.7.3.3 Sand Backfill or Sand Bedding

Measurement shall be made of the volume of sand backfill or sand bedding with materials as described in Clause 3.4.2. to the lines and levels as shown on the Drawings.

For backfilling of trenches, measurement of trench width shall be that permitted for excavation.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including material, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
2.2.5 3.2.3	Sand Bedding: including supply and placement	m^3

3.7.3.4 Free Draining Gravel

Measurement shall be made of the volume of free draining gravel with materials as described in Clause 3.4.2. to the lines and levels as shown on the Drawings.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including material, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
3.2.6	Free Drainage Gravel: including supply and placement	m^3

3.7.3.5 Geotextile Cloth

Measurement shall be made of the area of geotextile cloth with materials as described in Clause 3.3.2. to the lines and levels as shown on the Drawings. Measurement shall not be made of the area of laps or waste.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including material, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
3.2.7	Geotextile Cloth: including supply and placement	m^2

3.7.3.6 Rip Rap

Measurement shall be made of the volume of rip rap with materials as described in Clause 3.5.2. to the lines and levels as shown on the Drawings.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including material, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
3.2.8	Rip Rap 250 – 300 dia : including supply and placement	m^3

SECTION 4. CONCRETE WORKS
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SECTION 4. CONCRETE WORKS

4.1 GENERAL

This section covers the general and specific requirements for the mixing, placing and use of concrete of the various classes to be used in the structures, precast concrete units and non-structural applications in the Works for Package D which includes the use of concrete in sewers and related sewerage structures, and all works in which concrete is specified, shown on the Drawings or directed to be used by the Engineer.

All concrete works shall be constructed in accordance with these specifications, to the lines, grades and dimensions shown on the Drawings, and as directed by the Engineer.

References to concrete classes A or to bridge work shall be disregarded as they are not applicable to the Works in Package D.

4.2 CONCRETE

4.2.1 Description

4.2.1.1 Scope

Portland cement concrete shall consist of a mixture of cement, water and coarse and fine aggregates.

4.2.1.2 Concrete Classes and their Use

The use of each class of concrete shall be as follows unless otherwise specified, shown on the Drawings, or directed by the Engineer :

Table 4.2.1.2

CLASS	USE OF EACH CLASS OF CONCRETE	STRENGTH* MPa
A	Jacking pipes	50
B	Prestressed concrete for bridge girders	42
C	Diaphragm wall	30
D	Precast concrete	25
E	General use reinforced concrete	21
F	Plain (unreinforced) concrete	18
G	Levelling concrete	10

*Note: Minimum 28-day compressive strength by cylinder test (300 mm x 150 mm diameter).

4.2.1.3 Mix Design

No structural concrete shall be placed in the Works until the relevant mix has been approved by the Engineer.

The Contractor shall submit to the Engineer for his consent details of the concrete mix design, including the water-cement ratio proposed to be used for each class of concrete. These details shall be supplied six (6) weeks in advance of placing that particular class of concrete in the work so as to permit strength tests to be made from trial mixes.

The maximum aggregate size shall be 25 mm for reinforced concrete and 15 mm for secondary concrete unless otherwise directed by the Engineer.

(a) Trial Mixes

The trial mixes shall be carried out using samples of the materials submitted, and in the proportions proposed, by the Contractor. Alternatively the Engineer may request the Contractor to prepare, at the Contractor's expense, a trial mix of each class of concrete proposed to be used incorporating only such materials as have been tested and their use consented to by the Engineer. The trial mixes shall be made in the presence of the Engineer or his representative using the plant and the degree of quality control proposed for the work. Each mix shall be tested for slump, workability and strength.

If the coarse aggregate or fine aggregate is composed of more than one material or size of material the mix proportions of each shall be specified separately. Samples of each type of material and/or each size of material shall also be supplied by the Contractor as specified in Clause 4.2.2

The Proportions of the concrete mixes shall be designed by the Contractor to satisfy the specified requirements of strength, grading and consistency.

Unless otherwise specified or consented to by the Engineer, slump, water cement ratio and cement content shall conform to the values in Table 4.2.1.3.

Table 4.2.1.3

Class **/1**	Strength MPa /2	Minimum Cement Content **(kg/m^3)** **/3**	Maximum Water/Cement Ratio by mass	Slump (mm) **/4**
A /5	50			
B	42	470	0.375	80 ± 20
C /6	30	370	0.45	180 ± 25
D	25	330	0.60	80 ± 20
E	21	268	0.60	80 ± 20
F	18	280	0.60	80 ± 20
G	10	200	0.60	80 ± 20

Notes:

1. Class of concrete shall be applied as shown in Clause 4.2.1.2.
2. Minimum 28-day compressive strength by cylinder test (300 mm x 150 mm diameter) determined in accordance with the requirements of AASHTO T22 and 23.
3. Concrete to be placed under water shall have a minimum cement content of 400 kg/m^3.
4. Slump will be determined in accordance with AASHTO T119 or JIS A 1101.
5. Concrete Class A shall not be batched by the Contractor but shall be supplied by a specialist manufacturer of jacking pipes
6. Concrete Class C, which is to be used exclusively for diaphragm wall construction, shall contain admixtures subject to the provisions of Clause 4.2.2.3.

(b) Trial Mix Results

Prior to consent being given to a mix by the Contractor its compressive strength and shrinkage at 28 days will be checked from trial mixes.

A minimum of 20 specimens shall be cast for the purpose of ascertaining the compressive strength of the trial mix.

Laboratory test results on samples from trial mixes shall show an adequate working strength margin, in accordance with normal good practice, so that the probability of site working strength test values falling below the minimum specified strength shown in Table 4.2.1.2 is reduced to a value not exceeding 5%.

In the case of urgency or for mixes which contain special admixtures, or are stream cured the Engineer may give a provisional consent based on tests at an earlier age than 28 days but tests at age 28 days shall be the basis of final consent.

No change in the source or character of the materials shall be made without due notice to the Engineer and no new materials shall be used until the Engineer has accepted such materials and has designated new proportions based on tests or trial mixes as provided herein. Should the changes due to the new materials require an increase in the amount of cement, no additional payment shall be made to the Contractor for the cost of such additional cement.

4.2.1.4 Sampling of Concrete

In order to asses compliance of concrete during construction, the Contractor shall prepare and cure test specimens which shall be tested at 7 days and 28 days as determined by the Engineer, or at any other interval that may be deemed necessary to determine the strength of concrete. (Site Working Strength).

(a) Specimens shall be made in pairs as follows:

(i) For batches Individual Pours

- $< 1\ m^3$:

  Not more than one sample shall be taken from which not less than 2 specimens shall be tested.

- For batches $> 1\ m^3$ $< 20\ m^3$:

  Not more than two samples shall be taken from which not less than 4 specimens shall be tested.

(ii) Continuous Pours

For any given section of the work that does not qualify as bulk concrete i.e. > 20 m^3 < 100 m^3 a minimum of three random samples shall be taken from which not less than 6 specimens shall be tested.

For any given section of the work that is considered as bulk concrete i.e. > 100 m^3 a minimum of four random samples shall be taken for every 100 m^3 of concrete or fraction thereof greater than 100 m^3 placed during one day's work or as deemed necessary by the Engineer from which not less than eight specimens shall be tested.

(b) Irrespective of the quantity, every day's production of concrete shall be tested both for strength and for slump and every structure and every component of every structure shall likewise be so tested for strength and for slump. The checking and testing of the concrete shall be the prerogative of the Engineer, and he may increase the specified strength and condition as required for the project.

The concrete test specimens will be tested by the Contractor at a conveniently located and properly equipped laboratory.

The Contractor shall take, on his own responsibility, every precaution to prevent injury to the test specimens during handling, transporting and storing.

4.2.1.5 Strength Requirements

(a) Specimen Preparation

The ultimate compressive strength of the concrete shall be determined on specimens obtained and prepared in accordance with AASHTO T141 (ASTM C 172) and AASHTO T23 (ASTM C 31). Test cylinders shall conform to AASHTO T126 (ASTM C 192).

The compression test performed on cylinders shall be according to specifications AASHTO T22 (ASTM C 39).

(b) Compressive and Flexural Strength

The average site working strength value of any 4 consecutive results of the 28 day tests shall not be less than the minimum strength specified in Table 4.2.1.2 for the respective class of concrete. In the event of failure to comply with this requirement all of the concrete in all the batches represented by such samples and specimens, including any batches within the sequence which were not sampled shall be deemed not to comply with the strength requirement of this Clause.

If at any time the average of any 4 consecutive results of 7 day tests falls below 70% of the prescribed minimum value at 28 days for compressive strength or below 80% of the prescribed minimum value at 28 days for flexural strength the cement content of the concrete will be increased by at least 20 kg per cubic metre of compacted concrete, without extra payment, until any necessary mix modifications have been agreed following examination of 28 day tests.

(c) Characteristic Strength

The characteristic strength of the various classes of concrete shall be determined as soon as the first 30 test results of each class become available.

The characteristic strength shall be calculated by the equation:

$\overline{X}_0 = X - kS$

Where :

$\overline{X}_0$: characteristic strength

X : mean or average of the series of results

k : a factor depending upon the percentage of results that fall below the characteristic strength

S : standard deviation given by the equation :

$$S = \left[\frac{\sum (X - \overline{X})^2}{(N-1)} \right]^{\frac{1}{2}}$$

Where :

X : the individual result

N : the total number of results

The values for the factor k are :

Percentage of results falling below the minimum	Value of k
0.1	3.09
0.6	2.50
1.0	2.33
2.5	1.96
5.0	1.64

If the characteristic strength so determined falls below the minimum site working strength the Contractor shall increase the cement content in the same manner as described in Item (b) above until such time as adjustments shall be made in the mix proportions or improvements made in the quality control measures to raise the average strength or reduce variation to the satisfaction of the Engineer.

(d) Failure to Comply with Compressive Strength Requirements

In the event of compressive strength results not complying with the strength requirements of this Clause or in the event of doubtful results, the Engineer will proceed to check the sample compressive strength by means of crushing tests performed on test specimens taken with a rotary core borer at suitable points indicated by the Engineer on the structure already constructed.

Such tests shall be carried out by an agreed authority having suitable test facilities. If such tests show strength in compliance with the requirements herein specified, the concrete will be considered satisfactory. If such tests do not comply with the requirements, the Engineer may direct the Contractor to cut out and make good the defective work at the Contractor's expense.

(e) Care of Specimens

The cost of taking specimens and performing the tests including the cost of providing stout, substantial packing cases and the cost of shipping or transporting the test specimens from the site to the laboratory shall be included as part of the price bid for Portland cement concrete. The Contractor shall take, on his own responsibility, every precaution to prevent injury to the test specimens during handling and transporting.

(f) Records

The original records of all tests shall be kept by the Engineer and a copy retained by the Contractor. The records of all tests shall be kept by the Engineer but results shall be available at all times to the Contractor. The Contractor shall be responsible for making such adjustments as may be necessary to produce specification concrete and the test results shall include whether or not the concrete is satisfactory.

4.2.2 Materials

4.2.2.1 General

All materials to be furnished and used that are not covered in this Clause shall conform to the requirements stipulated in other applicable sections.

4.2.2.2 Cement

Unless specified to the contrary or otherwise permitted by the Engineer the Contractor shall use only one brand of any one type of cement having uniform quality for the Works. All cement used in the Works shall be Ordinary Portland Cement (ASTM Type-I) conforming to the minimum requirements of JIS R 5210, AASHTO-M 85, BS 12: 1978 or TCVN 2682 - 1992 for PC-40 Cement.

4.2.2.3 Admixtures

Admixtures may only be used if consented to by the Engineer and then only in such quantities and manner as he may consent to in writing.

Such admixtures shall conform with the requirements of:

- AASHTO M 194 (ASTM C 494) “Specification for Chemical Admixtures for Concrete”:
  - Type A - Water-reducing
  - Type B - Retarding
  - Type C - Accelerating
  - Type D - Water-reducing and retarding
  - Type E - Water-reducing and accelerating
  - Type F - Water-reducing (high range) and
  - Type G - Water-reducing(high range) and retarding
- AASHTO M 154 (ASTM C 260) “Specification for Air-entraining Admixtures for Concrete”.

Admixtures shall not reduce the strength of concrete below that specified. Shrinkage and dosage sensitivity characteristics will be taken into account, if relevant.

Admixtures shall not contain chlorides, chlorine, sulphides or sulphites, or any other substance which may be detrimental to concrete or steel.

Use calcium chloride or admixtures containing calcium chloride will not be permitted.

4.2.2.4 Water

All water used in concrete shall be subject to the Engineer's approval. Water used in mixing, curing, or other designated applications shall as a general rule be potable, otherwise reasonably clean and free from oil, salt, acid, alkali, sugar, vegetable, or any other substance injurious to the finished product. If required by the Engineer, water shall be tested by comparison with distilled water. Comparison shall be made by means of standard cement test for soundness, time of setting and mortar strength. Indication of unsoundness, change in time of setting of plus or minus 30 minutes or more, or decrease of mortar strength more than 10 percent compared with distilled water shall be sufficient cause for rejection of the water that is being tested.

Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials.

4.2.2.5 Fine Aggregate

(a) The fine aggregate for concrete shall consist of natural sand or, subject to approval of the Engineer, other inert materials with similar characteristics, having clean, hard and durable particles, and it shall be free from objectionable quantities of dust, silt, clay, organic matter, and other impurities.

(b) The fine aggregate shall be uniformly graded and shall meet the following grading requirements :

Grading of Fine Aggregate:

Sieve Size (mm)	Cumulative Passing Percentage by Weight
9.5	100
4.75	95 – 100
2.36	80 – 100
1.18	50 – 85
0.600	25 – 60
0.300	10 – 30
0.150	2 – 10

Sieve analysis of fine aggregate shall be made in accordance with JIS A 1102 (Method of Test for Sieve Analysis of Aggregate) or AASHTO - T 27.

The gradation requirements given above are the extreme limits to be used in determining the suitability of material from all possible sources of supply. The gradation of materials from any one source shall not vary in composition beyond the range of values that govern the selection of a source of supply. For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made upon representative samples, submitted by the Contractor, from such sources as he proposes to use. If fineness modulus of fine aggregate varies more than 0.2 from the value used in selecting concrete proportions, the fine aggregate shall be rejected unless suitable adjustment of the mix proportions are made with the approval of the Engineer.

(c) The amount of deleterious substances in fine aggregate shall not exceed the limits specified in Table 4.2.2.5. Treatment of other deleterious substances which are not shown in the above table shall be determined by the direction of the Engineer.

Tests for material finer than 0.075 mm sieve shall be made in accordance with JIS A 1103 (Method of Test for Amount of Material Passing Standard Sieve 0.074 mm in Aggregates), or AASHTO - T 11.

Table 4.2.2.5

Limits for Deleterious Substances in Fine Aggregates

Item	Maximum % by Weight
* Clay lumps	1.0
* Material finer than 0.075 mm sieve:	
Concrete subject to abrasion	3.0 1/
All other concrete	5.0 1/
* Material coarser than 0.300 mm sieve floating on a liquid having a specific gravity of 1.95	0.5 2/

Note :

1/ In the case of crushed aggregate, if the material finer than 0.075 mm sieve consists of the dust of fracture essentially free from clay or shale, these percentages may be increased to 5 and 7 percent respectively.

2/ This requirement does not apply to manufactured sand produced from blast furnace slag.

(d) All fine aggregate shall be free from injurious amounts of organic impurities. Approximate determination of the presence of injurious organic impurities in natural sand shall be in accordance with JIS A 1105 (Method of Test for Organic Impurities in Sands) or AASHTO T 21. Aggregate subjected to the colourimetric test for organic impurities, and producing a colour darker than the standard, shall be rejected.

However, any sand that fails to meet the above requirement may be used provided that the compressive strength of mortar specimens using such sand is more than 95% of that of mortar specimens using the same sand which is washed by 3% solution of sodium hydroxide and then by water, and approved by the Engineer. Testing age of mortar specimens shall be 7 and 28 days for normal Portland cement.

Compressive strength of mortar specimens shall be determined by AASHTO T 71, "Effect of Organic Impurities in Fine Aggregate on Strength of Mortar".

4.2.2.6 Coarse Aggregate

(a) The coarse aggregate shall consist of one or more of the following: crushed stone, gravel, blast-furnace slag, or other approved inert materials of similar characteristics having clean, hard, durable pieces. It shall be free from objectionable quantities of flat or elongated particles, organic matter or other deleterious matter.

(b) Sieve analysis of coarse aggregate shall be made in accordance with JIS A 1102 (Method of Test for Sieve Analysis of Aggregate) or AASHTO T 27 and material shall meet the following grading requirements:

Grading of Coarse Aggregate

SIZE	PERCENTAGE BY WEIGHT (JIS A 1102)										
	AMOUNTS FINER THAN EACH STANDARD SIEVE (mm)										
mm	100	80	60	50	40	25	20	15	10	5	2.5
50 - 5	-	-	100	95-100	-	37-70	-	10-35	-	0-5	-
40 - 5	-	-	-	100	95-100	-	35-70	-	10-30	0-5	-
25 - 5	-	-	-	-	100	95-100	-	30-70	-	0-10	0-5
20 - 5	-	-	-	-	-	100	90-100	-	20-55	0-10	0-5
15 - 5	-	-	-	-	-	-	100	90-100	40-70	0-15	0-5
80 - 40	100	90-100	45-75	-	0-15	-	0-5	-	-	-	-
60 - 40	-	100	90-100	35-70	0-15	-	0-5	-	-	-	-
50 - 25	-	-	100	90-100	35-70	0-15	-	0-5	-	-	-
40 - 20	-	-	-	100	90-100	20-55	0-15	-	0-5	-	-

The amount of deleterious substance in coarse aggregate shall not exceed the limits prescribed in Table 4.2.2.6

(c) Treatment of the other deleterious substances which are not shown in the table shall be determined by the direction of the Engineer.

Table 4.2.2.6

Limits of Deleterious Substance (Percent by Weight) in Coarse Aggregate

Item	Maximum
Clay lumps	0.25
Soft particles	5.0
Material finer than 0.075 mm sieve	1.0 1/
Material floating on a liquid having a specific gravity of 1.95	1.0 2/

Note :

1/ In the case of crushed aggregate, if the material finer than 0.075 mm sieve consists of the dust of fracture essentially free from clay or shale, this percentage may be increased to 1.5.

2/ This requirement does not apply to manufactured sand produced from blast furnace slag.

(d) Test for material finer than 0.075 mm sieve shall be made in accordance with JIS A 1103 (Method of Test for Amount of Material Passing Standard Sieve 0.075 mm in Aggregates), or AASHTO T11. Test for soft particles shall be made in accordance with JIS A 1126 (Method of Test for Soft Particles in Coarse Aggregate by Use of Scratch Tester), or AASHTO T 112.

4.2.2.7 Lightweight Aggregate

Lightweight aggregate for use in concrete Class H (cinder concrete) shall conform to the requirements of AASHTO M 195 (ASTM C 330). The Engineer shall direct the required grading. The Contractor shall submit samples of proposed lightweight aggregate for the Engineer's approval.

4.2.2.8 Test of Aggregate

Before use, results of the foregoing tests of aggregate from each source shall be submitted to and approved by the Engineer. Coarse aggregate shall meet the requirements ASTM C39 for Compressive Strength and the percentage of wear of the Aggregate shall not be greater than 50 as determined by AASHTO T96 . Tests for aggregate in use shall be made when required by the Engineer.

4.2.2.9 Expansion Joint Materials

Jointing materials, joint filler, sealants etc. shall comply with ASTM D 2125, Class 1, Grade15, or BS 8007: 1987 and BS 6213, AASHTO M 33 or other equivalent standards

Expansion joint filler shall consist of formed polythene elastic material sheet material 20 mm thick and with asphaltic sealant on the external surfaces as shown on the Drawings.

Cut-off plate for water stops used for the expansion joints, where required, shall be flexible PVC to JIS K 6773

All expansion joint materials shall be subject to approval by the Engineer following submission of samples and technical specifications by the Contractor of proposed materials.

4.2.2.10 Storage of Materials

(a) Storage of cement - Cement may be shipped from pre-tested and approved bins at the mill. Cement shall be stored in a damp-proof warehouse with a floor raised at least 300 mm from the ground so as to permit easy access for inspection and for use in the delivered order. Bagged cement shall not be piled more than 13 sacks high. Cement which has become damp, lumpy or otherwise not in proper condition shall not be used. Cement stored by the Contractor for a period longer than 60 (sixty) days shall require the Engineer's approval before being used on the work.

(b) Storage of aggregate - Fine and coarse aggregates shall be stored separately to prevent contamination by foreign material. Aggregate shall be stored in such a manner as to keep the moisture content as uniform as possible, and shall be handled in such a manner as to prevent segregation. Aggregate shall be stored so as to protect it from the direct rays of the sun. Aggregate from different sources of supply shall not be stored in the same place without permission from the Engineer.

4.2.3 Equipment and Tools

Equipment and tools necessary for handling materials and performing the work, and satisfactory to the Engineer as to design, capacity, and mechanical condition, shall be at the site of the work before work is started.

If any equipment is not maintained in full working order or if the equipment as used by the Contractor proves inadequate to obtain the results prescribed, such equipment shall be improved or other satisfactory equipment substituted or added at the direction of the Engineer.

4.2.3.1 Batching Plant and Equipment

(a) General - All material in the mix shall be proportioned wholly by weight. The batching plant shall include bins, weighing hoppers and scales for the fine aggregate and for each separated size of coarse aggregate. If cement is used in bulk, a bin, hopper and scales for the cement shall be included. The container shall be watertight. Provision satisfactory to the Engineer shall be made for batching other components of the mix at the batching plant, which may be either stationary or mobile type. It shall be always properly levelled within the accuracy required for the proper operation of weighing mechanisms.

(b) Bins and hoppers - Bins with adequate separate compartments for fine aggregate and for each required size of coarse aggregate shall be provided in the batching plant. Each compartment shall discharge efficiently and freely into the weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision. A port or other opening for removing any overload of the several materials from the hopper shall be provided. Weighing hopper shall be constructed so as to discharge completely.

(c) Scales - The scales for weighing aggregates and cement shall be of either the beam type or the spring-less dial type. They shall be accurate within one-half of 1% under operating conditions throughout the range of use. Ten weights of 25 kilograms each shall be available for checking accuracy. All exposed fulcrums, clevises and similar working parts of scales shall be kept clean. When beam-type scales are used, provision

shall be made for indicating to the operator that the required load in the weighing hopper is being approached. The device shall indicate at least the last 100 kilograms of load and up to 25 kilograms overload.

All weighing and indicating devices shall be in full view of the operator while charging the hopper and he shall have convenient access to all controls.

Cement may be measured by weight, or in standard sacks considered to weigh 50 kilograms net. When measured by weight a separate, satisfactory scale and hopper shall be provided together with a boot or other approved device to transfer the cement from the weighing hopper. Satisfactory methods of handling shall be employed.

Batching shall be so conducted as to result in the weights of material required, within tolerances of 1% for cement and 2% for aggregates.

4.2.3.2 Mixers

(a) General - All concrete shall be mixed in batch mixers. It may be mixed at the site of construction, at a central plant, or in transit.

(b) Each mixer shall have attached to it in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of mixing drum.

(c) Mixers at site of construction - Mixers at the site shall be approved drum-type capable of combining the aggregate, cement and water into a thoroughly mixed and uniform mass within the specified mixing period and of discharging the mixture without segregation. The mixer shall be equipped with a suitable charging hopper, water storage, and a water measuring device, accurate within 1%. Controls shall be so arranged that the water can be applied only while the mixer is being charged. The discharge level shall lock automatically until the batch has been mixed the required time after all materials are in the mixer.

(d) Suitable equipment for discharging the concrete on the roadbed shall be provided. The mixer shall be cleaned at suitable intervals. The pick-up and throw-over blades in the drum shall be replaced when they have lost 10% of their depth.

(e) Central plant mixers - These mixers shall be of approved drum type capable of combining the aggregate, cement and water into the thoroughly mixed and uniform mass within the specified mixing period and of discharging the mixture without segregation. Central plant mixers shall be equipped with an acceptable timing device that will not permit the batch to be discharged until the specified mixing time has elapsed. The water system for a central mixer shall be either a calibrated measuring tank or a metre and shall not necessarily be an integral part of the mixer.

The mixers shall be cleaned at suitable intervals. They shall be examined daily for changes in interior condition. The pick-up and throw-over blades in the drum shall be replaced when they have lost 10% of their depth.

(f) Truck or transit mixers - These shall be equipped with electrically actuated counters by which the number of revolutions of the drum or blades may readily be verified and the counters shall be actuated at the commencement of mixing operations at designated mixing speeds. The mixer when loaded shall not be filled to more than 60% of the drum gross volume. The mixer shall be capable of combining the ingredients

of the concrete into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

Except when intended for use exclusively as agitators, truck mixers shall be provided with a water measuring device to measure accurately the quantity of water for each batch. The delivered amount of water shall be within plus or minus 1% of the indicated amount.

4.2.3.3 Vibrators

Unless otherwise directed, the concrete shall be consolidated with approved mechanical vibrators operating within the concrete. When required, vibrating shall be supplemented by hand spading with suitable tools to assure proper and adequate compaction.

The vibrators shall be of a type approved by the Engineer, with a minimum frequency of 3500 impulses per minute and shall be capable of visibly affecting a properly designed concrete with a 20 mm slump over a circular area of 450 mm radius. The number of vibrators used shall be sufficient to consolidate the concrete properly within 10 minutes after it is deposited in the forms and in addition at least 3 spare vibrators shall be available on standby at the site of the pour to maintain immediate continuity in case of breakdown.

4.2.3.4 Forms

(a) Forms shall be made of metal, timber or other approval material and shall conform to the shape, lines and dimensions of the members shown on the Drawings, and shall be so constructed as to prevent deformation due to load, vibration, and other causes.

(b) Forms shall be properly equipped with braces, ties and other devices, so as to maintain them in the positions and the shape as shown on the Drawings.

(c) Forms shall be so constructed that they can be removed easily and safely. Joints in linings or panels shall be either horizontal or vertical as far as possible, and shall be sufficiently tight to prevent any leakage of mortar.

(d) Curved forms shall be of the radius called for on the Drawings and acceptable flexible forms shall be installed with that radius.

(e) After forms have been set in the correct location, they shall be inspected and approved by the Engineer before concrete is placed.

(f) Care shall be exercised to keep forms free from dust, grease or other foreign matter. No material or treatment that will adhere to concrete or discolour concrete shall be used. All forms shall be treated with an approved form-release-oil prior to placing reinforcement.

(g) For narrow walls, columns, etc., where the bottom of the form is inaccessible, lower form boards or parts thereof shall be left loose so that they may be removed for cleaning out extraneous material immediately before placing concrete.

(h) Forms for exposed surfaces shall be constructed with triangular fillets not less than 25 mm x 25 mm attached so as to prevent mortar runs and to produce smooth straight chamfers at all sharp external edges of the concrete.

4.2.3.5 Batching and Transporting Materials

For mixing at site of construction, aggregates shall be transported from the batching plant to the mixer in batch boxes, vehicle bodies, or other containers adequate in design and construction to properly carry the batch required. Partitions separating batches shall be adequate and effective to prevent spilling from one compartment to another while in transit or while being dumped.

Cement in original shipping containers may be transported on top of the aggregates. The number of sacks of cement required for each batch shall be placed on the aggregates for that batch. Sacked cement shall be emptied into the aggregates prior to dumping into mixer.

Batches shall be delivered to the mixer separately and intact. Each batch container shall be dumped cleanly into the mixer without loss of cement or mixing or spilling of material from one batch compartment into another.

4.2.3.6 Mixing Concrete

(a) General - Concrete shall be mixed at the construction site, at a central mixing plant, in a truck mixer, or by a combination of central plant and truck mixing. Hand-mixing may be used only when approved by the Engineer. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

(b) Mixing at site of concrete construction - Concrete shall be mixed in a batch mixer of the type and capacity approved by the Engineer. Mixing time shall be determined by the Engineer in accordance with JIS A 1119 (Method of Test for Variation in Unit Weight of Air Free Mortar in Freshly Mixed Concrete). When results of the above tests are not available, the mixing time shall be longer than 1 1/2 minutes after all the materials have been introduced into the mixer, but in no case shall the mixing time exceed three times the mixing time prescribed above. Charging of water into the mixer shall begin before the cement and aggregates enter the drum. During mixing, the drum shall be operated at speeds specified by manufacturers. Pick-up blades in the drum of the mixer which are worn down 20 mm or more at any part must be replaced.

The volume of a batch shall not exceed the manufacturer's rated capacity of the mixer without written permission of the Engineer. No mixer whose rated capacity is less than a one-bag batch shall be used.

Concrete shall be mixed only in such quantities as are required for immediate use, and concrete which is not of the required consistency at the time of placement shall not be used.

Re-tempering of concrete will not be permitted. Entire content of the mixer shall be removed from the drum before materials for the next batch are placed therein. Upon cessation of mixing for a considerable length of time, the mixer shall be cleaned thoroughly. Upon resumption of mixing, the first batch of concrete material placed in the mixer shall contain sufficient sand, cement, and water to coat the inside surface of the drum without diminishing the required mortar content of the mix.

(c) Central plant mixing - When mixed at a central plant, the mixer and methods used shall be in accordance with the requirements of Sub-Clause 4.2.3.6 (b). Mixed concrete shall be transported from the central mixing plant to the site of work in agitator or non-agitator trucks approved by the Engineer.

Agitator trucks shall be equipped with a water-tight revolving drum, and shall be capable of transporting and discharging concrete without segregation. The agitation speed of the drum shall be between 2 and 6 revolutions per minute. The volume of mixed concrete permitted in the drum shall not exceed the manufacturer's rating nor exceed 70% of the gross volume of the drum. Upon approval of the Engineer, truck mixers may be used in lieu of agitator trucks for transportation of central plant mixed concrete. Gross volume of agitator bodies, expressed in cubic metres, shall be as determined by the mixer manufacturer. The interval between introduction of water into mixer drum and final discharge time shall be a maximum of 45 minutes unless the use of additives have been approved. Depending on the type and usage of the approved additives this interval may be extended up to a maximum of 2 hours. During this interval the mixture shall be agitated continuously.

Bodies of non-agitator trucks shall be smooth and water-tight. Covers shall be provided when needed for protection against rainfall. The non-agitator trucks shall deliver concrete to the work site in a thoroughly mixed and uniform mass. Uniformity shall be deemed satisfactory if samples from the one-quarter and three-quarter points of the load do not differ more than 25 mm in slump. Placing of concrete shall be completed within 30 minutes after introduction of mixing water into the cement and aggregates or if admixture is used at a time to be determined by the Engineer.

(d) Truck mixing - Concrete may be mixed in truck mixers of approved design. Truck mixing shall be in accordance with the following provisions. The truck mixer shall be either a closed, water-tight, revolving drum or an open-top revolving-blade or paddle type. It shall combine all ingredients into a thoroughly mixed and uniform mass, and shall discharge the concrete with satisfactory uniformity. A maximum difference of 25 mm between slumps of samples from the one-quarter and three-quarter points of the discharge load shall be deemed satisfactory.

Mixing speed for revolving drum type mixers shall not be less than 4 revolutions per minute of the drum nor greater than a speed resulting in a peripheral velocity of the drum of 1 metre per second. For the open-top type mixer, mixing speed shall be between 4 and 16 revolutions per minute of the mixing blades or paddles. Agitation speed for both the revolving-drum and revolving blade type mixers shall be between 2 and 6 revolutions per minute of the drum or mixing blades or paddles.

The capacities of truck mixer shall be in accordance with the manufacturer's ratings except that they shall not exceed the limitation herein. Standard for normal rated capacity, expressed as percentage of the gross volume of the drum, shall not be more than 50% for truck mixing and 70% for agitating.

The concrete shall be delivered to the site of the work and discharge shall be completed within 45 minutes after the introduction of the mixing water into cement and aggregates unless the use of additives have been approved by the Engineer. Depending on the type and usage of

the approved additives this interval may be extended up to a maximum of 2 hours During this interval the mixture shall be agitated continuously.

When the concrete is mixed in a truck mixer, the mixing operation shall begin within 30 minutes after the cement has been mixed with the aggregates. Except when intended for use exclusively as agitators, truck mixers shall be provided with a water measuring device which will measure accurately the quantity of water for each batch. The delivered amount of water shall be within plus or minus 1% of the indicated amount when the tank, if mounted on the truck mixer, is satisfactorily and practically level.

(e) Hand mixing - Hand mixing will not be permitted, except in case of emergency, without written permission from the Engineer. When permitted, it shall be performed only on water-tight mixing platforms made of metal, etc. Concrete shall be turned and returned on the platform at least six times and until all particles of the coarse aggregate are covered thoroughly with mortar and the mixture is uniform.

4.2.3.7 Retempering Concrete

Retempering concrete by adding water will not be permitted under any circumstances. Concrete that is not within the specified slump limits at the time of placement shall not be used. Admixtures for increasing the workability or for accelerating the set will be permitted only with the written approval of the Engineer.

4.2.3.8 Consistency

Slump will be measured in accordance with AASHTO T 119 or JIS A 1101 and shall be in accordance with Table 4.2.1.3.

4.2.4 Construction

4.2.4.1 General

The Contractor shall maintain an adequate number of trained and experienced supervisors and foremen at the site to supervise and control the work. All construction, other than the concrete, shall conform to the requirements prescribed in other sections or Clauses for the several items of work entering into the complete structure.

4.2.4.2 Foundation

Preparation of foundations shall conform to the details as shown on the Drawings in accordance with the requirements of Section 3, Earthworks. The Engineer may order further excavation as necessary to obtain satisfactory foundations in the event that unsuitable foundations are encountered at the depths shown on the Drawings.

Pile foundations shall be constructed in accordance with the provisions set out in the other relevant Clauses and as shown on the Drawings.

4.2.4.3 Falsework

Falsework shall be built on foundations of sufficient strength to carry the loads without appreciable settlement. Falsework that cannot be founded on solid footings must be supported by ample falsework piling provided at the Contractor's expense.

Before constructing forms or falsework the Contractor, if required, shall submit detailed drawings of proposed forms or falsework for approval by the Engineer, but such approval shall not relieve the Contractor of any of his responsibilities under the Contract for the successful completion of the structure.

4.2.4.4 Formwork

Before concrete is placed the Engineer shall inspect all formwork and falsework and no concrete shall be placed until the Engineer has inspected and approved such formwork and falsework. Such approval shall not relieve the Contractor of any of his responsibilities under the Contract for the successful completion of the structure.

Internal formwork for hollow slab construction shall be made of plywood, thin metal plate or other materials. These materials shall have sufficient strength to resist the pressure and the buoyancy effects of fresh concrete.

Type and structure of joint and cover for the cylindrical form shall be tight to prevent any leakage of concrete, and shall be approved by the Engineer. Nominal diameter of cylindrical forms shall be the outer diameter, or the outer diameter of projecting portion in case of thin metal plate having projection. The height of the projection shall be less than 10 mm.

Internal forms shall be fixed in the correct position such that they will not displace or deform during placing concrete. U-shape bolts shall be used to fix the internal forms and the method of supporting and fixing the internal forms shall be approved by the Engineer. Care shall be taken to ensure that U-shape bolts and other items can resist the buoyancy forces on the formwork.

In falsework, bridge camber shall be considered in accordance with the Working Drawings prepared by the Contractor and approved by the Engineer.

4.2.4.5 Reinforcement

The Engineer shall inspect and approve all reinforcement in place in accordance with the requirements of Clause 4.3, before concrete is placed. An experienced steel fixer shall be present while all concrete is placed to ensure that no reinforcement becomes displaced during placing and if it does to reposition reinforcement before placing continues.

4.2.4.6 Placing Concrete

(a) General - All concrete shall be placed within the time specified in Sub-Clause 4.2.3.6. Concrete shall be placed in such a manner as to avoid segregation and the displacement of reinforcing bars and shall be spread in horizontal layers where practicable. Concrete shall be placed where necessary inside forms by hand shovels and in no instance shall vibrators be so manipulated to transport concrete inside formwork. Care shall be taken to prevent mortar from spattering forms and reinforcing steel and from drying ahead of the final covering with concrete. When spattering has occurred the forms and steel shall be cleaned with wire brushes or scrapers before concrete is placed around steel or in forms which have been spattered.

Troughs, pipes, or short chutes used as aids in placing concrete shall be positioned in such a manner that segregation of the concrete will not occur. All chutes, troughs, and pipes shall be kept clean and free from coating of hardened concrete or mortar. Concrete shall not be dropped freely over a vertical distance of more than 1.5 metres.

Concrete shall generally be placed continuously throughout each section of the structure or between indicated joints if shown on the Drawings or as directed by the Engineer.

If in an emergency it is necessary to stop placing concrete before a section is completed, bulkheads shall be placed as the Engineer may direct and the resulting joint shall be deemed a construction joint, and treated as specified herein below.

(b) Concrete columns - Concrete in columns, bents or walls shall be placed in one continuous operation subject to a maximum height of 4m unless shown on the Drawings or otherwise permitted by the Engineer.

(c) Concrete slab and girder spans - Slabs and girders having spans of 10 metres or less shall be placed in one continuous operation unless otherwise stated on the Drawings. Concrete preferably shall be deposited by beginning at the centre of the span working from the centre toward the ends.

Concrete in slab spans shall be placed in one continuous operation and in one layer for each span, unless otherwise stated on the Drawings.

Concrete in girders spanning more than 10 metres may be placed in two operations, the first operation being the placing of concrete in the girder stems to the bottom of the slab haunches or the bottom of the slab whichever is applicable. A period of at least 24 hours shall elapse between the completion of placing concrete in the girder and the commencement of placing concrete in slab.

The construction procedure for the concrete deck slab on steel box girders shall be so arranged as to eliminate excessive stress in new or recently placed concrete.

Immediately before placing concrete, the top surface of the previously placed concrete shall be hammered with a sharp hand tool (scrabbled) until the aggregate is exposed and cleaned. The Contractor shall check all falsework for shrinkage and settlement, and shall tighten all wedges to ensure minimum deflection of all formwork.

(d) Walls, piers, etc. - Where walls, piers, columns, struts, posts and other such structural members allow horizontal construction joints, concrete shall not be placed on top of other concrete which has not been allowed to set for 12 hours or more.

Work shall not be discontinued within 450 mm of the top of any face, unless provision has been made for a coping less than 450 mm thick, in which case, if permitted by the Engineer, the construction joint may be made at the underside of the coping.

(e) Culverts - The slabs of box culverts shall be placed for their full depth in one mass or layer and allowed to set not less than 12 hours before any additional work is done on them.

Before concrete is placed in sidewalls, bottom slabs shall be cleaned of all shavings, sticks, sawdust and other extraneous material.

The Contractor shall submit to the Engineer for approval his proposals for pouring culvert walls before commencing culvert construction. Concrete shall not be placed in layers more than one metre high relative to the concrete already placed. Deposition shall proceed in a systematic manner.

(f) Depositing concrete underwater - Concrete shall not be deposited in water except with the approval of the Engineer and with his immediate supervision, and by the method described in this paragraph.

To prevent segregation, the concrete shall be carefully placed in a compact mass in its final position by means of a tremie tube or pipe, or a closed bottom-dump bucket, or by other means, and shall not be disturbed after being deposited. Special care must be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Concrete seals shall be placed in one continuous operation. When a tremie tube or pipe is used, it shall consist of a tube or pipe not less than 250 mm in diameter, constructed in sections having flanged couplings fitted with gaskets.

The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the concrete and permit its being lowered rapidly when necessary to choke off or retard the flow. The tremie shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie shall contain sufficient concrete to prevent any water entry.

When concrete is placed with a bottom-dump bucket, the bucket shall have a capacity of not less than 1.20 cubic metres and shall be equipped with loose-fitting top covers. The bottom door shall open freely downward and outward when tripped. The bucket shall be completely filled and be lowered gradually and carefully until it rests on the surface upon which the concrete is to be deposited. It shall then be raised very slowly during the discharge travel, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

Dewatering shall proceed only when the concrete seal is considered strong enough to withstand any pressures to be exerted upon it. This time will be decided by the Engineer. All laitance or other unsatisfactory material shall be removed from the exposed surface by scraping, jetting, chipping or other means which will not unduly injure the seal.

(g) Construction joints - Construction joints shall be located where shown on the Drawings or permitted or instructed by the Engineer. Construction joints shall be perpendicular to the principal lines of stress and in general shall be located at points of minimum shear.

At horizontal construction joints, details shall be as approved by the Engineer. Before placing fresh concrete, the surfaces of construction joints shall be scabbled, sandblasted or washed and scrubbed with a

wire brush to expose clean aggregate, drenched with water until saturated, and kept saturated until the new concrete is placed. Immediately prior to placing new concrete the forms shall be drawn tight against the concrete already in place and the old surface shall be coated thoroughly with a 1.5 mm thick coating of neat cement mortar. Concrete in substructures shall be placed in such a manner that all exposed horizontal construction joints will be truly horizontal.

Where vertical construction joints are necessary, reinforcing bars shall extend across the joint in such a manner as to make the structure monolithic. Special care shall be taken to avoid construction joints through panelled wing walls or other large surfaces which are to have an architectural finish. Necessary dowel, load-transfer devices, and bonding devices shall be placed as shown on the Drawings or directed by the Engineer.

(h) Expansion joints – Expansion joints shall comprise formed polythene elastic material with asphaltic sealant, 20mm thick, and shall be located and formed as required on the Drawings. Cut-off plate for water stops used for the expansion joints shall be placed in accordance with the Drawings. The water stops shall be held firmly in place to prevent displacement during concreting. If after placing concrete water stops are materially out of position or shape, the surrounding concrete shall be removed, the water stop reset, and the concrete replaced, all at the Contractor's expense.

Water stop shall be furnished full length for each straight portion of the joint, without field splices. Water stop shall be cut and spliced at changes in direction as may be necessary to avoid buckling or distortion. All field splices shall be performed by heat sealing, hot-air welding or vulcanising the adjacent surfaces in accordance with the manufacturer's recommendations to form continuous watertight joints.

Dowel bars, where required, shall be complete with uPVC sleeves and shall be accurately installed in expansion joints in accordance with the Drawings or as directed by the Engineer. Particular care shall be taken to ensure that concrete cannot enter the uPVC sleeves during casting.

(i) Open joints - Open joints shall be constructed where shown on the Drawings by insertion and subsequent removal of a wooden strip, metal plate, or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless so specified on the Drawings.

(j) Anchor bolts - All necessary anchor bolts shall be accurately set in holes formed while the concrete is being placed. Holes may be formed by inserting in the fresh concrete oiled wooden plugs, metal pipe sleeves, or other approved devices, and withdrawing them after the concrete has partially set. Holes so formed shall be at least 100 mm in diameter. Bolts shall be set accurately and fixed with grout completely filling the holes. The grout shall be non-shrink mortar of a type approved by the Engineer.

(k) Shoes and bearing plates – Not applicable to the Works in Package D

(l) Drainage holes and weep holes - Drainage holes and weep holes shall be constructed in the manner and at the locations indicated on the

Drawings or required by the Engineer. Ports or vents for equalizing hydrostatic pressure shall be placed below low water.

(m) Forms for weep holes through concrete shall be PVC pipe. Exposed surfaces of weep drain pipe shall be flush with the concrete.

(n) Pipe, conduits, and ducts - Pipes, conduits, and ducts that are to be encased in concrete shall be installed by the Contractor before the concrete is placed. Unless otherwise indicated, pipe embedded in concrete shall be standard, light-weight, non-corrosive pipes. Pipes shall be held or braced rigidly during concrete placement in order to prevent their displacement.

(o) Piers and abutments - Not applicable to the Works in Package D

4.2.4.7 Curing Concrete

Immediately after forms have been removed and finishing completed, all concrete shall be cured by one of the following methods. The Engineer will specify the concrete surface which may be cured by either method.

(a) Water method - The entire exposed surfaces other than slabs shall be protected from the sun and the whole structure shall be covered with wet burlap, cotton mats, or other suitable fabric for a period of at least seven days. These materials shall be kept thoroughly wet for the entire curing period. Curbs, walls, and other surfaces requiring a rubbed finish may have the covering temporarily removed for finishing, but the covering must be restored as soon as possible. All concrete slabs shall be covered as soon as possible with sand, earth or other suitable material and kept thoroughly wet for at least seven days. This covering material shall not be cleared from the surface of the concrete slabs for a period of twenty one days.

If wood forms are allowed to remain in place during the curing period, they shall be kept moist at all times to prevent them from shrinking.

(b) Membrane forming curing compound - All surfaces shall be given the required surface finish prior to application of the curing compound. During the finishing period, the concrete shall be protected by the water method of curing.

Membrane curing compound shall be applied after the removal of forms, or after the disappearance of surface water. It can be sprayed or applied to the concrete surface by means of an applicator in one or more coats at the rate instructed by the manufacturer.

Should the membrane seal be broken or damaged before the expiration of the curing period, the damaged area shall be immediately repaired by the application of additional membrane material.

The Contractor's proposals for the use of liquid membrane curing compound and the locations shall be subject to the approval of the Engineer.

4.2.4.8 Removal of Formwork and Falsework

(a) Time of removal - formwork and falsework shall not be removed without the approval of the Engineer. The Engineer's approval shall not relieve the Contractor of responsibility for the safety of the work. Blocks and bracing shall be removed at the same time as the forms and in no case shall any portion of wooden forms be left in the concrete.

Falsework removal for continuous or cantilevered structures shall be as approved and directed by the Engineer and shall be such that the structure is gradually subjected to its working stress.

When the time for removal of forms and supports is determined based on concrete strength tests, such removal shall not begin until the concrete has attained the percentage of the specified design strength shown in the table below.

If field operations are not controlled by compressive strength tests, the time shown below for removal of forms and supports shall be used as a minimum:

In continuous structures, falsework shall not be released in any span until the first and second adjoining spans on each side have reached the strength specified herein or in the special provisions. When cast-in-place post-tensioned bridges are constructed, falsework shall remain in place until all post-tensioning has been accomplished.

Removal of Formwork and Falsework

Structure	Standard Concrete	Early Strength Concrete	Percentage of Design Strength
Centering under girders, beams, frames or arches	14 days	7 days	80%
Floor slabs	14 days	7 days	70%
Walls	1 day	12 hours	-
Columns	2 days	1 day	-
sides of beams and all other vertical surfaces	1 day	12 hours	-

Falsework under all spans of continuous structures shall be completely released before concrete is placed in railings and bridge parapets or other upper elements depending on the type of structure.

Forms and falsework shall not be released from under concrete without first determining if the concrete has gained adequate strength without regard to the time element. In the absence of strength determinations, the forms and falsework are to remain in place until removal is permitted by the Engineer.

The forms for footings constructed within cofferdams or cribs may be left in place when, in the opinion of the Engineer, their removal would endanger the safety of the cofferdam or crib, and when the forms so left intact will not be exposed to view in the finished structure. All other forms shall be removed whether above or below the ground line or water level.

All formwork shall be removed from the cells of concrete box girders within which utilities are required, and all formwork except that necessary to support the deck slab shall be removed from the remaining cells of the box girder.

To facilitate finishing, forms used on ornamental work, railings, parapets, and exposed vertical surfaces shall be removed at least 12 but not more than 48 hours later depending upon weather conditions.

In order to determine the condition of concrete in columns, forms to columns shall always be removed before releasing supports from beneath beams and girders.

Falsework supporting the deck of rigid frame structures shall not be removed until fill has been placed behind the vertical legs.

(b) Patching - Immediately following removal of the forms all projecting wires or metal devices that have been used for holding the forms in place shall be removed or cut back at least 25 mm beneath the surface of the concrete. Fins or runs of mortar and all irregularities caused by form joints shall be removed. Small holes, depressions, and voids that show on the concrete shall be filled with cement mortar mixed in the same proportions as that used in the body of the work, except without coarse aggregate.

The surface of this mortar shall be floated with a wooden float before initial set takes place. It shall be uniform in colour with the surrounding concrete and neat and workmanlike in appearance.

(c) Cause for rejection - Excessive honeycombing shall be sufficient cause for rejection of portions of the structure containing this honeycombing. The Contractor, on receipt of written orders from the Engineer, shall remove and rebuild such portions of the structure at his own expense.

4.2.4.9 Finishing Concrete

All concrete surfaces exposed in the completed work shall comply with the requirements of Item (c) Ordinary finish herein except where otherwise shown or specified.

(a) Concrete bridge decks - Immediately after placing concrete, concrete decks shall be struck off with templates to provide proper transverse sections and shall be hand finished smooth to the concrete levels. Finish shall be slightly but uniformly roughened by brooming. The finished surface shall not vary more than 10 millimetres from a 4 metre straightedge placed parallel to the centreline of the roadway and 10 millimetres from a transverse template cut to the true cross section of the roadway. (This Item is not applicable to this Package)

(b) Curb, footpath and concrete paved surfaces - Exposed faces of curbs and footpath shall be finished true to lines and grades. The curb surface shall be wood floated to a smooth but non-slippery finish. Footpath surfaces shall be slightly but uniformly roughened by brooming across the direction of travel. Concrete paved surfaces shall be wood float finished.

(c) Ordinary finish - An ordinary finish is defined as the finish left on a surface after the removal of the forms when all holes left by form ties have been filled, and any minor surface defects have been repaired. The surface shall be true and even, free from depressions or projections and of reasonably uniform colour.

Repaired surfaces, the appearance of which is not satisfactory, shall be "rubbed" as specified in Item (d) Rubbed finish.

The concrete in bridge seats, caps, and tops of walls shall be struck off with a straightedge and floated to true grade. Unless shown on the Drawings the use of mortar topping for concrete surfaces will not be permitted.

(d) Rubbed finish - After the removal of forms the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in patching to set thoroughly. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in the same proportions as those used in the concrete being finished. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place. After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform colour.

After the final rubbing has been completed and the surface has dried, it shall be rubbed with burlap to remove loose particles and laitance. The final surface shall be free from all unsound patches, paste, powder and objectionable marks.

(e) Backfill and road fills - All spaces which have been excavated and the volumes of which are not occupied by the concrete structure shall be backfilled and compacted with acceptable material in accordance with the provisions of Section 3 of these Specifications.

If there is likelihood of water accumulating behind any wall, the backfill shall not be placed until after the retaining, diaphragm, or spandrel walls are 28 days old. No fill shall be placed over arches and slabs until the concrete is 28 days old or until test specimens indicate the concrete has attained the required 28-day strength.

(f) Loading - Traffic or heavy construction equipment shall not be allowed on reinforced concrete structures until 28 days have elapsed from the last placing of concrete except as noted below. If it is proposed to use the structure at an earlier date, extra test specimens shall be cast. The structure may be used when tests of these specimens show that the concrete has attained its specified 28-day strength.

4.2.4.10 Floor Slab Finishes

(a) General

Floor slabs shall be finished as specified below unless shown otherwise on the Drawings or directed by the Engineer.

(b) Floated finish

After the concrete has been placed, struck off, consolidated, and levelled, it shall not be worked further until the water sheen has disappeared, and/or when the mix has stiffened sufficiently to permit the proper operation of a power-driven float. The surface shall then be consolidated with power-driven floats. Hand floating with wood or cork-faced floats shall be by machine. All high spots shall be cut down and all low spots filled to within a tolerance of 1/1000. The surface shall then be refloated immediately to a uniform, smooth, granular texture.

Floated finish shall be required for concrete flat work surfaces that will receive waterproof membranes.

(c) Towelled finish

The surface shall be finished first with power floats as specified above for "Floated Finish", then with power trowels, and finally with hand trowels.

The finished surface shall be dense and smooth, free of any trowel marks, uniform in texture and appearance and shall be in a true plane with a tolerance of 3 mm in 3.0 m. On surfaces intended to receive resilient floor coverings, any defects that would show through the floor covering shall be removed by grinding.

Trowelled finish shall be required for concrete flat work surfaces that will be exposed, or that will receive resilient flooring, carpeting, or any other floor coverings requiring a smooth base slab.

(d) Broomed Finish

Immediately after the concrete has been floated, as specified above under "Floated Finish" to a true plane the surface shall be given a scored texture, at right angles to the direction of traffic, by lightly drawing a broom across the surface. Use a stiff broom for ramps.

Broomed finish shall be required for exposed concrete ramps and walks.

(e) Towelled Floated Finish

The surface shall be finished first as specified above for "Trowelled Finish", then the surface shall be finished with a wood floats to obtain a uniform, non-directional; grainy or sandy texture.

Trowelled floated finish shall be required for site concrete (borders, bands, curbs, paving, steps).

(f) Hardener and Dustproofer

After the concrete surface has been finished and cured for at least 28 days, apply 3 coats of hardener and dustproofer in accordance with manufacturer's written instruction. Allow to dry between coats.

Hardener and dustproofer shall be required for all exposed interior concrete floor surface that will receive carpeting.

(g) Non-Slip Finish

Trowel abrasive aggregate into the surface at the floating stage at the rate as specified by the manufacturer.

Non-slip finish shall be required at landings or stair treads.

4.2.4.11 Cement Mortar Surfacing

Where shown on the Drawings, stair treads shall be plastered with a 20 mm thick 1:2 cement :sand mortar screed which shall be finished with a non-slip finish as specified in Clause 4.2.4.10.

4.2.4.12 Cleaning Up

Upon completion of structure and before final acceptance, the Contractor shall remove all falsework, falsework piling, etc., down to 1.0 metre below the finished ground line. Excavated, or useless materials, rubbish, etc. shall be removed from the site and the site shall be left in a neat and presentable condition satisfactory to the Engineer.

4.3 REINFORCING STEEL BARS

4.3.1 Description

This work shall consist of furnishing, fabricating, and placing reinforcing steel bars of the type and size provided in accordance with these Specifications and in reasonably close conformity with the Drawings or as directed by the Engineer.

4.3.2 Materials

Reinforcing steel shall conform to the requirements of the following specifications except that the weights of the standard bar sizes will be taken as per Table 4.4.2.a and Table 4.4.2.b, irrespective of the specification used in manufacture.

Round Bar :

A-I (CT-3) 22TCN 18-79; or
JIS G 3112 (Grade SR 235); or
ASTM A615

Deformed Bars :

A-II (CT-5) 22TCN 18-79; or
JIS G 3112 (Grade SD 295A); or
JIS G 3112 (Grade SD 345); or
ASTM A615

Reinforcing bars shall be kept off the ground and stored within a building or provided with suitable cover.

4.3.3 Construction

4.3.3.1 Fabrication

(a) Reinforcing bars shall be accurately formed to the shapes and dimensions indicated in the design, and shall be fabricated in a manner that will not injure the material.

(b) Unless otherwise permitted, all reinforcing bars requiring bending shall be bent cold. When reinforcing bars are bent by heating, the entire operation shall be approved by the Engineer. Should the Engineer approve the application of heat for field bending reinforcing bars, precautions shall be taken to ensure that the physical properties of the steel will not be materially altered.

(c) Reinforcing bars that cannot be straightened by means of fabrication shall not be used. Bars partially embedded in concrete shall not be bent except as shown on the Drawings or otherwise permitted.

(d) Qualified workers shall be employed for cutting and bending, and proper appliances shall be provided for such work.

(e) If it is necessary for the Engineer to ascertain the quality of reinforcing bars, the Contractor shall test reinforcing bars, at his own expense, by means as directed by the Engineer.

4.3.3.2 Placing

(a) Reinforcing bars before being positioned shall be cleaned and free from rust, dirt, mud and loose scale and from paint, oil, or any other foreign substance that destroys or reduces the bond.

(b) Reinforcing bars shall be accurately placed in proper position so that they will be firmly held during placing concrete. Reinforcing bars for erecting shall be used when needed.

(c) Bars shall be tied at all intersections by using annealed iron wire 0.9 mm or larger diameter or suitable clips. Welding will not be permitted for this requirement.

(d) Distances from the forms shall be maintained correctly by means of metal hangers, mortar blocks, metal supports, or other supports approved by the Engineer.

(e) Reinforcing bars shall be inspected by the Engineer after placing. When a long time has elapsed after placing reinforcing bars, they shall be cleaned and inspected again by the Engineer before placing concrete.

4.3.3.3 Splicing

(a) When it is necessary to splice reinforcing bar at points other than shown on the designs, positions and methods of splicing shall be determined based on strength calculations approved by the Engineer.

(b) In lapped splices, the bars shall be lapped the required length and wired together at several points by using annealed iron wire larger than 0.9 mm.

(c) Exposed reinforcing bars intended for bonding with future extensions shall be effectively protected from injury and corrosion.

(d) Welding of reinforcing steel shall be done only if detailed on the Drawings or if authorized by the Engineer in writing.

(e) Substitution of different size bars shall be permitted only upon the specific authorization of the Engineer. If steel is substituted, it shall be of a size equivalent to the design size or larger.

4.4 MEASUREMENT AND PAYMENT

4.4.1 Concrete

(a) Measurement

Measurement shall be made of the volume of concrete of the various classes in place and approved by the Engineer.

In computing quantities the dimensions used shall be those shown on the Drawings or ordered in writing by the Engineer but the measurement shall not include any concrete used for the construction of temporary works. No deduction from the measured quantity shall be made for the volume occupied by pipes less than 200 mm in diameter nor for reinforcing steel, anchors, conduits, weep holes or piling.

No pay allowance shall be made for any increased cement content, for any admixtures nor for any finishing of any description of concrete or concrete floor.

Unless described otherwise, Concrete used for the works on other Pay Items in these Specifications (e.g. precast concrete culverts) will not be measured for payment under this Clause.

(b) Payment

Payment for the various classes of concrete shall be paid for at the respective unit rate per cubic metre entered in the Bill of Quantities. The payment shall be full compensation for furnishing and placing all

materials, including all labour, tools, equipment, formwork, falsework (scaffolding and supporting; for mixing, placing, finishing and curing the concrete, etc., and all incidental work thereto.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.5	Concrete Class E (Box Culvert): including supply, placement and formwork	m^3
2.4.4 3.3.2 3.4.1 3.5.1 3.6.2	Concrete Class E: including supply, placement and formwork	m^3
3.3.3 3.4.2 3.6.3	Concrete Class F: including supply, placement and formwork	m^3
2.3.6 3.3.4	Concrete Class G (Levelling Concrete): including supply, placement and formwork	m^3
3.4.3 3.5.2 3.6.4	Concrete Class G: including supply, placement and formwork	m^3

4.4.2 Reinforcing Steel Bar

(a) Measurement

The quantity of reinforcing steel bar to be paid for shall be the mass (kg) of reinforcing bar erected as shown on the Drawings or ordered by the Engineer in writing. The mass calculated will be based upon the following tables :

Table 4.4.2.
Unit Mass of Reinforcing Steel Bars

Nom. Bar Size (diameter mm)	9	10	12	14	16	18	20
Mass per linear metre in kg	0.499	0.617	0.888	1.210	1.580	2.000	2.470

Nom. Bar Size (diameter mm)	22	28	30	32	36	40	-
Mass per linear metre in kg	2.98	4.83	5.55	6.31	7.99	9.89	-

The lengths to be taken in calculating the mass for the purpose of payment shall be shown on the Drawings or ordered in writing by the Engineer.

No measurement or payment will be made for splices added by the Contractor for his convenience or for splices which are not shown on the Drawings and are not approved by the Engineer.

Clips, ties or other material used for positioning and fastening the reinforcing bars in place shall not be measured for payment. Reinforcing steel bars used for precast concrete elements shall not be measured for payment under this Clause.

(b) Payment

Payment for reinforcing steel bar shall be made at the unit rate entered in the Bill of Quantities. This payment shall be full compensation for furnishing all labour, equipment, and materials, necessary for fabricating, bending, assembling and erecting reinforcing bar, for unloading at the specific location, storing and handling of reinforcing steel bar and any other associated costs.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.7 2.4.7 3.3.14 3.4.5 3.5.3 3.6.5	Deformed Reinforcing Bars: including supply, bending and placement	kg

4.4.3 Expansion Joints

(a) Waterstop

Measurement shall be made of the length in metres of water stops constructed in accordance with the Drawings and the specification.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for providing all materials equipment, labour and all incidentals required for completing the water stop and for protecting the waterstop from damage or sunlight exposure, all to the Engineer's approval.

(b) Joint Filler

Measurement shall be made of the area of the expansion constructed in accordance with the Drawings and the specification.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for providing all materials (formed elastic polythene material, and asphaltic sealant), equipment, labour and all incidentals required for completing joint filler for the expansion joint to the Engineer's approval.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.8	Water Stop: including supply, installation and protection	m
2.3.9	Elastic Joint Filler (t=20 mm): including supply and installation	m^2

SECTION 5. PILING WORKS
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SECTION 5. PILING WORKS

5.1 GENERAL

This section covers the general and specific requirements for piling works including precast concrete piling and timber piling to be furnished and driven in the various parts of the Works as shown on the Drawings or directed by the Engineer.

5.2 PRECAST CONCRETE PILING

5.2.1 General

This work shall consist of precast reinforced concrete piling furnished and driven in accordance with these specifications and in close conformity with the requirements on the Drawings or elsewhere in the Contract Documents.

In this contract package precast concrete piling foundations shall be constructed for the conveyance sewer.

5.2.2 Materials

5.2.2.1 General

Pre-cast reinforced concrete piles shall be constructed in accordance with the details shown on the Drawings, of concrete Class D, mixed and placed in accordance with the provisions of Clause 4.2 of these Specifications. Reinforcement shall comply with the provisions of Clause 4.3 of these Specifications. Main reinforcing bars shall be supplied in one complete length and should this prove impractical separate lengths shall be effectively spliced by a method approved by the Engineer. The pile shall be so straight that a line stretched from tip to butt on any face will not be more than 1/1000 of the length of the pile from the face of the pile at any point.

Bearing piles shall not be constructed or ordered until the Engineer instructs the required lengths.

5.2.2.2 Formwork

Forms for pre-cast piles shall conform to the general requirements for concrete formwork as described in Clause 4.2 of these Specifications. Forms shall be accessible for compacting the concrete. Side forms may be removed at any time not less than 24 hours after completion of the placing of concrete but the entire pile shall remain supported for at least 7 days and shall not be subjected to any handling stress until the concrete has been in place for 21 days or such reduced time as the Engineer may decide as a result of tests.

5.2.2.3 Reinforcement

Reinforcement shall be in accordance with the provisions set out in Clause 4.3 and positioned as shown on the Drawings.

5.2.2.4 Casting

The piles shall be cast in a horizontal position. Special care shall be taken to place the concrete so as to produce a pile free from any air pockets, honeycomb or other defect.

Concrete shall be placed continuously and shall be compacted by vibrating or by other means satisfactory to the Engineer. The forms shall be slightly overfilled, the surplus concrete screeded off, and the top surface finished to a uniform, even texture similar to that produced by the forms.

5.2.2.5 Finish

When removed from the forms piles shall present true, smooth, even surfaces free from any surface blemishes, and true to the dimensions shown on the Drawings.

5.2.2.6 Curing

Concrete piles shall be covered with wet burlap immediately after placing is complete and shall be kept continuously wet for at least 7 days.

5.2.2.7 Handling

When raising or transporting pre-cast concrete piles the Contractor shall provide slings and other equipment necessary to prevent any appreciable bending of the pile or cracking of the concrete. No concrete pile shall be lifted other than by slinging from the lifting holes, the positions of which shall be submitted to and approved by the Engineer. Piles damaged in handling or driving shall be replaced. Concrete piles shall be so handled at all times to prevent breaking or chipping the edges.

Piles shall not be driven until 28 days have elapsed from the time of casting or such reduced time as the Engineer may decide as a result of tests.

5.2.3 Construction

5.2.3.1 Preparation for Driving

(a) Caps - The heads of all concrete piles, when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design having a suitable cushion next to the pile head and fitting into a casing which in turn supports a timber shock block. No pile head will be held so firmly that the slight rotation of the pile normally occurring while the pile is being driven will be prevented.

(b) Splicing piles - Splicing of piles shall be made by means of fabricated steel sleeves as shown on the Drawings. The Contractor shall submit to the Engineer for his approval the proposed design of the sleeves and the method of attachment to the pile lengths to be spliced, in accordance with the procedures in Clause 1.3.5 of the Specification

5.2.3.2 Handling, Pitching and Driving

(a) General - The main setting out for the piles is to be completed prior to commencement of driving. Secondary or individual pile setting out is to be completed and agreed not less than 8 hours prior to commencing work on the piles concerned. All main setting out points, lines and stations are to be maintained safe and undisturbed until the work is complete.

Piles shall be pitched accurately in the positions and driven to the lines shown on the Drawings or fixed by the Engineer. Piles deflected from the vertical or proper line shall, where ordered by the Engineer, be withdrawn and re-pitched until the correction of the position or line of any pile will be permitted. Any pile damaged by reason of improper driving or driven out of its proper location or driven below the elevation fixed by the Drawings or by the Engineer, shall be corrected at the Contractor's expense by one of the following methods approved by the Engineer for the pile in question :

- The pile shall be withdrawn and replaced by a new and, if necessary, longer pile. Any holes from which piles are withdrawn shall be packed with approved non-plastic material before re-driving takes place; or
- A second pile shall be driven adjacent to the defective or low pile.

  All piles pushed up by the driving of adjacent piles or by any other cause shall be driven again.

(b) Batter piles – Where batter piles are called for they shall be driven accurately to the batter shown on the Drawings. The pile frame employed for the driving of the batter piles shall have leads capable of adjustment to the required angle. When piles have to be driven below the level of the bottom of the leads extension leads shall be provided except where the use of a follower is specifically permitted by the Engineer. (Note: Batter Piles are not applicable to the Works for Package D)

(c) Driving equipment - Before any piling work is commenced the Contractor shall submit to the Engineer full details of the pile driving equipment and the method of carrying out the work he intends to use. All piles shall be provided with caps for driving as specified in Clause 5.2.3.1 above. For special types of piles, driving head mandrels, or other devices in accordance with these requirements shall be provided so that piles may be driven without damage.

Piles shall be driven with steam, air or diesel hammers, a combination of hammers with water jets or gravity hammers.

In general:

- where diesel hammers are used for driving pre-cast concrete piles, the energy of the hammer shall numerically approximate one half of the weight of pile plus 4000 kg.
- when gravity hammers are used for driving pre-cast concrete piles, the drop of the hammer shall not exceed 2.5 metres and the hammers shall have a weight of not less than half the weight of the pile. The fall shall be regulated so as to prevent injury to the pile.
- plant and equipment furnished for steam and air hammers shall have sufficient capacity to maintain, under working conditions, the pressure in the manner specified by the manufacturer. The boiler or tank shall be equipped with an accurate pressure gauge, and another gauge shall be supplied at the hammer intake.

(d) Driving - Piles shall be supported in line and position with leads while being driven. Pile drive leads shall be constructed so as to afford freedom of movement of the hammer, and they shall be held firmly in position to ensure rigid lateral support to the pile during driving. Except where piles are driven through water, the leads shall be of sufficient

length to make the use of a follower unnecessary, and shall be so designed as to permit the proper placing of batter piles. Once started driving shall be continuous.

When water jets are considered by the Engineer to be necessary, the number of jets and the nozzle volume and pressure shall be sufficient to freely erode the material adjacent to the piling. The plant shall have at all times a pressure of at least 7 kPa (7kg/cm2) at two 20 mm dia jet nozzles. Before the required penetration is reached, the jets shall be shut off and the piles driven by hammer to final penetration.

A detailed accurate record of the driving of all piles shall be kept by the Engineer. The Contractor shall give every assistance to the Engineer to help him keep this record which will include the following : pile numbers, positions, types, sizes, actual lengths, dates driven, lengths in footings, penetration under final blows of the hammer, striking energy of the hammer, length cut off, and final pay lengths. No pile shall be driven near freshly placed concrete.

(e) Bearing values - Piles shall be driven to a bearing value of not less than that shown on the Drawings or advised by the Engineer. The Engineer will specify the penetration and the Contractor shall drive the piles to the penetration specified, but if the Engineer is not satisfied that the desired bearing value has been attained, he may instruct action as for a defective pile as detailed in Clause 5.2.3.2. of this section. Provided that the pile is not defective because of the failure of the Contractor to fulfil his obligations under this Contract, both the first pile and its replacement will be measured for payment under this clause.

(f) Pile Head Treatment - Concrete piles shall be cut off as indicated on the Drawings or as directed by the Engineer at such elevation that the pile reinforcement will extend into and connect with the cap or footing.

Unless otherwise specified, pile cut-off length shall become the property of the Contractor and shall be removed from the Site.

Reinforced concrete piles may be cast the full length of the reinforcing bars, provided that the concrete is cut off to expose the steel as shown on the Drawings after the piles have been driven.

5.2.3.3 Test Piles

The Engineer may order the execution of test piles as he may consider necessary to ascertain the type of the foundation for the project. The Contractor shall furnish and execute test piling at the locations designated by the Engineer.

The lengths of the piles shown on the Drawings are based on information obtained from previous site investigations. However, piles of different lengths may be required as directed by the Engineer. Before final pile lengths are settled, the Contractor shall construct to the lengths shown on the Drawings such pilot piles as may be found necessary. These piles shall be driven in the positions specified by the Engineer and the Contractor shall assist the engineer in making a full, detailed record of the driving of all test piles throughout the full depth of driving.

After attaining the approved set, driving shall be continued until the Engineer directs that it shall cease. Driving of test piles beyond the point at which the approved set is obtained will be called for to demonstrate that driving resistance continues to increase. The Contractor shall then furnish the

remainder of the piles in the structure. In determining the lengths of piles the Contractor shall base his list on the lengths assumed to remain in the completed structure.

Note that test piles are not applicable to Package D.

5.3 TIMBER PILING

5.3.1 General

Timber piles shall be driven to the depths and at the spacing (or density) as shown on the Drawings for the foundations of parts of the conveyance sewer, for foundations of sewer outlets or as directed by the Engineer.

5.3.2 Materials

Timber Piles (Wooden Piles) shall be cut from Paper Bark or other locally available timber which, subject to the Engineer's approval, is suitable for the intended application. Piles shall be of single length, not shorter than 4500 mm and with diameter not less than 80 mm at any point in the length and not greater than 150 mm and shall be straight to a tolerance of 50 mm over their full length, stripped of any branches and of sound condition. Piles which do not comform to the foregoing requirements shall be removed from the Site. Splicing shall not be permitted.

5.3.3 Construction

Timber piles shall be driven at the density of 25 per square metre to depths such that the pile heads, after allowing for trimming off the top 100 mm correspond to the lines and levels 100 mm below the underside of the upper surface of the sand layer as shown on the Drawings.

Piles shall be driven true and plumb and spacings shall be regular. Any pile which is split, broken, or is more than 300 mm out of position shall be replaced at the Contractor's expense.

5.4 MEASUREMENT AND PAYMENT

5.4.1 Reinforced Concrete Piling

(a) Supply of Reinforced Concrete Piles

Measurement shall be made of the length of precast reinforced concrete piles furnished in compliance with the Drawings, the Engineer's instructions and the requirements of these specifications and stockpiled in good condition at the site of the work by the Contractor, and accepted by the Engineer.

No allowance will be made for the length of piles furnished by the Contractor to replace piles previously accepted by the Engineer that are subsequently lost or those that are damaged prior to completion of the Contract while in stockpile, or during handling or driving, and are ordered by the Engineer to be removed from the site of the work or disposed of otherwise.

The length to be cut back to expose reinforcement for incorporation in the pile cap shall not be included for measurement.

Payment for shall be made for at the rate per linear metre entered in the Bill of Quantities. The rate shall constitute full compensation for supply of piles, hardware, splicing collars and all other materials, labour, equipment, transportation and stacking on the Site and other incidental equipment and work.

The following pay items shall be measured and paid under this clause:

Pay Item No.	Description	Unit of Measurement
2.3.2	Reinforced Concrete Piling 300 x 300 : including supply only	m

(b) Driving Reinforced Concrete Piles

Measurement shall be made of the length of pre-cast reinforced concrete piles actually driven and accepted. The pay lengths of the satisfactorily driven piles shall be measured from the tip to the cut-off.

Payment for shall be made at the rate per linear metre entered in the Bill of Quantities. The rate shall constitute full compensation for labour, equipment, transportation including driving, jetting, welding, splicing and all related tools, rigs, cranes, hammers, jets, and other incidental equipment and work.

The following pay items shall be measured and paid under this clause:

Pay Item No.	Description	Unit of Measurement
2.3.3	Driving of Reinforced Concrete Piles: including handling pitching, driving to required resistance	m

(c) Pile Head Treatment

Measurement shall be made of the number of pile heads cut back and with reinforcement bent as shown on the Drawings and approved by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities which shall constitute full compensation for labour, equipment, transportation and all other incidental requirements to complete the work.

The following pay items shall be measured and paid under this clause:

Pay Item No.	Description	Unit of Measurement
2.3.4	Pile Head Treatment: including breaking back pile head and bending of reinforcement	No.

5.4.2 Timber Piling

Measurement shall be made of the length of timber piling driven and approved by the Engineer. The length determined shall be calculated by the multiplying the number of piles by the nominal length of 4500 mm. Piles shorter than 4500 mm shall not be counted for payment unless specifically approved by the Engineer in instances where full penetration is prevented by ground conditions.

The length of any pile above the level of the head of the pile shown on the Drawings shall not be measured for payment. Piles, which after cutting off to the required level, are shorter than 4500 mm similarly shall not be measured unless the Engineer consents to shorter lengths in which case actual driven lengths shall be measured.

Payment shall be made at the rate per metre entered in the Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of the timber piling.

The following pay items shall be measured and paid under this clause:

Pay Item No.	Description	Unit of Measurement
2.3.1 3.3.1 3.6.1	Timber Piling 80 - 100 dia x 4500: including supply and installation	m

SECTION 6. ROADS AND PAVEMENTS
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SECTION 6. ROADS AND PAVEMENTS

6.1 GENERAL

This section covers the requirements for the construction of roadworks in Package D.

Roadworks to be completed include the following:

- Reconstruction and reinstatement of those portions of roadways which have been disturbed by the works for the improvement of the existing combined sewers in the city area;
- Construction of an operation/maintenance road along the major portion of the route of the conveyance sewer leading from the Intermediate Wastewater Pumping Station including a section of road from the new public road to the interface with Package E near the abutment of the new bridge across the Tac Ben Ro Canal (to be constructed under Package E).

All roadworks shall be constructed to the lines, grades and levels shown in the Drawings.

This section shall be read in conjunction with Section 7 for roadworks in relation to sewer works.

6.2 EARTHWORKS FOR ROADS

All earthworks for road construction shall be carried out in accordance with the requirements of Section 3.

6.3 PREPARATION OF SUBGRADE

6.3.1 General

This Clause specifies the requirements for the preparation of the surface on which the sub-base for road construction is to be constructed.

6.3.2 Testing and Preparation

Before placing any sub-base or base course the sub-grade shall be prepared as follows.

(a) All surfaces below carriageway, footways and hard shoulders shall, after reinstatement of any soft areas, be well cleaned and free from mud and slurry.

(b) The surface if dry shall be watered and compacted by 4 passes of a smooth wheeled roller having load of 45 kN/m (45 kg/cm) width or 8/10 tonne tire roller.

(c) The formation shall be regulated and trimmed to the road width as shown on the Drawings by using a motor grader.

(d) The trimmed formation shall be rolled by 1 pass of a smooth wheeled roller having and load of 22kN/m (22 kg/cm) width or a vibratory roller having a static load of 8kN/m (8 kg per cm) width or vibratory plate compactor having a static pressure under base plate of not less than 14kPa

The sub-grade shall be in such a condition that it will carry 8 to 10 ton smooth wheel roller without any deformation and/or visible springing effect.

Any portion of the subgrade which shows deformation under the above loading shall be replaced with sub-base course material and re-rolled until no deformation occurs under rolling.

6.4 SUB-BASE COURSE

This item comprises the supply and placement of granular sub-base material in accordance with the following:

6.4.1 Materials

Aggregates for sub-base shall consist of hard, durable particles or fragments of crushed stone, crushed slag, or crushed or natural gravel and filler of natural or crushed sand or other finely divided mineral matters. The composite material shall be free from organic matters and lumps or balls of clay, and shall be of such nature that can be compacted readily to form a firm, stable sub-base.

Materials for sub-base shall conform to the requirements for sub-base as specified below or directed by the Engineer.

Grading Requirements of Sub-Base Course

AASHTO Designation No.	Percentage Passing by Weight
2 inch	100
1 1/2 inch	70 - 100
1 inch	55 - 85
3/4 inch	50 - 80
3/8 inch	40 - 70
No. 4 (5 mm)	30 - 60
No. 10 (2 mm)	20 - 50
No. 40 (0.4 mm)	10 - 30
No. 200 (0.074 mm)	5 - 15

The percentages passing the various sieves are subject to appropriate correction by the Engineer when aggregates of varying specific gravities are used.

Other Requirements of Sub-Base Course

Liquid Limit (AASHTO T89)	25 max
Plasticity Index (AASHTO T91)	6 max.
Sand Equivalent (AASHTO T176) :	25 min.
Loss by Abrasion of particles retained on ASTM No. 12 sieve (AASHTO T96) :	40% max.
Soaked CBR at the required density (100% of the maximum dry density according to AASHTO T180) :	60% max.

6.4.2 Placing and Spreading

(a) Sub-base material shall be placed as a uniform mixture on the prepared subgrade in a quantity which will provide the required compacted thickness. When more than one layer of sub-base material base is required, each layer shall be shaped and compacted before the succeeding layer is placed. When uniformly mixed, the sub-base material shall be spread to the required thickness as shown on the Drawings or as directed by the Engineer.

(b) Sub-base material shall be distributed in a continuous uniform layer or windrow of such size that, when spread and compacted, the finished layer shall be equal to or slightly greater than the nominal thickness of sub-base shown on the Drawings.

(c) When hauling is done over previously placed sub-base material, hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

(d) Where the required thickness is 150 mm or less, the material may be spread and compacted in one layer. Where the required thickness is more than 150 mm, sub-base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 150 mm. All subsequent layers shall be spread and compacted in a similar manner.

(e) The moisture content of sub-base material shall be adjusted before compaction by watering with approved sprinklers mounted on trucks or by drying out, as required, in order to obtain the required compaction.

6.4.3 Compacting the Sub-base

(a) Immediately after each layer of the sub-base has been spread, the full width shall be compacted by approved compaction equipment. Compaction shall progress gradually from the sides to the centre, parallel to the centreline of the road, and shall continue until the whole surface has been compacted. All irregularities or depressions that develop shall be corrected by loosening material at these places and adding or removing material until the surface is smooth and uniform. At all places not accessible to the compaction equipment, the sub-base material shall be compacted thoroughly with approved tampers or compactors.

(b) Each layer of the sub-base shall be compacted to a density of at least one hundred percent (100%) of the maximum dry density determined in accordance with AASHTO T180, Method D. In-situ density of the compacted sub-base shall be measured in accordance with AASHTO T191 at the location directed by the Engineer.

6.4.4 Tolerances

Tolerances for the sub-base course shall be as specified in the following table:

Tolerances for Sub-Base Course:

Feature	Tolerance
Permitted variation from thickness of layer	± 20 mm
Permitted variation from design level of surface	+ 10 mm - 20 mm
Permitted surface irregularity measured by 3m straightedge	20 mm
Permitted variation from design crossfall or camber	± 0.3%
Permitted variation from design longitudinal grade over 25 m in length	± 0.1%

6.5 BASE COURSE

This item comprises the supply and placement of granular base course material in accordance with the following:

6.5.1 Materials

Aggregate for base course shall consist of hard, durable particles or fragments of stone or gravel crushed to the size and of the quality requirements of this Clause. It shall be clean and free from organic matters, lumps or balls of clay and other deleterious substances. The material shall be of such nature that it can be compacted readily to form a firm, stable base.

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

Physical Requirements of Base Course Material

(i)	Toughness (ASTM D3)	6 min.
(ii)	Loss by Sodium Sulphate Soundness Test (AASHTO T104)	10% max.
(iii)	Loss by Magnesium Sulphate Soundness Test (AASHTO T104)	12% max.
(iv)	Loss by Abrasion after 100 revolutions (AASHTO T96)	10% max.
(v)	Loss by Abrasion after 500 revolutions (AASHTO T96)	40% max.
(vi)	Thin and elongated pieces, by weight (pieces larger 1 inch., with thickness less than 1/5 of length)	5% max.
(vii)	Soft fragments (AASHTO T189)	5% max.
(viii)	Clay lumps (AASHTO T112)	0.25% max.

Aggregate for base course shall conform to the requirements as specified herein. Crushed gravel or rock fragments for base course shall consist of the product obtained by crushing gravel or rock, which, if directed by the Engineer, has first been screened in such a manner that when the aggregate is produced from gravel, not less than eighty percent (80%) by weight of the coarse aggregate shall be of particles having at least one fractured face.

Base course material shall be crushed rock or crushed gravel conforming to the following grading requirements:

Grading Requirements for Base Course

AASHTO Designation No.	Percentage Passing by Weight
2 1/2 inch	100
2 inch	90 - 100
1 1/2 inch	35 - 70
1 inch	0 - 15
1/2 inch	0 - 5

Blending material shall be quarry screenings or natural sand of suitable binding quality as approved by the Engineer. Blending material shall be free from foreign or organic matter, dirt, shale and clay lumps or other deleterious matter and shall conform to the following requirements:

Grading Requirements of Blending Materials for Base Course

AASHTO Designation No.	Percentage Passing by Weight
3/8 inch	100
No. 4 (5 mm)	85 - 100
No. 100 (0.15 mm)	10 - 30
Plasticity Index (AASHTO T90)	6 max.
Sand Equivalent (AASHTO T176)	30 min.

The percentage of crushed aggregate composed of elements having at least one fractured face shall be at least eighty percent (80%) by weight of the material retained on sieve No. 4.

6.5.2 Spreading and Compacting

The course and fine components of the base course material shall be mixed in proportions as directed by the Engineer

Base course material shall be spread and compacted in the same manner as specified above for Sub-base Course.

6.5.3 Tolerances

Tolerance for the base course shall be as specified in the following table.

Tolerances for Base Course

Feature	Tolerance
Permitted variation from thickness of layer	± 10 mm
Permitted variation from design level of surface	+ 5 mm -10 mm
Permitted surface irregularity measured by 3-m straightedge	5 mm
Permitted variation from design crossfall or camber	± 0.2%
Permitted variation from design longitudinal grade over 25 m in length	± 0.1%

6.6 BITUMINOUS PRIME COAT

6.6.1 General

This work shall consist of furnishing and applying bituminous material to the completed and approved base course or to other areas shown on the Drawings, in accordance with this Clause and/or as directed by the Engineer.

6.6.2 Material

Asphalt for the prime coat shall be either AC-20 grade asphalt cement (which is approximately equivalent to 60/70 Pen.) diluted with kerosene or cutback asphalt MC-70 conforming to the requirements of AASHTO M82 or equivalent.

6.6.3 Surface Preparation before Prime Coating

Immediately before applying the asphalt material all loose dirt and other objectionable material shall be removed from the surface with a power broom and blower as required. Such cleaning shall continue until the entire surface shows a pattern of exposed large particles well wedged together and free from dust. When so ordered by the Engineer a light application of water shall be made just before the application of asphaltic material. No application shall be made during wet weather.

6.6.4 Application of Prime Coat

(a) Asphaltic materials shall be applied by means of a pressure distributor or other equipment approved by the Engineer, at a temperature between 40.5°C and 85°C. in accordance with the following table:

Spraying Temperatures of Prime Coat

Type of Material	**Temperature Range**
Cutback, 50 pph kerosene (MC-70 grade cutback)	70 ± 10 deg. C
Cutback, 75 pph kerosene (MC-30 grade cutback)	45 ± 10 deg. C
Cutback, 100 pph kerosene	30 ± 10 deg. C
Cutback, more than 100 pph kerosene	Not Heated

(b) The rate of application of the liquid asphalt shall be from 0.8 to 2.5 litre per square meter, but the exact rate shall be as directed by the Engineer.

(c) The prime coat shall be left undisturbed for at least 24 hours and shall not be opened to traffic until the prime coat has penetrated and cured sufficiently so that it will not be picked up by the wheels of passing vehicles. The primed area shall be maintained until the next course is applied. Care shall be taken that the application of bituminous material is not in excess of the specified amount; any excess shall be blotted with sand or removed as directed.

(d) All areas inaccessible to the distributor shall be sprayed manually using the device for hand spraying from the distributor.

(e) Structures and trees adjacent to the area being treated shall be protected to prevent their being spattered or marred.

6.7 TACK COAT

6.7.1 General

This work shall consist of furnishing and applying asphaltic material to an existing pavement, in accordance with the specification and to the width and area required by the Engineer prior to construction of so surfacing, so as to provide a bond between the binder course and the surface course or other layers as directed by the Engineer.

6.7.2 Materials

Material for tack coat shall be either AC-20 grade asphalt cement (which is approximately equivalent to 60/70 Pen.) diluted with between 25 and 30 parts per hundred of kerosene per hundred parts of asphalt cement by volume, or slow setting emulsified asphalt conforming to the requirements of AASHTO M 140 or M 208. The Engineer may permit or require dilution of the emulsion with 1 part clean water per 1 part of emulsion.

6.7.3 Construction Method

6.7.3.1 Equipment

The equipment shall be as for bituminous prime coat.

6.7.3.2 Surface Preparation

When, in the opinion of the Engineer, it is necessary, the full width of surface to be treated shall be cleaned with a power broom or power blower to remove loose dirt and other objectionable material. The surface to be treated shall be dry.

6.7.3.3 Application of Tack Coat

Immediately after cleaning the surface, asphaltic material shall be applied by means of a distributor at the rates directed by the Engineer, but not to exceed 0.45 litre per square meter and at the temperature within the range specified in the following table:

Spraying Temperatures of Tack Coat

Type of Material	Temperature Range
Cutback, 50 pph kerosene	110 ± 10 deg. C
Emulsified Asphalt or Diluted Emulsified Asphalt	20 to 70 deg. C

The tack coat shall be applied only when the surface is dry except with the permission of the Engineer.

The surfaces of structures and trees adjacent to the areas being treated shall be protected in such a manner as to prevent their being spattered or marred. No asphaltic material shall be discharged into a borrow pit or gutter. The Engineer may direct that emulsions shall be diluted with clean water in order to control the rate of spread. This shall be done at the Contractor's expense.

The surface course shall not be placed over the tack coat until it is in a proper condition of tackiness to receive it. Tack coat shall be applied only so far in advance of surface course placement as is necessary to obtain this proper condition of tackiness. Until the surface course is placed, the Contractor shall protect the tack coat from damage.

6.8 ASPHALT BINDER AND WEARING COURSES

6.8.1 General

The work shall consist of providing dense durable binder course and wearing course hot asphaltic mixtures composed of aggregate and bituminous materials mixed in a central plant, and of spreading and compacting the mixtures in accordance with this Specification and in conformity with the lines, grades and cross sections shown on the Drawings or as required by the Engineer.

6.8.2 Materials for Asphaltic Mixtures

6.8.2.1 Composition of mixtures

The bituminous material shall be composed of a mixture of aggregate, filler and hydrated lime-if required, and asphalt cement. The several aggregate fractions shall be size, uniformly graded and combined in such proportions that the resulting composite blend meets the job-mix formula and the following index of retained strength as determined in accordance with AASHTO T 245

Requirements for Binder and Wearing Courses

Stability (kg)	900
Flow (mm)	2.5 – 4.0
Void in total mix (%)	3 - 5
Void Filled with Asphalt (%)	75 - 85

In calculating the void characteristics of the mixture the Contractor shall allow for the asphalt absorbed by the aggregate and use the effective specific gravity of aggregate and the maximum specific gravity of the loose paving mixture (AASHTO T 209)

The several aggregate and filler fractions for the mixture shall be sized, graded, and combined in such proportions that the resulting composite blend meets one of the grading requirements in the following table

Aggregate Grading Requirements

Sieve Designation (mm)	*Percentage Passing by Weight*	
	For Asphalt Binder Course	For Asphalt Wearing Course
50	-	-
37.5	-	-
25	100	-
19	95-100	100
12.5	68-86	95-100
9.5	56-78	74-92
4.75	38-60	48-70
2.36	27-47	33-53
1.16	18-37	22-40
0.600	11-28	15-30
0.300	6-20	10-20
0.075	0-8	4-9

The Contractor shall submit a proposed job-mix formula in writing, for use by the Engineer in setting the job-mix to be used with the proposed materials. The formula submitted shall propose definite single values for:

- The percentage of aggregate passing each specified sieve.
- The percentage of bituminous material to be added, on the total aggregate basis.
- The temperature of the mixture leaving the mixer.
- The temperature of the mixture delivered on the road.
- The grade of bituminous material.

Values shall be proposed within the limits specified for the particular type of bituminous concrete called for. The Engineer will determine a job-mix formula with single values for the above- mentioned and so notify the Contractor in writing.

The mixture furnished by the Contractor shall conform to this job- mix formula, within the following range of tolerances and within the grading ranges shown in the following table:

Tolerances for Mixture

Aggregate passing the 4.75 mm and large sieve	± 7 percent
Aggregate passing the 2.36 mm through the 0.150 mm sieve	± 4 percent
Aggregate passing the 0.075 mm sieve	± 2 percent
Bituminous material	± 0.4 percent
Temperature leaving the mixer	± 6 deg. C
Temperature delivered on the road	± 6 deg. C

When unsatisfactory results make it necessary, the Engineer may establish a new job-mix formula and notify the Contractor in writing. Should a change in sources of material be proposed, a new job-mix formula will be established before the new material is used.

The plant mixed material will be tested after blending or mixing at the plant or prior to final incorporation in the work.

6.8.2.2 Coarse aggregate

The coarse aggregate (retained on the 2.36 mm sieve) shall consist of clean tough, durable fragments free from an excess of flat, elongated, soft or disintegrated pieces and free from stone coated with dirt or other objectionable material. The percentage of wear when tested according to AASHTO T 96 , shall be as follows:

For use in asphalt binder and wearing course – not more than 40

The sodium sulphate soundness loss shall not exceed 9 percent and the magnesium sulphate soundness loss shall not exceed 12 percent. When crushed gravel is used, not less than 50 percent of the particles by weight retained on the 4.75 mm sieve shall have at least one fractured face.

6.8.2.3 Fine aggregate

The fine aggregate (passing a 2.36 mm sieve), shall have General Characteristics and Soundness in accordance with AASHTO M 29.

6.8.2.4 Filler

Mineral filler, when required, shall consist of limestone dust, Portland cement or other non plastic mineral matter from sources approved by the Engineer. Mineral filler shall be dry, free flowing, free from lumps and other objectionable material and when tested by means of laboratory sieve, shall meet the following gradation requirement:

Sieve Designation (mm)	*Percentage Passing by Weight*
0.600	100
0.180	95 – 100
0.075	65 – 100

6.8.2.5 Asphalt cement

Asphalt cement shall be of penetration grade 60 – 80, and shall conform with the requirements of AASHTO M 20.

6.8.3 Preparation of Sub-base

The prime coat shall be applied in accordance with the Clause 8.6.

Twenty-four (24) to forty-eight (48) hours after application of the prime coat, when it has sufficiently dried, it shall be broomed. A limited amount of sand, as directed by the Engineer, may be sprinkled on the prime coat to make further work possible if it is necessary to perform further work without waiting for the prime coat to dry sufficiently. Excess sand shall be removed by brooming before spreading the binder course

6.8.4 Preparation of the Bituminous Mixture

(a) Aggregates shall be dried and heated at the paving plant so that, when introduced into the mixer, the moisture content does not exceed 0.5%.

(b) Water in aggregates shall be removed by heating to the extent that there is no subsequent foaming in the mixture before placing and spreading. Aggregates shall be heated to the temperature designated by the job formula with the specified job tolerance, with a maximum temperature and a rate of heating that will not cause permanent damage to the mixture.

(c) Particular care shall be taken so that aggregates high in calcium or magnesium content are not damaged by overheating. The quantity of bituminous material for each batch or the calibrated amount for continuous mixer, as determined by the Engineer, shall be measured by weight and introduced into the mixer, at the specified temperature, using the lowest rate possible for adequate mixing and spreading.

(d) For batch mixers, all mineral aggregates shall be placed in the mixer before the bituminous material is added. The exact temperature within the specified range shall be as directed by the Engineer.

(e) Mixing shall continue for the time necessary to coat all particles uniformly, as directed by the Engineer. This time is dependent upon the mix design and type of mixing equipment used.

6.8.5 Transportation and Delivery of the Mixture

(a) Trucks used for hauling bituminous mixtures shall have tight, clean and smooth metal beds. To prevent mixtures from adhering, beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Each truck shall have a suitable cover to protect the mixture from adverse weather and an insulated bed to maintain the mixture at the specified temperature.

(b) The mixture shall generally be placed at a temperature of between 120°C to 150°C when asphalt cement is used. When the mixture is placed during warm weather and the Engineer has determined that satisfactory results can be obtained at a lower temperature, he may direct that the mixture be mixed and delivered at the lower temperature.

(c) Loads shall not be dispatched from the mixer if it is expected that spreading and compaction of the mixture cannot be completed under conditions of adequate lighting.

(d) Mixtures shall be delivered to the point of placement at a temperature within the tolerances required by the Job Mix Formula.

6.8.6 Spreading

(a) Immediately before placing the bituminous mixture, the prime coat shall be cleaned using a power sweeper equipped with a blower, supplemented with hand brooms if necessary, or by other approved means.

(b) The mixture shall be laid upon an approved surface which is thoroughly dry and in suitable condition, and only when weather conditions are fair unless otherwise directed by the Engineer.

(c) Placing shall commence at points farthest from the mixing plant and progress continuously toward the plant, unless otherwise directed by the Engineer. Traffic shall not pass over the base course until it has been thoroughly compacted as specified, and allowed to cool to atmospheric temperature.

(d) Upon arrival the mixture shall be dumped into an approved bituminous paver, immediately spread to the full width required, and struck off in a uniform layer at such thickness that, when work is completed, the layer will have the required thickness conforming to the specified grade and surface profile.

(e) The bituminous paver shall be a self-contained, power propelled unit with an activated screed or strike-off assembly heated as necessary. The paver shall be capable of spreading and finishing courses of bituminous plant mix material of the specified thickness, smoothness and grade, and shall also be equipped with an automatic line and grade controlling device.

  (i) The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation, and the hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.

  (ii) The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging.

  (iii) The paver shall be capable of operating at forward speeds consistent with the satisfactory laying of the mixture and the paver speed shall be regulated to eliminate pulling and tearing of bituminous material.

(f) The mixture shall be placed in strips not less than 3 meters wide. To ensure proper drainage, spreading shall begin along the pavement centreline on a crowned section, or on the high side of a pavement with a one-way slope.

  (i) After the first strips has been compacted, the second strip shall be placed, finished, and compacted in the same manner as the first strip. After the second strip has been placed and rolled, a 5-meter straightedge shall be placed across the longitudinal joint to determine if the surface conforms to the grade and contour requirement.

(g) In areas where use of mechanical spreading and finishing equipment is impractical because of irregularities or unavoidable obstacles, the mixture may be hand-spread.

6.8.7 Compaction of the Mixture

(a) After spreading, the mixture shall be thoroughly and uniformly compacted with power rollers. Sufficient rollers shall be furnished and operated to handle plant output.

(b) Rolling shall begin as soon as the mixture can bear the roller without undue displacement or hair cracking, and shall start from the centre of the first strip and continue toward either edge. On subsequent strips, rolling shall start from the edge adjacent to the previously laid material and continue toward the opposite edge.

(c) The speed of roller shall, at all times, be slow enough so as to avoid displacement of the hot mixture. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once by rakes and by applying fresh mixture where needed.

(d) Rolling shall continue until all roller marks are eliminated, the surface is of uniform texture and true to grade and cross section, and the in-situ density is not less than ninety-eight percent (98%) of the specified laboratory density as obtained from laboratory compacted specimens of the same materials and same proportions used in the asphalt mixture as determined by AASHTO T166. The method of sampling the mixture and the compaction of specimens shall be in accordance with AASHTO T168 and AASTHO T245, respectively. Field density tests shall be made at least twice daily.

(e) In areas not accessible to the roller the mixture shall be thoroughly compacted with hot mechanical tampers.

(f) Any mixture which becomes loose and broken, contaminated with dirt, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding areas, all at Contractor's expense. Skin patching will not be permitted.

6.8.8 Trimming and Clean-up

(a) Placing of the bituminous mixture shall be as continuous as possible. Rollers shall not pass over the unprotected and freshly laid mixture unless authorized by the Engineer.

(b) Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. When so directed by the Engineer, a brush coat of bituminous material shall be used on contact surfaces of transverse joints just before additional mixture is placed against the previously rolled material.

(c) The exposed edges of the completed pavement shall be cut true to the required lines. Material trimmed from the edges and any other discarded or rejected bituminous mixture shall be removed from the roadway and disposed of in an approved manner.

6.8.9 Application of Asphalt Wearing Course

Prior to placing the asphalt wearing course a tack coat shall be applied in accordance with Clause 6.7.

(a) The mixture shall be spread at a temperature of not less than 107°C and all initial rolling shall be done immediately after spreading. The mixture shall not be placed on any wet surface or when weather conditions will otherwise prevent its proper handling and finishing.

(b) Asphalt pavers shall be self-propelled, mechanical, spreading and finishing equipment, provided with a screed or strike-off assembly capable of distributing the material to not less than the full width of a traffic lane.

(c) Screed action shall include any cutting, crowning or other practical action which is effective on the mixture without tearing, shoving or gouging, and which produces a surface texture of uniform appearance. The screed shall be adjustable to the required section and thickness. The paver shall be provided with either a full width roller or tamper or other suitable compacting device. Pavers that leave ridges, indentations or other marks in the surface that cannot be eliminated by rolling or prevented by adjustment in operation shall not be used.

(d) Where a course previously laid is joined to a course to be laid later, the first course shall be cut back and painted with asphalt as directed.

(e) The mix shall be compacted immediately after placing. Initial rolling with a tandem steel roller or a three-wheeled steel roller shall follow the paver as closely as possible. Immediately following the sealing of the longitudinal joints, rolling shall commence at the outside edges and progress towards the centerline. Rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. In areas too small for the roller, a vibrating plate compactor or hand tamper shall be used to achieve thorough compaction.

(f) Rolling shall continue as long as required to attain a minimum compaction of ninety-seven percent (97%) of the Marshall density of the approved Job Mix.

6.8.10 Completion Test

(a) Surface Test : Tests for conformity with the specified crown, grade and width shall be made by the Contractor immediately after initial compaction. Any deviation shall be corrected by removal or addition of materials and continuous rolling.

(b) After completion of final rolling, the smoothness of the course shall again be tested along the whole distance. Humps or depressions that exceed the specified tolerances or that retain water on the surface shall be immediately corrected by removing defective work and replacing it with new material at the Contractor's expense.

(c) Finished surfaces shall not vary from the design elevations by more than 5 mm when tested with a crown template and a 3 m straightedge furnished by the Contractor. Tests shall be performed at 10 m intervals along the road centreline.

(d) The width shall not be less than 25 mm of the design section measured at 20 m intervals.

(e) Thickness Tests : The total thickness of each completed course of asphalt treated base shall be determined by cores taken by the

Contractor for each completed layer at places designated by the Engineer. One core test shall be performed for every 200 m2 of paved area. The thickness shall not be 5 mm less than the design depth for any one test, and not less than 2.5 mm for an average of 10 tests.

(f) When deficiencies in either elevation or thickness exceed the specified tolerance, the Contractor shall remove and replace the asphalt treated base with new material.

6.9 MEASUREMENT AND PAYMENT

6.9.1. Subgrade Preparation

Measurement shall be made of the area in m^2 of subgrade preparation made on original ground on which the sub base was constructed. No measurement for payment shall be made of areas of subgrade comprising fill or backfill (as in the case of road restoration after sewer construction).

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for the cost of all labour, materials and incidental items necessary to complete the subgrade preparation in accordance with the Specification and the instructions of the Engineer.

The cost of subgrade preparation for sub base constructed on fill is deemed to be included in the cost of fill, specified elsewhere.

Items to be paid under this Clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.5.1 3.7.1	Subgrade Preparation	m^2

6.9.2. Sub-Base Course

Measurement shall be made of the volume of sub base course material placed and compacted to the lines grades and dimensions shown on the drawing or as directed by the Engineer and approved by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the Works in accordance with the Specifications and instructions by the Engineer.

Items to be paid under this Clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.5.2 3.7.2	Sub Base Course : including supply and placement	m^3

6.9.3. Base Course

Measurement shall be made of the volume of Base Course material placed and compacted to the lines grades and dimensions shown on the drawing or as directed by the Engineer and approved by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the Works in accordance with the Specifications and instructions by the Engineer.

Items to be paid under this Clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.5.3 3.7.3	Base Course (Crushed Aggregate): including supply and placement	m^3

6.9.4. Asphalt Binder Course

Measurement will be made of the mass in tonne (1 tonne = 1000 kg mass) of asphalt binder course, based on certified delivery notes from the supplier, placed to the lines, grades and dimensions as shown on the Drawings or directed by the Engineer and approved by the Engineer. Materials placed outside the limits shown on the Drawings shall not be measured for payment.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the asphalt binder course in accordance with the Specifications and instructions by the Engineer.

Items to be paid under this Clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.5.4 3.7.4	Asphalt Binder Course : including supply and placement	m^3

6.9.5. Asphalt Wearing Course

Measurement will be made of the mass in tonne (1 tonne = 1000 kg mass) of asphalt wearing course, based on certified delivery notes from the supplier, placed to the lines, grades and dimensions as shown on the Drawings or directed by the Engineer and approved by the Engineer. Materials placed outside the limits shown on the Drawings shall not be measured for payment.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the asphalt wearing course in accordance with the Specifications and instructions by the Engineer.

Items to be paid under this Clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.5.5 3.7.5	Asphalt Surface Course : including supply and placement	m^3

6.9.6. Bituminous Prime Coat

Measurement shall be made of the actual volume in litres of bituminous prime coat material placed on the prepared subgrade at the rate of application directed by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for all labour, materials, equipment and all incidentals necessary for the completion of bituminous prime coat in accordance with the Specification and the instructions of the Engineer.

Items to be paid under this Clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.5.6 3.7.6	Prime Coat: including supply and application	litre

6.9.7. Tack Coat

Measurement shall be made of the actual volume in litres of tack coat material placed on the prepared subgrade at the rate of application directed by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for all labour, materials, equipment and all incidentals necessary for the completion of tack coat in accordance with the Specification and the instructions of the Engineer.

Items to be paid under this Clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.5.7 3.7.7	Tack Coat:: including supply and application	litre

SECTION 7. SEWERS CONSTRUCTION

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SECTION 7. SEWERS CONSTRUCTION

7.1 GENERAL

This section covers the general requirements for all sewerage works to be constructed under the Contract and the specific requirements for the existing combined sewer improvements works and the construction of the major portion of the conveyance sewer.

7.2 SCOPE OF WORK

The work to be completed by the Contractor consists of the following:

(a) Existing Combined Sewer Improvements – comprising the construction of 8,962 m of new or replacement sewers comprising 3,650 m of reinforced concrete pipe of diameters 800 to 2000 mm and 5,312 m of precast box culvert section units up to 2500 x 2500 mm internal dimensions complete with manholes, outlets connections to existing sewers and other associated works.

(b) Conveyance Sewer – comprising the construction of a 2,780 m long portion of double-cell box section sewer from the defined interface with the works for Package C to the defined interface with the works for Package E near the abutment of the proposed bridge across the Tac Ben Ro Canal.

The works shall be constructed in accordance with the Drawings, the specification and the directions of the Engineer.

7.3 WORKS SPECIFIED ELSEWHERE

Care of Water shall be in accordance with Section 2

Demolition shall be in accordance with Section 2

Earthworks shall be in accordance with Section 3

Concrete work shall be in accordance with Section 4

Piling work shall be in accordance with Section 5

Metal work shall be in accordance with Section 8

Roadworks shall be in accordance with Section 6

7.4 SUBMITTAL

The Contractor shall prepare a method statements for each division of the works in which shall be submitted for the Engineer's approval in accordance with the procedures in Clause 1.3.5

The method statements shall provide comprehensive descriptions of the materials, equipment, construction methods, quality control procedures and safety measures to be used and shall be supported by material specifications, detailed drawings of temporary works and calculations of their structural and functional adequacy. Particular attention shall be given to illustrating how the Contractor will manage public safety, accommodation of traffic and care of water pursuant to his obligations stated elsewhere in the Contract.

7.5 MATERIALS

7.5.1 Concrete

Concrete shall be of the following classes in accordance with the requirements of Section 4:

Cast in-situ concrete: - Class E

Plain Concrete: - Class F

Precast Concrete Sewer and Stormwater Drainage Pipes: - Class D

Precast Concrete Jacking Pipes: - Class A

7.5.2 Reinforcement

Reinforcement shall be deformed bars of the sizes shown on the Drawings.

7.5.3 Earthworks Materials

Earth fill, sandy soil fill and sand bedding, free draining gravel, rip rap and geotextile cloth shall be in accordance with Clause 3.4.2 of Section 3, Earthworks.

7.5.4 Reinforced Concrete Pipes

The requirements for reinforced concrete pipes listed hereunder shall apply to all such pipes to be used for sewers.

Reinforced concrete pipes shall be of spigot and socket type Class 1 or Class 2 as shown on the Drawings complying with the requirements of JIS A 5372.

Concrete and reinforcement shall comply with the requirements of Section 4.

Dimensional tolerances shall be in accordance with Annex 2, Table 6 of JIS A 5372.

Permeability shall be in accordance with Clause 5.1 of JIS A 5372.

Strength (cracking and crushing loads) shall meet the requirements of Annex 2, Table 3 of JIS A 5372.

Testing for compliance with the requirements for dimensional tolerance, permeability and strength shall be in accordance with the methods and limits stated in Annex 2 of JIS A 5372. Prior to the procurement of pipes the Contractor shall submit for the Engineer's approval, a quality assurance programme for pipe quality which will include testing of pipes (including destructive testing). The cost of the quality assurance programme including the cost of testing shall be borne by the Contractor. Pipes which have not been manufactured under a quality assurance programme approved by the Engineer shall be subject to rejection.

Pipes in a batch shall be considered as meeting the strength test requirements when all test specimens conform to the test requirements. Should any of the test specimens fail to meet the test requirement the Contractor shall be allowed a retest on two additional specimens for each specimen that failed and the pipes shall be acceptable only when all of the retest specimens meet the strength requirements.

The following information shall be clearly marked on each section of pipe.

- Pipe class and standard of manufacture
- Date of manufacture
- Name or trade mark of the manufacture
- Where tests have been successfully carried out on representative samples from the batch in which the unit was made

The quality of materials, the process of manufacture and the finished pipe shall be subject to inspection and approval by an inspector of the Engineer. Pipes shall be subject to rejection on account of failure to conform to any of the specification requirements. Pipes may be rejected because of any of the following:

- Fractures or cracks passing through the wall, except for a single end crack that do not exceed the depth of the joint.
- Defects that indicate imperfect proportioning mixture and moulding.
- Surface defects indicating honeycombed or open texture.
- Damaged ends where such damage would prevent the making of a satisfactory joint.

Pipes may be repaired, if necessary, because of occasional imperfections in manufacture or accidental damage during handling and will be acceptable if, in the opinion of the Engineer, the repairs are sound and properly finished and cured and the repaired pipes conform to the requirements of the specification.

Joint rings for spigot and socket pipes shall be manufactured from ethylene propylene rubber (EPM or EPDM) or styrene butadiene rubber (SBR) or natural rubber and shall comply with the requirements of BS 2494. They shall be suitable for use in sewerage pipelines at an ambient temperature of 30^0 C and shall be of size and shape that, when joined, will provide a watertight seal.

Lubricant for application to rubber rings to assist jointing shall be in accordance with the manufacturer's recommendations.

7.5.5 Precast Reinforced Culverts

Precast reinforced culvert units for use in the works for the Existing Combined Sewer Improvement shall be manufactured in accordance with the requirements of section 4.

Prior to the procurement of precast reinforced culvert units the Contractor shall submit for the Engineer's approval, a quality assurance programme the cost of which shall be borne by the Contractor. Any unit which has not been manufactured under the quality assurance programme approved by the Engineer shall be subject to rejection.

Concrete shall be Class D.

Reinforcement shall be deformed bars.

All precast units of the same cross section shall be regular in shape and shall have accurately formed rebated joints which permit adjacent pipes to lap together as shown on the Drawings.

The quality of materials, the process of manufacture and the finished pipe shall be subject to inspection and approval by the Engineer. Precast units shall be subject to rejection on account of failure to conform to any of the specified requirements and/or evidence of any of the following defects.

- Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.
- Defects that indicate imperfect proportioning mixture and moulding.
- Surface defects indicating honeycombed or open texture.
- Damaged ends where such damage would prevent the making of a satisfactory joint.

Any precast unit rejected by the Engineer shall be so marked and removed from the Site.

7.5.6 Manhole Covers

Manhole covers shall be of the following types:

TYPE	DESCRIPTION	DIMENSIONS Lid Dimensions (Opening Dimensions)	APPLICATION
Type A	1 No. cast iron, 30 ton design load cover comprising a cast iron inner frame and circular removable lid and an outer frame consisting of precast concrete and fabricated, galvanized steel	900 x 900 (800 x 800)	Manholes in roadway
Type D	1 No. 30 ton design load precast concrete cover with fabricated, galvanized steel surround and an outer frame consisting of precast concrete and fabricated, galvanized steel. A precast concrete water trap unit shall be included with the cover.	900 x 900 (800 x 800)	Inlet Pits
Type E	1 No. 6 ton design load cover comprising a cast iron square lid and an outer frame consisting of precast concrete and fabricated, galvanized steel. A precast concrete water trap unit shall be included with the cover.	900 x 900 (800 x 800)	Inlet Pits in sidewalk

All manhole covers and their respective frames shall be made in accordance with the Drawings, the directions of the Engineer and the Specification.

Cast iron components shall comply with the requirement of the Ho Chi Minh City Urban Drainage Company.

Fabricated steel components shall comply with the requirements of Section 8, Metal Work

All fabricated steel components shall be galvanized in accordance with the requirements of Section 8, Metal Work.

7.5.7 Timber Piles

Refer to Section 5

7.5.8 Stone Masonry

Refer to Section 9

7.6 CONSTRUCTION OF SEWERS

7.6.1 General

Preparatory works, excavation, bed preparation and backfilling shall be carried out in accordance with the referenced specifications in Clause 7.3.

All reinforced concrete sewer pipes and precast box culvert section sewer units shall be laid to the lines and levels as shown on the Drawings or as directed by the Engineer. Laying of pipes shall start from the downstream end unless otherwise agreed to by the Engineer. Pipes shall be laid to a tolerance of + or - 15 mm from the given grade line of the invert and without low points.

All work shall be carried out in the dry and the Contractor shall keep excavations dewatered in accordance with his obligations for care of water under Section 2.

The method of pipe bedding shall differ according to the type of pipe support as shown on the Drawings.

7.6.2 Pipes with Sand Bedding and Surround

Where sand bed and sand surround is to be provided, after bottoming up the trench, sand bedding material shall be carefully placed and compacted in layers not exceeding 100 mm thickness to the required thickness for the full width of the trench. The material shall preferably be compacted by vibrating plate type plant using a minimum of one pass per layer. Should hand tamping be allowed by the Engineer the Contractor shall demonstrate by means of in-situ test to the approval of the Engineer that his proposed method of compaction will achieve a minimum of 90% of the maximum dry density as determined by the AASHTO T 99 test or equivalent.

The bedding shall be constructed so as to ensure even and continuous support throughout the length of the barrel of each pipe. Recesses shall be formed in the bedding to accommodate pipe sockets.

After laying and jointing pipes, the bedding shall be placed and hand compacted in layers not exceeding 100 mm thick. Care should be taken that the bedding material is well rammed into the cavities under the two lower quadrants of the pipe and that the bedding is brought up simultaneously and evenly on both sides of the pipe. Sand bedding shall be placed and compacted up to a minimum of 200 mm above the crown of the pipe.

Backfilling of the trench above this level shall be performed in accordance with the requirements of Section 3.

7.6.3 Pipes with Concrete Base or Concrete Encasement

Where the Drawings call for concrete base (120 deg or 180 deg) or concrete encasement, a sand bed shall be constructed up to 200 mm below the final invert level of the pipe to be laid in the manner described in Clause 7.6.2 above.

Pipes shall be jointed and accurately laid to the required level and gradient with supporting chocks, wire cradles or wedges.

Concrete bedding (Concrete Class F) or reinforced concrete (Concrete Class E) as the case may be, shall then be placed in accordance with the requirements of Section 4, taking care that concrete fully supports the pipe and that the pipe is not dislodged during casting. Concrete cover to reinforcement shall be 50 mm.

Where the design calls for concrete base support (120 or 180 deg) backfilling shall be carried out in the manner specified in Clause 7.6.2. Such backfilling shall not commence until the concrete has reached an age of at least 7 days or as otherwise approved by the Engineer.

Where pipes are fully encased backfilling of the void between the concrete encasement and the trench walls shall be carried out using hand tamping in layers not thicker than 100 mm up to the top of the encasement. Above this level backfilling shall be in accordance with the requirements of Section 3.

7.6.4 Precast Box Culvert

After bottoming up the trench, sand bedding material shall be carefully placed and compacted in layers not exceeding 100 mm thickness to the required thickness for the full width of the trench as specified in Clause 7.6.2.

The bedding shall be constructed so as to ensure even and continuous support throughout the length of each unit. Recesses of the required dimensions shall be formed in the bedding at each joint and the jointing concrete (class F) shall be placed just prior to laying precast units.

Units shall be carefully placed on the sand bed ensuring that adjacent units are properly jointed and that the concrete under the joint is in contact with the joint.

Concrete haunching (class F) shall be formed around each joint as shown on the Drawings.

Haunching concrete shall be allowed to cure for a minimum of 7 days before backfilling. Backfilling with sandy soil at the sides of the precast units shall be placed in layers not exceeding 100 mm and hand compacted up to a level 250 mm above the top of the sewer. Trench sheeting shall be partially withdrawn immediately in advance of compacting backfill material to ensure that it is fully compacted against the sides of the trench.

Above this level backfilling may proceed in accordance with the requirements of Section 3.

7.7 CONSTRUCTION OF MANHOLES AND INLETS

Preparatory works, excavation, bed preparation and backfilling shall be carried out in accordance with the referenced specifications in Clause 6.3.

Manholes and inlet pits shall be constructed in the locations and to the lines and levels shown on the Drawings or as directed by the Engineer. Care shall be taken to ensure a complete seal of the cast-in-situ concrete of the manhole or inlet pit with the precast concrete pipes which join the structures.

All manholes and inlet pits shall be constructed such that they are watertight.

Benching consisting of plain concrete (Concrete Class F) shall be placed in the bottom of manholes or as shown on the Drawings. A 20 mm thick granolithic topping shall be provided to the surface of the concrete benching. Granolithic coating shall consist of cement : granite mix approximately 1: 2 by weight. The granite chips shall be hard, non-weathered granite, free of clay or other deleterious matter of maximum size 6 mm. Prior to application the benching surface shall be wire brushed to remove all laitance and loose material and the surface thoroughly wetted. The granolithic topping shall be steel trowel finished to produce a smooth surface and shall provide a uniformly graded channel through the manhole from inlet to outlet.

Water traps in inlet pits shall be constructed as shown on the Drawings. Care shall be taken to ensure that the weir is horizontal and higher than the underside of the baffle to ensure gas from the sewer cannot escape from the inlet pit. Separate payment shall not be made for water traps and the cost of supplying and installing water traps shall be included in the price for manhole covers.

Manhole frames shall be solidly bedded in 1:3 sand cement mortar so that the covers, when in position, are fair and even with the adjacent finished surfaces.

7.8 CONSTRUCTION OF OUTLET STRUCTURES

7.8.1 General

Four outlet structures for sewer pipelines shall be constructed along the Tau Hu canal to the lines, level and dimensions as shown on the Drawings or as directed by the Engineer.

7.8.2 Materials

Refer to Clause 7.5

7.8.3 Construction

Earthworks shall be in accordance with the requirements of section 3

Timber piling shall be driven at the spacings shown on the Drawings in accordance with the requirements of section 5.

Concrete shall be in accordance with the requirements of section 4.

The Contractor shall not obstruct the flow of water in the sewers whilst constructing outlets and shall divert water around the construction area in accordance with his obligations for care of water specified in section 2.

Headwalls and wing walls shall be positioned such that they conform to the alignment of the adjacent revetment structure being constructed under the works for Package A by others. The Contractor shall liaise with the other Contractor in accordance with his obligations in the general specification to ensure proper co-ordination of the work by different parties.

Construction of the slope protection works comprising wet stone masonry and sub structure, shall be constructed in accordance with the relevant portions of the requirements for revetment construction specified in Clause 9.5

7.9 INSPECTION, TESTING AND CLEANING OF SEWERS

7.9.1 General

All sewers, including manholes shall be tested, inspected and cleaned in accordance with this Clause 7.9.

Should the visual inspection or tests fail, the Contractor shall, at his own cost, replace defective pipes, make good any leaking joint, or otherwise re-execute defective work, after which cleaning, inspection and testing shall be repeated.

Only sewers which have undergone inspection and testing and have received the Engineer's approval shall be approved for payment.

The Contractor shall provide all equipment and personnel for carrying out tests and assisting the Engineer or his Representative in performing inspections.

All costs incurred by the Contractor in complying with the requirements of this Clause 7.9 shall be deemed to be included in the unit rates for the respective sewer elements.

7.9.2 Scope of Inspection and Testing

Testing and inspection shall be performed in accordance with the following schedule:

Sewer Type or Element	Size	Test(s) and Inspections to be carried out
RC Pipe uPVC Pipe	All	Visual Inspection Leakage Test
RC Box Culvert Section	All	Visual Inspection Leakage Test
Manholes	All	Visual Inspection Leakage Test

7.9.3 Visual Inspection

All joints, including joints between pipes and manholes, shall be subject to inspection by the Engineer or his Representative.

7.9.4 Leakage Test

After completion of backfilling and restoration of normal sub-soil conditions, all sewers and manholes shall be inspected for infiltration. Acceptance criterion for this test is infiltration not exceeding 0.5 litre per linear metre per metre of nominal bore (for circular sections) or 0.5 litre per linear metre per metre width (for rectancular sections including manholes).

7.9.5 Cleaning and Inspection of Sewers

The Contractor shall at all times take reasonable measures to prevent the ingress of solid matter into sewers. Such steps shall include, but not be limited to the provision of temporary plugs where appropriate.

Following completion of sewers and manholes, the interior of pipelines and box culvert sections shall be cleaned of all silt and debris and inspected by the Engineer.

Pipelines of 600 mm diameter or smaller shall be demonstrated to be clear or all obstructions by drawing a sphere 25 mm smaller than the internal diameter of the pipe throughout the length of the section under inspection.

Should the Contractor fail to keep an inspected sewer satisfactorily isolated after it has been inspected and shown to be free of obstruction, he shall repeat cleaning and demonstrate to the Engineer's satisfaction that it is clear of obstruction, all at his expense, shortly before taking over.

7.10 CONSTRUCTION OF CONVEYANCE SEWER

7.10.1 General

The Contractor shall construct the portion of the conveyance sewer from the defined interface with the works for Package C to the defined interface with the works for Package D as shown on the Drawings.

Works shall be carried out in accordance with the requirements of other sections of the Specification as noted in Clause 7.3, as specified in this Clause and the directions of the Engineer.

7.10.2 Liaison with Other Contractors

The Contractor liaise with other contractors whose works interface with those of this package to ensure proper and timely execution of works in such areas. The Engineer shall be informed of all meetings and discussions with other contractors with regard to such work.

7.10.3 Treatment at Contract Boundary

The joints at the contract boundaries (interfaces with Packages C and E) shall be constructed as shown on the Drawings. The Contractor shall provide temporary measures to shield the joint from mechanical damage and shield the waterstop from exposure to sunlight.

7.10.4 Tolerances

The conveyance sewer shall be constructed to the following tolerances:

Horizontal Alignment :	+ / - 50 mm
Vertical Alignment of Invert :	+ / - 15 mm from the given grade line of the invert and without low points.
Internal Width	+ 50 mm, - 0 mm

7.10.5 Cleaning and Inspection

The applicable provisions of Clause 7.9.5 shall apply to the conveyance sewer.

7.11 MEASUREMENT AND PAYMENT

7.11.1 Preparatory Works

The cost of all preparatory works is included in payment items in Section 2.

7.11.2 Earthworks

Common excavation, sandy soil fill, shall be measured and paid in accordance with the respective Clauses in Section 3, Earthworks.

7.11.3 Concrete

Concrete shall be measured and paid in accordance with the applicable Clause in Section 4, Concrete.

7.11.4 Piling

Piling shall be measured and paid in accordance with the applicable Clauses in Section 5

7.11.5 Metalwork

Metalwork items shall be measure and paid in accordance wit the applicable Clauses in Section 8.

7.11.6 Precast Reinforced Concrete Pipes

Measurement shall be made of the length of the various diameters of precast reinforced drainage pipes completed, in place and approved by the Engineer. Lengths cut off shall not be measured.

Payment shall be made at the respective rates per metre entered in the Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of precast reinforced concrete drainage pipes. Bedding, backfilling and concrete encasement shall be paid for separately.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
3.3.5	Precast Reinforced Concrete Pipe (600 dia): including supply and laying	m
3.3.6	Precast Reinforced Concrete Pipe (800 dia): including supply and laying	m
3.3.7	Precast Reinforced Concrete Pipe (1000 dia): including supply and laying	m
3.3.8	Precast Reinforced Concrete Pipe (1200 dia): including supply and laying	m
3.3.9	Precast Reinforced Concrete Pipe (1500 dia): including supply and laying	m
3.3.10	Precast Reinforced Concrete Pipe (1800 dia): including supply and laying	m
3.3.11	Precast Reinforced Concrete Pipe (2000 dia): including supply and laying	m
3.5.6	Reinforced Concrete Connection Pipe (400 dia): including supply and installation	m
3.5.7	Reinforced Concrete Connection Pipe (600 dia): including supply and installation	m

7.11.7 Precast Reinforced Concrete Culverts

Measurement shall be made of the length of the various sizes of precast reinforced concrete culvert section sewer lines completed, in place and approved by the Engineer. The length for measurement shall be that between the inner faces of manholes at opposite ends of a run of pipes. Lengths cut off shall not be measured.

Payment shall be made at the respective rates per metre entered in the Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of precast reinforced concrete culvert section sewer lines including the supply and placement of concrete haunching. Bedding and backfilling shall be paid for separately.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
3.3.11	Precast Reinforced Concrete Culvert (2,000 W x 2,000 H): including supply and laying	m
3.3.12	Precast Reinforced Concrete Culvert (2,500 W x 2,000 H): including supply and laying	m

7.11.8 Manhole Covers

Measurement shall be made of the number manhole covers of the various types described in Clause 7.5.6 completed, installed and approved by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and incidental costs (including the cost of the frame and its bedding), for completing the manhole covers in accordance with the Drawings and the Specification.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
2.4.8 3.4.6	Manhole Cover (Type A): including supply and installation	No.
3.4.7 3.5.5	Manhole Cover (Type E): including supply and installation	No.

7.11.9 Granolithic Topping

Measurement shall be made of the plan area of granolithic topping in manholes or diversion chambers completed and approved by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and incidental costs, for completing the granolithic topping in accordance with the Drawings and the Specification.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
3.4.4	Granolithic Topping: including supply and placement	m^2

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SECTION 8. METAL WORK

8.1 GENERAL

8.1.1 Scope

This Section covers the general requirements for designing, manufacturing, transporting, installing, coating and other common requirements incidental to all metal work to be furnished under the Contract.

The metal works herein specified shall mean steel works such as ladder rungs, flap gates and other metalwork components or items furnished under the Contract as shown on the Drawings or as directed by the Engineer.

The provisions of Clauses 8.1 and 8.2 shall apply to all metalwork furnished under the Contract.

8.1.2 Submittals

The Contractor shall prepare Shop Drawings showing complete details, sections and plans of all parts, assemblies, materials lists, components, connections and supports, and relations to the structures based on the Drawings. The Shop Drawings are subject to approval by the Engineer in accordance with Clause 1.3.5 of Section 1.

8.1.3 Standards

Unless otherwise specifically provided in this Specification, the metal works shall be manufactured, fabricated and installed in accordance with the latest provisions of JIS, or other equivalent standards approved by the Engineer.

All materials to be furnished by the Contractor shall be new and shall have the best quality of their respective kinds.

Unless otherwise specified in this Specification, all materials and methods of fabrication shall conform to the standards listed in the following table.

Standards for Metalwork

Item	Standard
Structural Steel	ASTM A36, JIS G3101 or JIS G3106
Structural Steel Pipe	ASTM 120 or JIS G3444
Steel Pipe	JIS G3452
Bolts and Nuts	ASTM A307 Grade A or JIS B1180
Arc Welding Electrodes	AWS, JIS Z3211
Hollow Steel Sections	JIS 3466

8.2 FABRICATION AND CONSTRUCTION

8.2.1 General

The Contractor shall be responsible for the correctness and completeness of the Shop Drawings and for shop fit and field connections. The work shall be shop-fitted and shop-assembled as practicable as possible, conforming to the details on the approved Shop Drawings.

Where necessary, metals shall be insulated to prevent electrolysis due to contact between dissimilar metals and to prevent corrosion due to contact between metals and masonry or concrete. Insulation shall be by means of bituminous paint or other approved means.

All fastening, anchors and accessories required for fabrication and erection shall be provided by the Contractor. Exposed fastenings shall be kept to an absolute minimum, evenly spaced and neatly set out. Wood plugs will not be permitted.

Workmanship in fabrication shall conform to the best modern shop and field practice. All joints and intersecting members shall be accurately fitted and all works shall be fabricated on true planes with adequate fastenings.

8.2.2 Welding

8.2.2.1 General

All welding shall be done either manually by the shielded metallic arc process or automatically by the shielded arc or submerged arc method.

The Contractor shall submit a welding procedure for the approval of the Engineer in the same manner as the Drawings. After the welding procedure has been approved, the Contractor shall record it in the operation and maintenance instructions. Welding sizes and types shall be shown on all Contractor's Drawings where welding is required.

Plates to be joined by welding shall be accurately cut to size and rolled by pressure to the proper curvature, which shall be continuous from the edge. Plattering in the curvature along the edges with correction by blows will not be allowed. The dimensions and shape of the edges to be joined shall be such as to allow thorough fusion and complete penetration and the edges of plates shall be properly formed to accommodate the various welding conditions. The surfaces of the plates for a distance of 25 mm from the edge to be welded shall be thoroughly cleaned of all rust, grease and scale, to bright metal.

Field welding shall not normally be permitted. However, when expressly authorised by the Engineer it shall not be performed under adverse weather conditions of rain, temperature, moisture and wind unless the welding work is protected in a manner approved by the Engineer.

8.2.2.2 Qualification of Welding Procedure

The technique of welding employed, the appearance and quality of the welds made and the methods used in correcting defective work, shall conform to the American Welding Society (AWS) standard or other approved equivalent standard.

8.2.2.3 Qualification of Welders and Welding operators

All welders and welding operators assigned to the works shall have passed a qualification test, within the preceding six months, for welders and welding operators, in accordance with JIS Z 3801 or equivalent. The Contractor shall furnish the Engineer with three (3) certified copied of report of the results of physical tests to the Engineer. If the work of any welder at any time appears questionable, he shall be required to pass the appropriate re-qualification test. All costs of qualification tests shall be borne by the Contractor.

8.2.2.4 Welding Electrodes

The welding electrodes shall conform to JIS Z 3211 or 3212, low hydrogen type covering or equivalent.

Stainless type weld metal, where used in the water passages for protection against pitting, shall be of chromium nickel steel. The type, chemical composition and JIS or approved standard number of welding rods used for this purpose shall be subject to the approval of the Engineer.

8.2.2.5 Inspection of Welds

All welds shall be visually inspected by the Engineer and shall be subject to his approval.

When so directed by the Engineer, welds shall be tested by radiographic tests specified in JIS 3104 or other testing method approved by the Engineer.

8.2.2.6 Repair Welding

Welds disapproved by the Engineer shall be chipped out to sound metal, tested and repair to the Engineer's approval using a procedure approved by the Engineer prior to carrying out the repair.

8.2.3 Protective Treatment of Metalwork

All minor metalwork shall be hot dip galvanised in accordance with the requirements of this Clause.

(a) Galvanizing of structural steel, where required, shall be at a rate of 0.6 kilograms per square meter and shall be performed in accordance with ASTM A123, JIS H8641, or equivalent.

(b) In metal work which is to be galvanized:

  (i) after fabrication, all joints which are not already welded shall be seal-welded; and

  (ii) tapped holes shall be tapped slightly oversize and tapped again to the correct size after galvanizing.

(c) For galvanized metal for handrails, ladders and fence, red lead prime painting will not be required except for weld joints, and one coat of approved paint shall be applied.

(d) Where painting is called for, galvanized metal surfaces shall be acid-etched prior to the application of the finishing surface coats.

(e) If painting is required, the Contractor shall submit a proposal of a painting system for the Engineer's approval.

8.2.4 Check Sheets

At least seven (7) days before placing concrete in any structure or installing any metal work, the Contractor shall submit, for approval, three (3) copies of an approved checkout sheet detailing all items of metalwork to be installed including unit masses and dimensions for materials to be furnished and installed and receipted invoices or other approved documentary evidence detailing the mass of any item which has been furnished and installed.

8.2.5 Installation

Metal works to be embedded in concrete shall be embedded when the concrete is being placed or, if shown on the Drawings or directed by the Engineer, recesses or block-outs shall be made in the concrete and the metalwork shall be grouted in place using cement or embedded in second-stage concrete.

The surfaces of all metal works to be in contact with concrete shall be thoroughly cleaned immediately before the grout or concrete is placed.

Metal works shall be accurately positioned and aligned in the locations as shown on the Drawings, and shall be held securely in the correct position during placing and setting of the concrete.

Where it is impracticable to place anchors or anchor bolts required for the installation of metal work when the concrete is placed, holes shall be drilled into the concrete after the concrete has set for 28 days and expansion bolts, adhesive anchor bolts, or other approved anchors shall be installed.

Field welding, cutting or drilling of prefabricated galvanised metalwork items shall not be permitted without the written approval of the Engineer.

8.3 LADDER RUNGS

Ladder rungs shall be fabricated to the size and dimensions as shown on the Drawings and galvanized.

Ladder rungs shall be installed accurately to the lines and spacings shown on the Drawings in the walls of manholes or other structures as shown on the Drawings.

All materials, workmanship, coating and installation shall be in accordance with the requirements specified in Clauses 8.1 and 8.2.

8.4 MEASUREMENT AND PAYMENT

8.4.1 Ladder Rungs

Measurement shall be made of the number of ladder rungs completed and installed and approved by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and incidental costs for completing ladder rungs in accordance with the Drawings and the Specification.

The following pay item shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.4.9 3.4.7 3.5.4	Ladder Rungs: including supply and installation in wall of manholes	No.

SECTION 9. REVETMENTS
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SECTION 9. REVETMENTS

9.1 GENERAL

This section specifies the requirements for the construction of revetments adjacent to four sewer outlet structures on the banks of the improved portions of the Tau canal.

9.2 SCOPE OF WORK

The Contractor shall construct the revetments the lines and level as shown on the Drawings, in accordance with this specification and the directions of the Engineer.

For the purposes of this specification, revetments shall include timber piling, free draining gravel, geotextile cloth, precast, reinforced concrete toe block, levelling concrete and plain concrete, wet stone masonry facing, weep holes, rip rap toe and any other incidentals necessary to complete the work.

9.3 PREPARATORY WORKS

The Contractor shall complete all necessary preparatory works in accordance with the requirements of Section 2, Preparatory Works.

Coffer dams shall be in place and an effective dewatering system in place and operating before construction of revetments commences.

Payment for preparatory works in connection with the construction of revetments will be paid under Section 2, Preparatory Works.

9.4 EARTHWORKS

The Contractor shall carry out all earthworks required for the construction of revetments in accordance with the requirements of Section 3, Earthworks. This work shall include, but not be limited to, excavating and trimming the bank to the required slope, compacting subgrade and placing and compacting sandy soil fill.

Payment for earthworks in connection with the construction of revetments will be paid under Section 3, Earthworks.

9.5 CONSTRUCTION OF REVETMENTS

9.5.1 General

The Contractor shall submit his proposal for construction of revetments, in accordance with the Drawings, for approval by the Engineer. The proposal shall clearly indicate the sequence of work, the method of dewatering, the materials and equipment to be deployed. Construction shall be made in the dry using coffering and dewatering. The work sequence shall be from timber piling, concrete toe footing construction then proceeding upwards.

The work shall be implemented in consideration of the outlet structures to which the revetments abut and the adjacent revetment construction to be constructed by the contractor for Package A of this project.

9.5.2 Timber Piling

Timber piles shall be driven to the depths and at the spacing (or density) as shown on the Drawings or as directed by the Engineer.

All materials and workmanship shall be in accordance with the requirements of section 5.

9.5.3 Gravel

Gravel bedding and free draining gravel shall comply with Clause 3.4.2 and shall be placed in accordance with Clause 3.4.9 of Section 3, Earthworks.

9.5.4 Levelling Concrete

Levelling concrete shall be placed on the bed of prepared gravel as shown on the Drawings. Concrete shall be in accordance with the requirements of Section 4.

9.5.5 Precast Reinforced Concrete Toe Blocks

9.5.5.1 General

Precast, reinforced concrete, toe block for revetments shall be furnished and laid to the lines and levels shown on the Drawings or as instructed by the Engineer.

9.5.5.2 Materials

Concrete shall be concrete class D as specified in Section 4.

Reinforcement shall be deformed bars as specified in Section 4.

9.5.5.3 Construction

Toe blocks shall be precast at least 14 days prior to installation. The concrete strength of blocks shall be verified by reference to the 7-day test results prior to use. Any block whose 7 day strength is below target strength shall not be used. The subsequent use shall be dependent on the 28 day strength results and the Engineer's approval.

Toe blocks shall be laid on the bed of levelling concrete accurately in position to a tolerance of + or - 25 mm.

Any block which is damaged in handling and deemed unsuitable for use by the Engineer shall not be used and shall be removed from the site.

9.5.6 Weep Holes

9.5.6.1 General

Weep holes shall be constructed at the locations shown on the Drawings.

9.5.6.2 Materials

Pipe:

Material for weep holes shall be 100 mm nominal diameter, black, Unplasticised Poly-Vinyl-Chloride (uPVC) conforming to the requirements of JIS K 6741. Pipe for weep holes shall be approved in writing by the Engineer before any purchase orders are placed.

Filter Cloth

Filter cloth shall be a polyester, staple fibre, needle punched felt with a minimum mass of 250 g/m^2 and shall comply with ASTHMA M 288 'Geotextiles used for Subsurface Drainage Purposes'.

9.5.6.3 Construction

Pipes for weep holes shall be cut to the required lengths as shown on the Drawings. Filter cloth shall be tied firmly to the pipe with nylon twine so as to ensure that all water which will enter the pipes must pass through the filter cloth.

Assembled units shall be placed in the work at the levels, positions shown on the Drawings taking care to ensure that filter constructed as described above remains intact and that the exposed ends on the face of the work are flush with the face of the structure through which the weep hole passes. Gravel backfill shall be carefully hand placed around inner ends of the filters ensuring that that the filter remains intact.

9.5.7 Geotextile Cloth

Geotextile cloth shall be placed on the prepared, trimmed, batter surface of the bank prior to placing the free draining gravel layer. Materials and workmanship shall be in accordance with Section 3, Clause 3.6. Laps shall not be less than 250 mm.

9.5.8 Concrete Works

9.5.8.1 General

Concrete works for revetment construction shall consist of levelling concrete, 100 mm plain concrete screed and plain concrete bedding for the wet stone masonry, reinforced concrete for toe blocks.

9.5.8.2 Materials

All materials shall comply with the requirements of Section 4, Concrete.

Reinforced Concrete shall be Class E

Plain Concrete shall be Class F

Levelling Concrete shall be Class G

Reinforcement shall be deformed bars in accordance with the requirements of Section 4.

9.5.8.3 Construction

All concrete construction relating to revetment construction shall be in accordance with Section 4, Concrete.

When placing concrete care shall be taken to ensure that weep holes are not blocked or dislodged from position.

The 100 mm thick concrete screed for the wet stone masonry shall not be placed until the underlying free-draining gravel bed has been place and approved by the Engineer.

9.5.9 Stone Masonry

9.5.9.1 General

Stone masonry to be constructed as part of revetments comprise wet stone masonry revetment facing and stone masonry stairways.

9.5.9.2 Materials

(a) Stone

Stone for all classes of masonry shall be clean, hard, and durable.

Samples of stone proposed for use in masonry construction shall be submitted to the Engineer for his approval.

Stones shall be of the sizes shown on the Drawings or appropriate for the particular application. Unless otherwise shown on the Drawings, stones shall have thickness of not less than 150 mm, widths of not less than one and a half times their respective thicknesses, and lengths of not less than one and a half times their respective widths. Each stone shall be free of depressions and projections that would prevent it from being properly bedded.

Stone to be used in wet stone masonry revetments shall be regular in size and their thickness shall be approximately 280 mm.

Stone shall be dressed to remove any thin or weak portions. Face stone shall be dressed to provide bed and joints lines that do not vary more than 20 mm from true lines and to ensure the meeting of bed and joints lines without the rounding of the corners of the stones in excess of 30 mm in radius. Bed surfaces of face stones shall be normal to the faces of the stones for 80 mm and from this point may depart from a normal plane by an angle which is not to exceed 50 mm in 300 mm.

Face stones shall be pitched to line along all beds and joints. The maximum projections of rock faces beyond the pitch lines shall not be more than 10 mm.

(b) Concrete Bedding

Concrete into which stones are bedded shall be concrete Class F

9.5.9.3 Construction of Wet Stone Masonry Revetment Facing

(a) Preparation

The gravel bed, the 100 mm concrete screed, the concrete toe block and edge forms shall be completed to the approval of the Engineer prior to placing wet stone masonry.

(b) Selection and Placing

All stones shall be cleaned thoroughly and wetted immediately before being set, and the concrete bed which is to receive them shall be cleaned and moistened before the bedding concrete is spread. Stones shall be laid with their longest faces horizontal in full beds of concrete, and the joint shall be flushed with concrete.

The exposed faces of individual stones shall be parallel to the revetment face in which the stones are set and the pattern shall be regular.

The stones shall be so handled as not to jar or displace the stones already set.

(c) Beds and Joints

Beds for stones may vary from 20 mm and to 50 mm in thickness. At no place shall corners of four stones be adjacent to each other.

(d) Pointing

Joints not pointed at the time the stone is laid shall be thoroughly wet with clean water and filled with mortar. The mortar shall be well driven into gaps between stones with a pointing tool. Stones shall be proud of the pointed mortar by approximately 20 mm. The wall shall be kept wet while pointing is being done.

(e) Weep Holes

Weep holes shall be constructed at the locations as shown on the Drawings or as directed by the Engineer in accordance with the requirements of Sub-Clause 5.5.6, Weep Holes.

(f) Cleaning Exposed Faces

Immediately after being laid, and while the mortar is fresh, all faces stones shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed.

(g) Curing

The masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least three days after completion.

9.5.10 Rip Rap

(a) General

The Contractor shall construct rip rap at the toes of the revetments to the lines and levels as shown in the Drawings or as directed by the Engineer

(b) Materials

Rip rap shall conform to the requirements of Clause 3.5 in Section 3.

(c) Construction

The bed of the canal shall be excavated to the lines and levels and grades as shown in the Drawings to accept the rip rap.

The rip rap shall be placed in accordance with the requirements of Clause 3.5 of Section 3.

9.6 MEASUREMENT AND PAYMENT

9.6.1 Earthworks

Common excavation, sandy soil fill, free draining gravel, geotextile cloth a and rip rap shall be measured and paid in accordance with the respective Clauses in Section 3, Earthworks.

9.6.2 Concrete

Concrete, excluding precast reinforced concrete toe blocks, shall be measured and paid in accordance with the applicable Clause in Section 4, Concrete.

9.6.3 Timber Piling

Timber piling shall be measured and paid under the relevant payment Clause in section 5, Piling Works

9.6.4 Wet Stone Masonry

Measurement will be made of the volume of wet stone masonry complete in place and accepted. Projections extending beyond the faces of the walls will not be included. In computing the quantity for payment, the dimensions used shall be those shown on the Drawings or ordered in writing by the Engineer. No deductions shall be made for weep holes, drain pipe, pipe, or other openings of less than 0.01 square metres in area.

Payment will be made at the unit rate entered in the priced Bill of Quantities which shall include full payment for providing all labour, materials including the concrete bedding and mortar, tools, equipment and any other works incidental to the completion of stone masonry.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
3.6.7	Wet Stone Masonry (250 dia, t=300)	m^3

9.6.5 Weep Holes

Measurement will be made of the number of weep holes of the various lengths completed in accordance with the Drawings, the Specification and to the approval of the Engineer.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
3.6.8	Weep Holes, PVC 100 dia x 1000 with filter: including supply and installation	No

9.6.6 Precast Reinforced Concrete Toe Block

Measurement will be made of the number of precast reinforce concrete toe blocks completed and laid in accordance with the Drawings, the Specification and to the approval of the Engineer

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other costs associated with precasting, testing, handling and laying.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
3.6.6	Precast Reinforced Concrete Block 800 W x 500 H x 2000 L	No.