

When so directed the Contractor shall hand over the water supply system to the Employer after the issuance of the Taking-Over Certificate.

Except where separate provision for payment for water supply and distribution is made in the Bill of Quantities, the cost of all other water supply and distribution as required under the Contract shall be deemed to be included in the other rates and prices in the Contract. The cost for water supply shall include the cost of delivery and consumption of water.

0.8 Engineer's and Employer's Site Office

0.8.1 General

The Contractor shall provide, construct, furnish, equip and maintain the Engineer's/Employer's site office as specified in this Article 0.8. The office building shall be a three-storeyed permanent structure as indicated on the sketches included in Appendix 4. The office shall be located on the west bank of the Rupsa River as shown on the Drawings and shall be used by the Engineer and the Employer for the Contract. The area containing the office shown on the Drawings shall be brought up to a general formation level of +4m PWD by suitably compacted fill.

The Contractor shall prepare and submit within 30 days of the Commencement Date for the Engineer's approval working drawings of the office building including the site layout, front and side elevations, floor plans, details of construction and finishes and all other data as required for the completion of the office in accordance with this Specification. The Engineer's review and comments/approval is expected to be communicated to the Contractor within 10 days of receipt of the detailed documentation.

The office will be used by the Employer for housing operation and maintenance staff after becoming his property. Upon completion of the Works and on the written instruction of the Engineer, therefore, the Contractor shall completely refurbish the building and facilities and hand them over to the Employer.

0.8.2 Description

All interior walls and ceilings shall be finished with a sound, painted plaster finish. The floor shall be covered with vinyl tile or similar washable covering to the approval of the Engineer. Exterior walls shall be covered by "snowcem" and interior walls, doors, windows and ceilings shall be painted with approved types of paint as appropriate.

All doors and door frames shall be of best quality mahogany timber and shall be lockable from both sides. Windows shall be horizontal sliding with anodized aluminium frames, glazed with tinted glass or with plain glass and roller blinds and shall be lockable from inside only. All window openings shall be provided with insect screens and shall be burglar proofed with metal grills.

Each room or area shall be entirely air conditioned, with the exception of kitchens, corridors, toilet rooms, pantries and stores.

The office shall be equipped with desks, tables, drafting boards, chairs, stools, files, plan racks, storage cabinets, book shelves, bulletin boards, and other furnishings as listed in Appendix 1. All furnishings shall be to western European standards.

The office shall be supplied with all necessary stationery (A4 pads - plain, colored, lined, millimeter squared, logarithmic, etc.), all necessary standard forms, headed paper, tracing paper, carbon paper and all typing supplies, pens, pencils, color crayons, felt tip pens, erasers, etc., all of the type, size and in the quantities specified and approved by the Engineer. All such supplies shall be kept replenished to the satisfaction of the Engineer.

All computers, word processors, laser printers, typewriters, calculators, surveying equipment, photocopiers, plan printers and similar equipment shall be new when supplied unless otherwise agreed with the Engineer, and shall be fully maintained and repaired by the Contractor to the satisfaction of the Engineer.

All computers shall be connected to voltage regulator and UPS units, the latter being able to bridge power cuts up to 30 minutes. These voltage regulator and UPS units shall be part of the computer hardware provided under this section.

Before any item is removed for maintenance or repair for a period of more than 12 hours, a similar approved item shall be provided as a temporary replacement unless otherwise agreed by the Engineer.

The office shall be provided with electric lighting and power, and with telephone service for use by the Engineer. All lighting in the office shall be recessed or surface mounted fluorescent lights with detachable diffusers. Each room or area shall be equipped with electrical outlets set in the walls at 600mm above the floor and spaced at approximately 2 meters centers.

The Contractor shall be responsible for and pay all charges, fees or other expenses for providing and maintaining the Engineer's office, all electric, gas and water services, telephone service and other utilities during the period of construction of the Works and beyond until the issuance of the Taking-Over Certificate.

The office shall be equipped with toilet rooms and a kitchen.

Each toilet room Type I shall be equipped with a toilet (pedestal type), wash basin with hot/cold water, hot water heater, wall mirror and 240/110V shaving socket, shower unit complete with shower curtain and duckboards, wall hooks for clothing etc.

Each toilet room Type II shall be equipped with three urinal stalls, toilets (pedestal type), wash basins and hot/cold water, hot water heater, wall mirror and 240/110V shaving socket, wall hook for clothing and a shower unit complete with curtains, duckboards etc.

The Contractor shall supply, and keep replenished at all times, all necessary toilet supplies.

The kitchen shall be equipped with a gas cooker (4 rings plus oven), gas cylinders, refrigerator (2 door, 12 cu. ft. minimum), water filter, hot and cold water, electric kettle, cooking equipment, crockery and cutlery, all of the type and in the quantity approved by the Engineer.

All component finishes and materials shall be approved by the Engineer before installation. Any component or material which proves unsuitable in use shall be promptly replaced by the Contractor.

The Contractor shall be responsible for the site grading required for the site office area specified in Article 0.8.1, including access to the project by means of all-weather roads and for covered parking areas adjacent to the facility. The office site shall be graded and properly drained so that there are not depressed areas where water will collect.

The Contractor shall provide security for the Engineer's office 24 hours per day, 7 days per week and such security shall be subject to approval of the Engineer. The Contractor shall also provide for the office a janitor/tea-boy for the exclusive use of the office for both normal working hours and all other times as the Engineer may direct.

The Contractor shall include for maintenance and servicing of the Engineer's office which shall include, but not by way of limitation, daily dusting, cleaning and janitorial work; window washing and wet floor mopping; as necessary mechanical, air-conditioning, heating, electrical and plumbing systems maintenance, providing potable drinking water and all toilet supplies; disposal of all waste - maintenance of interior and exterior of the building, ground and paved areas, and including any repairs thereto. Maintenance shall also include providing water, gas, electricity and local telephone services, subject to Article 0.7 and any other maintenance or services as specified herein or as further directed by the Engineer. Maintenance work by the Contractor shall be generally scheduled outside the normal working hours of the Engineer and as directed by the Engineer.

All waste water shall be disposed underground and as approved by the Engineer. The Contractor shall perform percolation tests at the location of the each field, and the size of the each field or pit will be subject to the results of these tests and the approval of the Engineer.

The septic tanks, of the size approved by the Engineer, shall be of reinforced concrete equipped with proper inlet and outlet baffles and sealed access hatch. The size shall be sufficient to operate for at least one year without the solids overflowing into the leach fields.

The leach fields or pits shall penetrate through the catch layer if there is one. The space below the distribution pipes shall be backfilled with a pervious material and compacted prior to installing the distribution pipes.

The design of the leach fields or pits shall take into consideration only the area of the side walls of the trench or pit below the level of the inlet pipes. The area of the bottom of the trench or pit may not be used for percolation calculations as it will be continuously saturated. The Contractor shall submit full details of the proposed system for the approval of the Engineer.

0.8.3 Temporary Office Accommodation

The Contractor shall complete the Engineer's Office to the satisfaction of the Engineer **within 120 days** of the Engineer's approval of working drawings given under Clause 0.8.1. For every day of delay in achieving this completion date for the Engineer's office a **penalty of Tk.10,000**

per day shall be applied and shall be deducted from monies due to the Contractor. Until such time as the Engineer's Office has been provided by the Contractor and accepted by the Engineer, the Contractor shall provide in a location to be agreed with the Engineer temporary office accommodation for the Engineer within 30 days of the Commencement Date or later date approved in writing by the Engineer. The temporary office accommodation shall be, as a minimum, six rooms each of 20 sq. m floor area and with equivalent facilities and furnishings as specified above. Existing buildings proposed by the Contractor for use as temporary accommodation are expected to require substantial refurbishment by the Contractor to achieve the standards required.

0.8.4 Personnel

The Contractor shall provide 29 No. drivers, 5 No. watchmen, 4 No. cleaners, 2 No. cooks, 2 No. gardeners and 10 No. office assistants (peons) to carry out duties exclusively for and as directed by the Engineer. Allowance shall be made for personnel to work shifts up to 12 hours per day, seven days per week, where necessary.

Refer also to Clauses 0.9.6 and 0.10.3 for additional personnel to be provided by Contractor for Engineer's Laboratory and Engineer's Accommodation.

0.9 Engineer's Laboratory

0.9.1 General

The Contractor shall provide, construct, furnish, equip and maintain the Engineer's site laboratory together with all the prescribed equipment for the Engineer's staff as described here following. The requirements of Article 0.8.2 in respect of the site office shall also apply to the laboratory where applicable.

The laboratory shall be located on the west bank of the river as shown on the Drawings and shall include soils, concrete and asphalt testing facilities. The laboratory will be used by the Engineer for works in connection with the Contract. The area containing the laboratory shown on the Drawings shall be brought up to a general formation level of $\pm 4\text{m}$ PWD by suitably compacted fill.

The Contractor shall prepare and submit within 30 days of the Commencement Date for the Engineer's approval working drawings of the laboratory building including the site layout, front and side elevation, floor plan with dimensions, details of construction and finishes and all other data as required for the completion of the laboratory in accordance with this Specification. The Engineer's review and comments/approval are expected to be communicated to the Contractor within 10 days of receipt of the detailed documentation.

0.9.2 Building and Utilities

The laboratory shall be generally as indicated in Appendix 5 and shall include:

- 2 Nos. air conditioned offices - 70m²

- Air conditioned laboratory - 120m²
- General working/storage area - 185m²
- Pantry, store
- Toilets type I and type II

The laboratory building shall be either fixed, portable or mobile and shall be completed with insulated roofs and exterior walls unless the walls are of 25 cm thick brick work. Minimum headroom or ceiling height shall be 3.0m.

The laboratory shall have the minimum internal floor areas indicated and shall be provided with +240V 50Hz electricity supply of adequate capacity and with sufficient outlets to accommodate the required testing equipment. Lighting shall be to the approval of the Engineer. In addition to the water supply to the kitchen and toilets the laboratory and general working/storage area shall be provided with a potable water supply and drainage system to serve the sinks scheduled in the Appendix 3. The flooring throughout shall be rigid and able to support heavy test equipment without vibration. Fixed shelving, benches and storage cupboards shall be supplied as scheduled. These shall be of the following minimum standard:

Work benches 900mm high 750mm deep of planed softwood and 19mm ply and top surface finished in approved plastic laminate or tin sheet. Supplied with 500mm deep shelf under.

Cupboards either 900mm high, 400mm deep constructed 600mm above work benches or 900mm high, 750mm deep constructed beneath work benches. All cupboards of planed softwood carcassing, faced with plywood and fitted with doors.

Sinks 'Belfast' pattern with cold tap wall mounted above sink supplied mounted at 900mm height together with plumbed-in waste.

The laboratory shall additionally have an extra set of double doors to the general/working area (min. 2m wide) together with covered parking for 4 vehicles. It shall be provided with two large capacity extractor fans to be wall mounted as directed by the Engineer. Compaction pedestals to meet the requirements of standard tests shall also be provided in locations approved by the Engineer.

0.9.3 Equipment

The Engineer's laboratory shall be supplied with the furniture, equipment and supplies detailed in Appendix 3. The equipment shall be of the highest quality and the Contractor shall submit a list of the proposed brand names, model numbers and data sheets for the Engineer's approval, within 30 days of the Commencement Date. All equipment shall remain the property of the Employer at the end of the contract.

The Contractor shall bear all costs pertaining to obtaining specimens of materials, mixes etc. and the provision of necessary equipment and plant for obtaining these specimens, mixes and samples and transporting them to the laboratory or other locations as designated by the Engineer.

No separate payment will be made for such costs which shall be considered incidental to the provision of this site laboratory.

0.9.4 Approval of Laboratory

The Contractor shall complete the Engineer's Laboratory to the satisfaction of the Engineer **within 90 days** of the Engineer's approval of working drawings given under Clause 0.9.1. Prior to acceptance of the laboratory building and of the equipment, the Engineer shall inspect the said building and equipment for compliance with this Specification.

The Contractor shall order all the required equipment for the Site Laboratory within 10 days of the issue of the Engineer's approval given under Clause 0.9.3, and shall provide documentary evidence of having placed the necessary orders.

If the Contractor fails to complete the laboratory within the specified period, the Engineer reserves the right to delay approval for commencement of the permanent works in the Contract and/or carry out any sampling and laboratory testing in any other laboratory with any fees and charges to be deducted from any amounts due to the Contractor.

0.9.5 Maintenance of the Laboratory

The Contractor shall at all times be responsible for maintaining the building, utilities and all testing equipment in an acceptable condition for use. The Contractor shall provide replacement equipment where required by the Engineer whilst equipment is being repaired. Disposable supplies and consumables, reagents, etc. associated with laboratory operations and testing shall at all times be kept replenished so as to prevent testing delays for the Contract.

The Contractor shall also include for routine maintenance of the facility which shall include, but not be limited to: daily dusting, cleaning and janitorial work; window washing and wet floor mopping; necessary maintenance and repair to mechanical, air-conditioning, heating, electrical and plumbing systems; providing potable water and toilet supplies; disposal of all wastes; maintenance of interior and exterior of building, grounds and paved areas, including any repairs thereto. Maintenance shall also include providing water, gas, electricity, and local telephone services, and any other maintenance or service as specified herein or as further directed by the Engineer. Maintenance work by the Contractor shall be generally scheduled outside of the normal working hours of the Engineer and as directed by the Engineer.

The Contractor shall be responsible for and pay all charges, fees or other expenses for maintaining water, gas, electricity and telephone services, and other utilities for the whole of the construction period for the Works until the issue of Taking-Over Certificate.

Unless otherwise directed by the Engineer, the Contractor shall, upon completion of the works, remove and clear away the laboratory building from the Site and reinstate the area to the satisfaction of the Engineer. However the laboratory equipment shall be handed over to the Employer with complete refurbishment.

0.9.6 Personnel

The Contractor shall employ a suitably qualified and experienced Materials Engineer proficient in the English language throughout the Contract to take primary responsibility for formulation and implementation of the Contractor's Quality Plan described in Clause 0.6.1. He shall be responsible for liaising and coordinating with the Supervision Consultant, Engineer's Laboratory, field sampling/testing staff and off-site laboratories to ensure all sampling, specified tests and inspections are carried out in a timely manner.

The Contractor shall provide 4 No. drivers, 2 No. suitably experienced and capable laboratory technicians and 2 No. laborers to assist the Engineer with the taking of samples and testing. Allowance shall be made for personnel to work shifts up to 12 hours per day, seven days, per week. Some of these staff must have an acceptable proficiency in the English language.

0.10 Engineer's and Employer's Accommodation

0.10.1 General

The Contractor shall provide, equip, service and maintain, until the issue of Taking-Over Certificate furnished accommodation for the sole use of the Engineer, the Employer, Supervision Consultant their staff, and their families during their duties in connection with the Contract. The requirements of Article 0.8.2 in respect of the Engineer's Site Office insofar as applicable shall also apply to the Engineer's and Employer's accommodation.

The Contractor shall prepare and submit within 30 days of the Commencement Date for the Engineer's approval working drawings of each of the accommodation unit types including the site layouts, front and side elevations, floor plans with dimensions, details of construction and finishes and all other data as required for the completion of the accommodation unit types in accordance with the Specification. The Engineer's review and comments/approval are expected to be communicated to the Contractor within 15 days of receipt of the detailed documentation.

The living accommodation shall be located on the area on the west bank as shown on the Drawings. The area containing the accommodation shown on the Drawings shall be brought up to a general formation level of +4 m PWD by suitably compacted fill.

0.10.2 Description

The categories of accommodation and the minimum floor areas of each unit type shall be as indicated below. Sketches indicating typical layouts are included in **Appendix 6**:

- i) 2 bed units - 18 No. units, each unit nominally 105m², as per the sketch marked "Engineers Quarters" (A6/1); one of these units shall be customized to function as a restaurant / dining facility for senior foreign and local staff.
- ii) Engineers' Mess — 3 No. blocks each containing 16 bed/bathroom units each of 36m², and recreation, dining, kitchen facilities as per the sketch marked "Engineers' Mess" (A6/2); - Total 48 No. bed/bathroom units.
- iii) Dormitory Quarters - a single 500m² unit providing 25 individual rooms, with

recreation/dining/kitchen facilities as shown on sketch marked "Staff Quarters (Dormitory)" (A6/3).

The accommodation units shall be either fixed, portable or mobile and shall be completed with insulated roofs and exterior walls unless the walls are of 25 cm thick brick work. Minimum headroom or ceiling height shall be 2.8 m.

Each unit shall include the kitchens, bathrooms, bedrooms, living rooms, stores and verandahs as indicated on the sketches in **Appendices 6/1, 2 and 3**. Accommodation units mentioned under 6/1 and 2 shall be provided with all the necessary hard furnishings including refrigerators, freezers, electric or gas 4 hob units with ovens, washing machines, installation for hot and cold water, washing facilities and sanitary fittings. Kitchens shall include appropriate fully fitted units to a specific standard approved by the Engineer.

Similarly all loose and built-in furniture, (such as beds drawer units, tables, chairs, etc.) bedding, floor coverings, curtains, etc. shall be to a specific approved standard. Housing and mess units as mentioned in 6/1 and 2 shall be supplied with sets of soft furnishings, cutlery, crockery and cooking utensils appropriate to the specific unit.

Each bedroom in the Dormitory Quarters (indicated in 6/3) shall be provided with necessary furnishings such as beds, drawer units, etc. The kitchen, dining room, lounge and recreation areas shall also be provided with appropriate furnishings, cutlery, crockery and cooking utensils sufficient for the number of occupants.

One third of the Engineers' Mess and all of the Dormitory Quarters shall be completed and furnished **within 60 days** of the Engineer's approval of working drawings given under Clause 0.10.1. The remaining accommodation shall be completed **within 90 days** thereafter. The Contractor shall provide temporary accommodation off an approved standard for the Engineer and Supervision Consultant staff from the date of the start of work on Site and shall maintain and service such accommodation until the permanent accommodation is habitable to the approval of the Engineer. Existing buildings proposed by the Contractor for use as temporary accommodation will usually require substantial refurbishment to achieve the standards required.

The Contractor shall provide and maintain adequate all-weather access roads and shall construct paved, covered parking areas adjacent to the accommodation, to the approval of the Engineer. Other areas without buildings shall be grassed and planted as directed by the Engineer.

The Contractor shall provide a basic food and beverage service for all residents in the Accommodation as specified in Article 0.10.5.

The living accommodation shall: be fully air-conditioned together with ceiling fans (accommodation mentioned under 6/1 and 2 only), or provided with ceiling fans in each room (accommodation mentioned under 6/3) fully lined and adequately sound proof; be provided with adequate dust, sand and insect proof doors and windows; and include all necessary features to maintain a 25°C temperature differential against ambient air temperature in hot weather, and a minimum internal room temperature of 20°C in cold weather.

The Contractor shall provide and maintain efficient water and electricity supply, and a piped sewage/waste water disposal and treatment system to all living accommodation, to the approval of the Engineer.

The Contractor shall provide all necessary security safeguards including; perimeter fencing, external lighting and watchmen, to the approval of the Engineer.

Unless otherwise directed by the Engineer, the Contractor shall, upon completion of the Works, remove and clear away all site accommodation units from the Site and reinstate the area to the satisfaction of the Engineer.

0.10.3 Temporary Residential Accommodation

The Contractor shall complete the Engineer's and Employer's Accommodation to the satisfaction of the Engineer **within 150 days** of the Engineer's approval of working drawings given under clause 0.10.1. For every day of delay in achieving this completion date, a **penalty of Tk 10,000 per day** shall be applied and shall be deducted from monies due to the Contractor. Until such time as the Engineer's and Employer's Accommodation has been provided by the Contractor and accepted by the Engineer, the Contractor shall provide, in a location to be agreed with the Engineer, temporary residential accommodation for the Engineer and Supervision Consultant staff **within 30 days** of the Commencement date or later date approved in writing by the Engineer. The temporary residential accommodation shall be sufficient and adequate to accommodate

- 5 No. Engineer's professional staff (from RHD)
- 4 No. foreign professional staff from Supervision Consultant
- 10 No. local professional staff from Supervision Consultant
- 10 No. local support staff from Supervision Consultant.

The Temporary residential accommodation shall have the equivalent facilities, furnishings and services as specified in Article 0.10.2 and Article 0.10.5. Existing buildings proposed by the Contractor for use as temporary accommodation are expected to require substantial refurbishment by the Contractor to achieve the standards required.

0.10.4 Personnel

The Contractor shall provide, 5 No. watchmen, 8 No. cleaners, 8 No. cooks and 3 No. gardeners to work in the accommodation of the Engineer all as directed by the Engineer. Some of these staff must have acceptable proficiency in the English language.

0.10.5 Meals for Residents of Engineer's and Employer's Accommodation

The Contractor shall provide all basic daily meals required by staff and dependents of the Engineer (RHD), Employer and Supervision Consultant who are officially resident in the Engineer's and Employer's Accommodation village throughout the Contract period, and resident in the Temporary Residential Accommodation during the initial Contract period.

Generally, the standard 3 meals per day (breakfast, lunch and dinner) are to be provided in appropriate quantity and to an acceptable standard. Daily mealtimes are to follow a timetable suited to the majority of residents and as approved by the Engineer.

The style, nature, and standard of meals provided shall be suitable for the 3 main groups of residents namely:

- (i) residents of the "Engineer's Quarters" comprising senior local and foreign professional staff of the Engineer and Supervision Consultant with some family dependants. Average number of people expected to be on site during the Contract period is 25 No. adults, and 5 No. children. It is intended that a restaurant/dining facility will be established in one of the "Engineers' Quarter" buildings, staffed by two suitable cooks and two assistants.
- (ii) residents of "Engineers' Mess", comprising senior local technical and administrative support staff of the Supervision Consultant and Engineer. Average number of people expected to be on site during the Contract period is 40 No. adults. There is one kitchen/dining room facility for each block of 16 No. bedroom/bathroom units. One cook and one assistant are required for each of the 3 No. blocks (total 3 cooks and 3 assistants).
- (iii) residents of the "Dormitory Quarters", comprising junior local technical and administrative support staff of the Supervision Consultant and Engineer. Average number of residents expected to be on site during the contract period is 20 No. adults. There is one kitchen/dining room facility for this group of 25 bedrooms. Two cooks and two assistants are required for this kitchen/dining room facility.

Payment for provision of this meals service will be based on the number of kitchen/dining facilities operational each month during the Contract.

0.11 Telecommunications

The Contractor shall provide **within 90 days** of the Commencement Date and maintain until the issuance of the Taking-Over Certificate the following **telephone and telefax** lines for the Engineer's and Supervision Consultant facilities:

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|------------------------------------|---|-------------------------|
| • for the Engineer's Office | - | 1 ISD telephone line |
| | - | 1 ISD telefax line |
| | - | 6 local telephone lines |
| • for the Engineer's Laboratory | - | 1 local telephone line |
| • for the Engineer's Accommodation | - | 1 ISD telephone line |
| | - | 6 local telephone lines |

During the first months of the Contract, until the telephone system described above is available, the Contractor shall provide and operate an interim communications system that is sufficient in the opinion of the Engineer during that period for the execution of the Works. If necessary, the Contractor may be required to provide a satellite telephone link during this interim period.

The Contractor shall provide, install, test, maintain and remove on completion of the Works a

radio telephone communication system for communications within the Site for the exclusive use of the Engineer. The Contractor shall be responsible for obtaining and making all payments in respect of all permits, licences and charges involved in the provision and use of the radio telephone system.

The radio telephone system shall be supplied and commissioned **within 90 days** of the Commencement Date and shall be capable of providing the Engineer and Supervision Consultant with interference-free and exclusive use of a channel and shall be capable of operation between master stations located at the Engineer's offices. It shall provide clear transmission/reception between all Engineer's facilities and up to 12 No. portable receiver/transmitter handsets at any location on the Site and up to 5 km beyond including the inside of structures such that 2-way conversation is available at all times between the office building and any portable handset.

The office building shall be supplied with recharging facilities, such that up to 6 handsets can be recharged at any time.

The system shall have the capacity for the master stations to have receiving/transmitting contact with any master station in use by the Contractor.

The Contractor shall provide whatever telecommunications equipment that he requires for the execution of the Works. The Employer will assist in obtaining permits for wave-lengths and licences for the Contractor to use a limited number of short-range VHF and medium-range HF transmitters and receivers.

The Engineer and the Supervision Consultant shall be allowed free use of the communications facilities provided under this Contract except that they shall be required to reimburse the Contractor directly for the cost of all communications beyond the Site.

The cost to be charged to the Engineer through the contract for communications shall be calculated on the basis of the corresponding billing by T and T for call charges plus 2½ percent. Refer BOQ Item 8.2.2.

0.12 Engineer's and Employer's Transport

0.12.1 General

The Contractor shall provide vehicles and boats as listed below, for the duration of the Contract until the issue of the Taking-Over Certificate, for the exclusive and personal use of the Engineer, the Employer, Supervision Consultant and their staff at all times for activities and work in connection with the Contract. Upon completion of the Works the vehicles shall become the property of the Employer. The Contractor shall fully service and repair the vehicles as instructed by the Engineer immediately prior to handover to the Employer. The boats shall remain the property of the Contractor and shall be removed by the Contractor from the Site with bathymetric survey equipment.

- Vehicles: 5 No. 5 seater saloon car (Toyota Corolla or equivalent)

	3 No.	approved vehicle) 9 seater LWB 4WD Jeep (Mitsubishi PAJERO, 5 door, GLX, Petrol powered with dual A.C or equivalent approved vehicle).
	2 No.	9 seater LWB 4WD station wagon (Toyota Landcruiser Prado, petrol powered with dual A.C, or equivalent approved vehicle.)
	14 No.	4wd twin cab pickup (Toyota Hilux petrol powered. or equivalent approved vehicle)
	2 No	9 seater minibus (Toyota Hi-Ace, petrol powered with dual A.C, or equivalent approved vehicle)
- Boats:	1 No.	14m launch
	4 No.	5m work boat.

0.12.2 Road Vehicles

The makes and models of road vehicles to be supplied shall be to the approval of the Engineer. The vehicles shall be suitable for Bangladesh conditions with a proven record of reliability and there must be an existing servicing/spare parts network available in Bangladesh.

All vehicles shall have factory-installed air conditioning (dual units for 4wd station wagons and Minibuses) and shall be fitted with seat belts for both the driver and passengers.

The Contractor shall provide, without charge to the Employer, all the necessary oil, fuel and maintenance, as well as paying the cost of insurance and all taxes. The vehicles shall be fully insured by the Contractor for use on the public highway by any driver at any time, anywhere in Bangladesh.

The Contractor shall issue to the Engineer at the time of providing each vehicle a copy of the insurance certificate noting full details of the insurance cover, and shall provide evidence prior to or on each insurance renewal date that the insurance has been renewed in accordance with this Specification.

The Contractor shall undertake, without charge to the Employer, all daily and routine maintenance, and all overhauls and repairs from whatever cause as may become necessary. During these events a similar vehicle shall be made available as a replacement.

The Contractor shall provide 2 No. 4wd station wagons (jeeps), 1 No. Minibus, 2 No. saloon cars and 2 No. 4wd twin cab pickups **within 30 days** of the Commencement Date, for use by Supervision Consultant staff. The dates on which all other vehicles shall be provided shall be as directed by the Engineer.

The vehicles shall be new when supplied and shall not be removed from the Site other than with the prior approval or upon the request of the Engineer.

The vehicles shall not bear any name, logo or advertising material.

The saloon cars shall have an engine capacity greater than 1.3 litres and the minibuses greater

than 1.5 litres. Both can be presumed to be restricted primarily to paved roads travel.

The 4 wheel drive vehicles shall have a minimum engine capacity of 2.5 litres. The vehicle shall have a hard top and shall be equipped with a plastic 5 litre insulated cooled water container. The 4 wheel drive vehicles shall be of the on-and-off-road type; long wheel based, twin cab or station wagon bodied, as detailed. All 4 wheel drive vehicles shall be provided with a 50mm towing ball.

0.12.3 Boats

All boats shall be supplied **within 90 days** of Commencement Date, as new and to a type and manufacture as approved by the Engineer. The boats shall be of two types, launches and work boats, as described below.

The launch shall be a craft of not less than 14m length with an enclosed cabin at deck level with seating capacity for 20 persons. At all times the launch shall carry life rafts for a minimum of 24 persons together with 30 life jackets. The launch shall have an inboard petrol or diesel engine and shall have a cruising speed of at least 20 knots. The launch shall be provided with a trained crew and shall be fueled and maintained at the Site until the issue of the Defects Liability Certificate. The launch shall be provided with a radio transceiver to operate within the system provided by Article 0.11 and shall be fully equipped for safe river navigation. The launch shall be for the exclusive use of the Engineer and Supervision Consultant.

The launch shall be capable of being used as survey launch and shall be equipped with the following:

- echo sounder - Atlas dual frequency type or equal;
- electronic positioning system capable of receiving the signals used by the Contractor himself for position finding;
- track plotter;
- recording and processing units to produce cross sections and charts of surveyed areas.

All equipment shall be interfaced to the satisfaction of the Engineer.

The work boats shall be light speedy small craft of nominal 5m length with a capacity for 6 passengers. They shall be to a type approved by the Engineer. The craft may be fixed hull with a cabin shelter and inboard engine or large inflatable with rigid floor and outboard motor, and they shall have a cruising speed of at least 25 knots when fully laden. Exact requirements shall be as ordered by the Engineer. The Contractor shall be required to supply fuel and maintain these light craft and provide the crew until the issue of the Taking - Over Certificate, without charge to the Employer. Each craft shall be supplied with sufficient life jackets for all persons that can safely be carried.

The Contractor shall provide 6 No. boatmen to operate the launches and the work boats until the issue of the Taking-Over Certificate. Allowance shall be made for personnel to work shifts up to 12 hours per day.

0.12.4 Berthing Facilities for Boats

The Contractor shall construct suitable berthing facilities for the boats on both sides of the river, providing secure mooring and safe boarding facilities at all normal river levels expected during each year. The locations of the berthing facilities shall be to the approval of relevant river authorities and the Engineer, and all-weather vehicle access and parking areas shall be provided close to the facilities. The berthing facilities shall be dismantled at the end of the Contract by the Contractor unless approved otherwise by the Engineer.

SECTION 3 TEMPORARY WORKS

Replace Article 3.1.2 paragraph 1 with the following :

3.1.2 Working Drawings/Calculations

The Contractor shall be responsible for the design, specification, execution and subsequent removal of all Temporary Works necessary for the completion of the Works. Temporary Works shall be designed in accordance with the Standards described elsewhere in this Specification or as agreed with the Engineer.

Before the Contractor starts construction on any part of the Temporary Works, he shall furnish to the Engineer complete drawings in the English language and, if so required, calculations relating to stability strength and deflection of that part of the Temporary Works. Where the Temporary Works have direct contact with any part of the Permanent Works, the drawings and calculations shall clearly indicate the relationship, illustrate erection sequences and show any loadings or stresses applied to or from the Permanent Works.

Calculation shall be submitted on size A4 paper and shall be clearly and neatly set out in the English language. All calculations shall be in SI units. All pages shall be uniquely numbered, dated and titled. Pages may be in manuscript provided this is clear and legible. Script shall be such that clear photocopies can be reproduced.

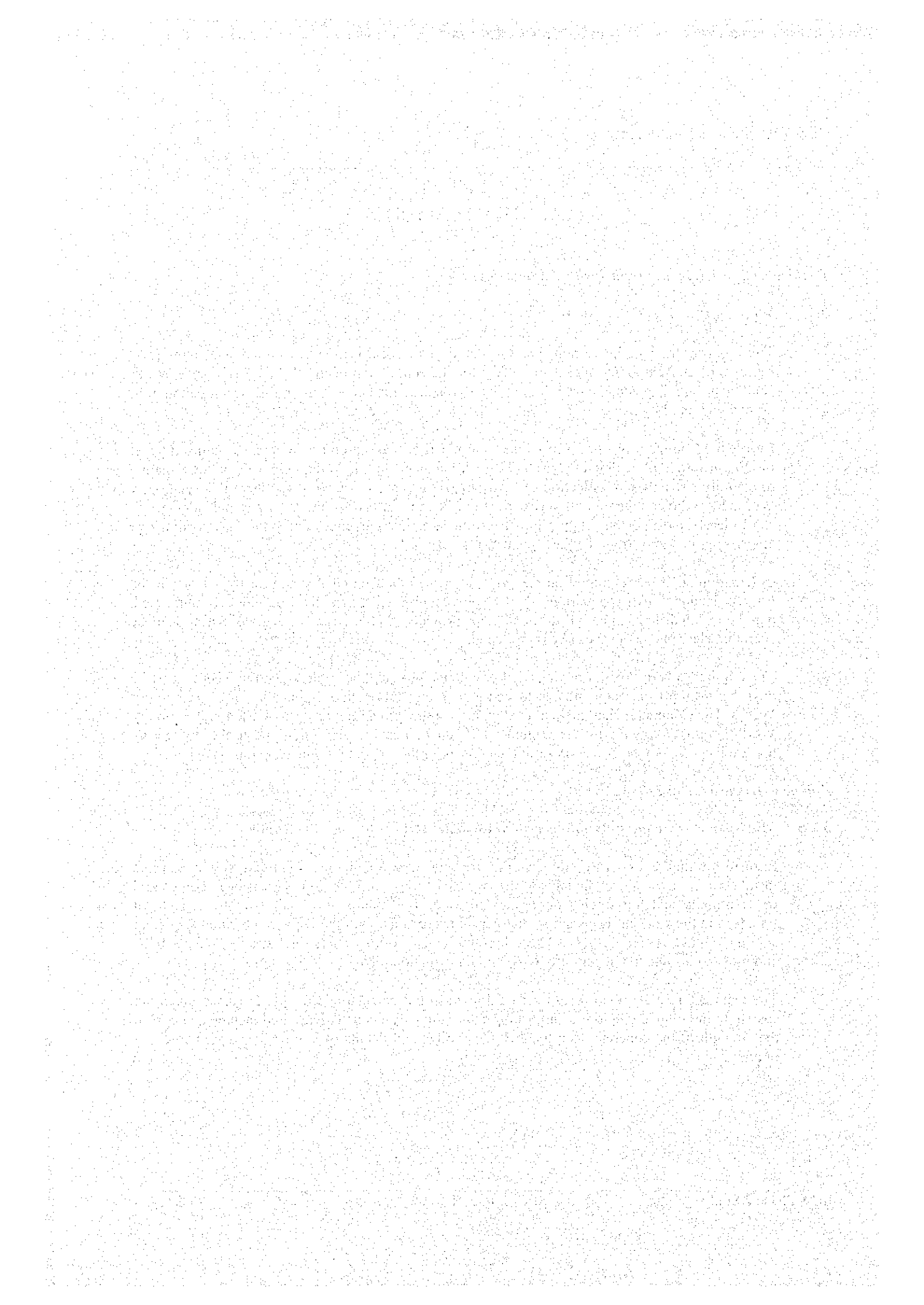
The required submission of drawings and/or calculations shall be made to the Engineer at least 30 days before the Contractor intends to commence any fabrication or installation of Temporary Works. The Contractor shall make due allowance in his programme for submission of Temporary Works proposals, review by the Engineer and amendment, resubmission and further review by the Engineer as may be necessary until the consent of the Engineer to the proposals is obtained.

Add new Article 3.2.5 as follows :

3.2.5 Mid-span closure pour clamping system for balanced cantilever construction

Prior to forming and pouring mid-span closure segments, a temporary clamping system shall be installed to rigidly connect the ends of the two cantilevers until the segment has been poured and the continuity and top stitch tendons are stressed. The clamping system shall be capable of transferring the working loads across the gap in accordance with the approved method statement submitted under Article 8.13.8. As used here the term 'working loads' includes the deformations and movements due to temperature, wind and construction loads.

The Contractor shall submit a full set of drawings and calculations for his proposed clamping system to the Engineer before commencing fabrication. The calculations shall include a check on the strength of the concrete deck local to the fixings and details of any proposed strengthening required.



SECTION 5 BORED PILES

Replace the whole of section 5 with the following :

5.1 General

The work covered by this section of the Specification comprises the provision of all necessary plant, labour, equipment and materials and performing all operations in connection with the installation of vertical base-grouted bored cast insitu concrete piles to support the bridge. The installation and testing of preliminary trial piles is also covered.

The term equipment as used herein shall include all equipment and appliances necessary to construct the piling works as specified and shown on the drawings.

The plant, equipment and methods of working for construction of the piles are to be proven in the preliminary test piling trial specified in Article 5.8. Any changes indicated as necessary by the trial shall be made by the Contractor notwithstanding any earlier approval by the Engineer. Only changes consequent on direction by the Engineer to increase lengths of piles beyond those specified herein or to provide additional measures to increase capacity shall be considered as changes to the design of the piles as shown on the Drawings.

5.2 Piling Plant and Equipment

The Contractor shall mobilise for the installation of bored piles to suit his construction programme. The Contractor shall provide full details of his proposed plant and equipment and methods for installation of the base-grouted bored piles to the Engineer for approval not less than 30 days before mobilisation. Mobilisation shall be initially for the preliminary trial piling programme. Adjustments or supplements to the plant and equipment and methods may be necessary following completion of each of the Soils Investigation and the preliminary trial piling programme.

The proposed plant and equipment shall be capable of installing vertical piles to the levels up to 8m below those shown on the Drawings without modification and shall be compatible with additional measures to increase pile capacity by further lengthening the piles or side-wall grouting if that was instructed by the Engineer following trial pile loading.

The Contractor shall demonstrate to the Engineer the capacity of the boring rig he proposes to use to form bores of the specified diameter and depth. The Contractor shall commission a power and torque analysis for different pile penetrations, considering the effect of changes in soil characteristics, to confirm the adequacy of the power source and the strength and durability of the transmission and tools.

Where construction of bored piles is to be carried out overwater the Contractor shall provide pontoons, jacked platforms, tenders, barges, etc, adequate to ensure that all the procedures trialed on land can be performed satisfactorily overwater including the supply and disposal of support fluid and delivery of concrete. The Contractor shall demonstrate this capability by full-scale rehearsals of all operations prior to initiating boring of bridge piles over water.

Plant and equipment shall be in good operating condition and be well maintained throughout pile installation.

5.3 Materials

Permanent steel casings shall be manufactured from steel conforming to the Specification for Structural Steel for Bridges, AASHTO M270 (ASTM A709) Grade 50, and shall conform to the requirements of AASHTO Specification Section 11.

Concrete shall comply with the requirements of Specification Section 8, including the requirements for underwater placement.

Reinforcement shall conform to the requirements of Specification Section 9.

5.4 Tolerances

The diameter of a pile shall be not less than the diameter shown on the Drawings.

The width of the drill tool shall be checked as necessary and recorded for each pile to ensure the specified diameter is achieved. A tolerance of +3% / - 0 on the drill tool width is permissible.

Piles shall be installed within the following maximum permitted tolerances :

Position: 150mm in any direction at commencing level

Verticality: 1 in 75 deviation from the vertical

Excavation methods equipment shall be designed so that the completed shaft excavation will have a flat bottom. The cutting edges of the excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of plus or minus 30mm per meter of diameter.

Reinforcement cages shall be no more than 100mm above or 75mm below the position shown on the Drawings.

Permanent casings shall be no more than 100mm above or 100mm below the position shown on the Drawings.

Top elevation of the bored pile concrete shall be within plus 25mm to minus 75mm of the top elevation shown on the Drawings.

No method of forcible correction will be permitted.

When the above tolerances are not met, design changes in the pile cap may be required by the Engineer to incorporate piles installed out of tolerance. The costs of redesign and Unforeseeable Work resulting from approved design changes to incorporate piles installed out of tolerance shall be at the Contractor's expense. Redesign drawings and computations prepared by the Contractor's engineer shall be signed and sealed by a Registered Professional Engineer experienced in the design of bridge foundations. Any redesign proposed by the Contractor shall not be implemented until the redesign has been reviewed and approved by the Engineer.

5.5 Boring and Casting

5.5.1 General

The pile shall be bored and the concrete shall be placed in a continuous operation without any

delay that, in the judgement of the Engineer, would lead to impairment of the performance of the pile.

During construction the level of fluid in the pile bore shall be maintained not less than 2 m above the higher of the piezometric level of the external groundwater and river level at all times.

Not less than 30 days prior to the start of the trial piling program, the Contractor shall submit for the Engineer's approval, proposed procedures to be implemented in the event of loss of support fluid from a pile bore or collapse of a bore wall. In the event of loss of support fluid from a pile bore or collapse of a bore wall, the contractor shall not delay immediate implementation of the approved procedures. Should these procedures be found inadequate, the Contractor shall take necessary measures, with the approval of the Engineer, to prevent further loss or damage.

From installation until 14 days after concreting the free length of casings of piles constructed overwater shall be adequately supported and restrained to maintain position and alignment and to prevent buckling. These constraint arrangements shall be such that damage to the piles due to currents or other causes is prevented. The proposed support measures shall be submitted to the Engineer for approval.

At any pier or abutment foundation, no casing shall be driven and no pile excavation shall be performed when there is an open pile hole or a pile in which the concrete has been in place for less than 48 hours

5.5.2 Records

The Contractor shall keep records as indicated below for the installation and concreting of each pile, and shall submit two signed copies of these records to the Engineer not later than 1200 hours of the next working day after the pile was installed. The Contractor shall submit the proposed pile record forms to the Engineer for approval not less than 30 days prior to the start of the trial piling programme. The signed records will form a record of the work. The records shall show the following:

- Pile reference number (location)
- Pile type and nominal diameter
- Names of pile foreman and inspector
- Pile Forming Equipment including rig no.
- Pontoon arrangements for piles constructed overwater
- Standing groundwater level from direct observation or given data
- River level if pile constructed overwater
- Date and time of commencement and termination of boring and of installing casings
- Date and time of inspection of base cleanliness and the result
- Date and time of placing the reinforcement cage
- Date and time of commencement and termination of concreting
- Ground level at pile position at commencement of installation of pile
- Working level on which piling machine stands
- Time and elevation of each excavation lift, and a description of the material removed
- Depth from ground level at pile position to pile toe
- Toe level of pile
- Pile head level as constructed
- Finished pile top level
- Toe level, length and wall thickness of temporary casing used and time of removal

Toe level, length and wall thickness of permanent casing
Depth from ground surface to changes in strata and to standing groundwater and any fluctuations.
Soil samples taken and in situ tests carried out during pile formation or adjacent to pile position
Length and details of and cover to reinforcement
Concrete mix
Volume of concrete supplied to pile
Plot of actual versus theoretical concrete volume versus elevation.
All information regarding obstructions, delays and other interruptions to the sequence of work

Any unexpected driving or boring conditions shall be noted in the records.

Records of integrity testing and base-grouting shall be submitted separately as described in Articles 5.6 and 5.7.

5.5.3 Damage to Piles

The Contractor shall ensure that during the course of the work, displacement or damage which would impair either performance or durability does not occur to completed piles.

The Contractor shall submit to the Engineer his planned sequence and timing for piling having regard to the avoidance of damage to adjacent piles.

The Contractor shall protect the completed piles from damage due to his operations and from other sources including but not limited to boat impact, damage from equipment and vehicles, and damage from floating debris. The Contractor shall repair any damaged piles to the satisfaction of the Engineer and at the Contractor's expense.

5.5.4 Temporary Support

5.5.4.1 General

Where a support fluid is used for maintaining the stability of a bore, an adequate temporary casing shall be used in conjunction with the support fluid so as to ensure stability of the strata near ground level and the safety of personnel until the permanent casing has been placed.

5.5.4.2 Support fluid

A support fluid shall be used for maintaining the stability of pile bores. The properties and use of the fluid shall be such that the following requirements are achieved:

- (i) continuous support of the excavation;
- (ii) solid particles are kept in suspension;
- (iii) the fluid can be easily displaced during concreting including from the sides of the bore so as to achieve side wall friction;
- (iv) the fluid does not coat the reinforcement to such an extent that the bond between the concrete and reinforcement is impaired.
- (v) the fluid shall not cause pollution of the ground, groundwater or river water before, during or after use.

Details of the Contractor’s proposals for the support fluid, with manufacturers certificates for the constituents and mix proportions, and of the mixing and screening equipment to be used shall be submitted to the Engineer for approval.

The Contractor shall provide details of the properties and previous use of the support fluid to demonstrate it will meet the specified requirements. These details shall be submitted at least 60 days prior to the commencement of preliminary trial piling work and shall include:

- (i) evidence from previous work with this support fluid and justification for its suitability for these ground conditions, the available water, the size of the piles and the method of pile construction. Particular issues which should be addressed are the types and sources of the support fluid constituents, time of construction of the piles, pile length, ambient temperature, and soil and groundwater chemistry;
- (ii) results of representative laboratory or field mixing trials with the support fluid to demonstrate compliance with the Specification;
- (iii) details of the tests to be used for monitoring the support fluid during the works, and the compliance values for these tests. Testing shall include rheological properties, density, sand content, fluid loss, filtercake thickness and pH.

The support fluid shall meet the following requirements, unless more restrictive requirements are recommended by the product manufacturer:

Item to be measured	Range of Results at 20°C	Test method
Density	(10.0 – 11.5) KN/m ³	Mud Density balance API 13B – Section 1
Viscosity	28-40 seconds	Marsh Funnel API 13B – Section 2
Ph	8-11	Electric pH Meter DR pH indicator API-13-Section 6

The Contractor shall establish a suitably equipped and properly maintained site laboratory for this sole purpose and provide skilled staff and all necessary apparatus to undertake the sampling and testing

All solid additives shall be stored in separate waterproof stores with a raised floor or in waterproof silos which shall not allow the material to become contaminated. Bentonite and other materials shall be tested on delivery of each new batch to ensure compatibility with the criteria on which the support fluid design is based.

Additives shall generally be used in accordance with the manufacturer’s recommendations unless demonstrated as suitable otherwise

The constituents of the fluid shall be mixed thoroughly to produces a homogeneous mix. The temperature of the water used in mixing, and of the support fluid at the time of commencing concrete placement shall not be less than 5°C.

Each batch of freshly prepared or reconditioned slurry shall be proven by sampling and testing to be within the compliance values and the results submitted before the batch is used.

Details of the method, frequency and locations for sampling and testing slurry from the bores shall be submitted at least 21 days prior to the commencement of work. As a minimum testing of Marsh cone viscosity, density and pH shall be carried out of the fluid being circulated at hourly intervals and the results tabulated for inspection. At least one sample from each of the base, middle and top of the bore shall be taken immediately prior to placing steel and concrete and be tested for the full range of compliance values. If tests show the support fluid does not comply with the Specification it shall be replaced before continuing boring or further cleaning. The support fluid shall meet all the approved compliance requirements before reinforcement steel is placed.

Discarded fluid shall be removed from the site without undue delay.

5.5.4.3 Temporary casing

The use of temporary casing is subject to the approval of the Engineer.

Temporary casings shall be of a quality of material, length and thickness adequate for the purpose of preventing water and unstable soil from entering the pile bores. As a minimum a sufficient length of temporary casing shall be provided until permanent casing is installed to support the top of the hole and be extended 1m above platform or pontoon level for safety.

Where boring takes place through unstable water-bearing strata, the temporary casing where employed shall be such that soil from outside the area of the pile is not drawn into the pile section and cavities are not created outside the temporary casing as it is advanced.

The use of a vibrator to insert and withdraw temporary casings is subject to the method not causing disturbance of the ground or placed concrete which would adversely affect the construction or the capacity of piles.

Temporary casings shall be free from significant distortion. They shall be of uniform cross-section throughout each continuous length. Casings shall be free from internal projections and encrusted concrete which might adversely affect the proper formation of piles.

Where piles are bored under water or support fluid in an unlined state, the insertion of a full-length loosely fitting casing to the bottom of the bore prior to placing concrete will not be permitted.

5.5.5 Permanent casing

The wall thickness and fabrication method of the permanent casing shall be adequate to ensure it maintains its shape during installation and that no distortion of the toe, top or elsewhere occurs to affect the casting of the pile. Design calculations for the casings shall be submitted by the Contractor for approval by the Engineer detailing the methods of working to which they apply and the stresses that will arise. Permanent casings shall have a wall thickness not less than thickness values shown on the Drawings. In addition, casings driven without preboring or jetting shall be in accordance with Section 6.10.6 of API RP2A-WSD (American Petroleum Institute).

A temporary extension above the permanent casing shall be used to continue concreting above the level required for the top of sound concrete so that the cut-back of unsound concrete is outside the permanent casing.

The manner of placing permanent casings shall be such that the casings will provide a smooth surface to the pile if exposed by scour below the current river bed level. The casings shall not be encrusted externally with concrete or grout.

5.5.6 Continuity of construction

The time period during which each pile is to be excavated and the concrete placed shall be stated in the Contractor's method statement and approved by the Engineer. Timings shall be given for the installation of casings and the reinforcement cage. The time period shall start when excavation below the temporary or permanent casing commences. Where the construction sequence is such that a time period of 36 hours will be exceeded, the construction procedures, equipment and contingency planning shall be designed to prevent delays and minimise the time period during which the pile is excavated and concrete placed.

Any pile excavation that is open more than 36 hours before placement of the concrete will require overreaming the sidewalls to the depth of softening or to remove excessive slurry cake buildup. The minimum depth of overreaming the pile perimeter shall be 15 mm and the maximum depth shall be 75 mm. The Contractor shall submit for the Engineer's approval a description of the proposed overreaming tool showing all details, dimensions and method of operations. The Contractor shall bear the cost of any overreaming required when the 36-hour limit is exceeded. The Contractor shall adjust his excavation operations so that the maximum time that water or slurry is in contact with the bottom 1.5 m of the pile (from time of drilling to concreting) does not exceed 12 hours. If the 12-hour time limit is exceeded, the bottom 1.5 m of the pile shall be overreamed at the Contractor's expense prior to performing other operations in the pile.

5.5.7 Cleanliness of pile bases

On completion of boring loose, disturbed or softened soil shall be removed from the bore using appropriate methods, which shall be designed to clean while at the same time avoiding ground disturbance below the pile base. After cleaning a minimum of 50% of the base shall have less than 15mm of sediment and at no place on the base shall there be more than 40mm of sediment. The Contractor will provide a means of demonstrating to the satisfaction of the Engineer that he has cleaned the base in a manner that meets this requirement.

Support fluid shall be cleaned of suspended spoil as part of the cleaning operation.

5.5.8 Concreting

5.5.8.1 Reinforcement

The reinforcing steel cage consisting of the steel shown on the Drawings plus cage stiffeners, Spacers, centralizers, tubes for integrity testing and grouting and other necessary appurtenances shall be placed immediately after the pile bore has been cleaned and approved for concrete placement. The cage may be comprised of not more than two sub-units linked during installation. The design and method of making a cage joint shall be to the approval of the Engineer. Cages shall be sufficiently rigid to enable them to be handled, placed and concreted without damage.

The number of joints in longitudinal steel bars shall be kept to a minimum. Joints in steel reinforcement shall be such that the full strength of each bar is effective across the joint and shall

be made so that there is no detrimental displacement of the reinforcement during the construction of the pile. Reinforcement shall be maintained in its correct position during concreting of the pile.

Wheel-type spacers shall be designed and manufactured using durable materials which shall not lead to corrosion of the reinforcement or spalling of the concrete cover. Details of the means by which the Contractor plans to ensure the correct cover to and position of the reinforcement shall be submitted to the Engineer for approval. Spacers shall be constructed of accepted material equal in quality and durability to the concrete specified for the bored pile. The spacers shall be of adequate dimension to ensure the required concrete cover outside the reinforcement cage. A minimum of one spacer per 1000mm of circumference of cage shall be used at each spacer level. Spacers shall be placed near the bottom of the reinforcement cage and at intervals not exceeding 5m up the bored pile. Unless otherwise approved by the Engineer, the reinforcement cage shall be hung from the top of the casing to provide a minimum cover of 75mm below the bottom of the cage.

The reinforcing cage shall be tied and supported so that the reinforcing steel remains within allowable tolerances until the concrete supports the weight of the cage. All intersections of bored pile reinforcement bars shall be tied with cross ties or "figure 8" ties. Double strand ties or ties with heavier tie wire shall be used when necessary. Final approval of the cage construction and placement is subject to satisfactory performance in the field.

The elevation of the top of the steel reinforcing cage shall be checked before, during and after the concrete is placed. If the rebar cage is not maintained within the specified tolerances, corrections shall be made by the Contractor subject to the approval of the Engineer. Additional bored piles shall not be constructed until the Contractor has modified the rebar cage support in a manner satisfactory to the Engineer.

5.5.8.2 Concrete

Concrete shall be placed immediately after installation of the reinforcement. Concrete shall be placed by tremie or pump. Mixing, transportation and placement shall be in accordance with the requirements for underwater placement in Section 8. In addition, the Contractor shall take all necessary steps to ensure that the concrete temperature in place does not exceed 70°C during hydration.

The workability and method of placing of the concrete shall be such that a continuous monolithic concrete shaft of the full cross-section is formed. Concrete shall be transported from the mixer to the position of the pile in such a manner that segregation of the mix does not occur. The concrete shall be placed without such interruption as would allow the previously placed batch to have achieved a stiffness which prevents proper amalgamation of the two concrete batches.

The elapsed time from the beginning of concrete placement in the bored pile to the completion of the placement shall not exceed six hours except as provided herein. The beginning of placement time is defined as the time that concrete is first placed in the tremie or the time that concrete is placed in the concrete pump used to place the concrete. The completion of placement includes the removal of any temporary casings that could or should cause the concrete to flow into the space previously occupied by the casing. At the time of placement the concrete shall have a slump between 175mm and 225mm. The concrete shall maintain a minimum slump of 100mm or more throughout the six-hour maximum placement time. The admixtures in the concrete mix shall be

adjusted as accepted by the Engineer for the conditions encountered on the job so that the concrete remains in a workable plastic state throughout the placement. Satisfactory slump loss tests that demonstrate that the concrete will maintain a 100mm or greater slump for a period of time equal to the estimated transport time plus the six-hour placement time shall be provided before bored pile construction begins.

The Contractor may request a longer placement time provided he supplies a concrete mix that will maintain a slump of 100mm or greater over the longer placement time as demonstrated by slump loss tests. The slump loss tests shall be conducted using concrete and ambient temperatures appropriate for site conditions.

The Contractor shall furnish and maintain concrete batch plant (s) and delivery system to produce and place concrete in the bored piles at a rate not less than 100 cubic meters per hour. After commencement of concrete placement operations the delivery and placement of concrete to the bored pile shall continue uninterrupted until completion of the pile. The Contractor shall furnish and maintain backup batching facilities and delivery system to assure continuous delivery and placement of concrete in the event of unforeseen problems with the primary batching and delivery system.

When nonagitator transport vehicles are used, the elapsed time between the addition of water to the mix and depositing the concrete in place shall not exceed 45 minutes, except that when a water reducing and retarding admixture is used, such elapsed time shall not exceed 75 minutes. When the hauling is done in agitator transport vehicles, such elapsed time shall not exceed 60 minutes, except that when a water reducing and retarding admixture is used, a maximum elapsed time of 90 minutes will be permitted.

The Contractor shall take all precautions in the placing of the concrete to avoid arching of the concrete. No soil, liquid or other foreign matter shall be permitted to contaminate the concrete.

The hopper and pipe of the tremie or slickline shall be clean and watertight throughout. The internal diameter of the pipe of the tremie shall be not less than 250mm. The internal diameter of the slickline for pumped placement of concrete shall not be less than 125mm. The tremie pipe or slickline shall be so designed that external projections are minimised, allowing the tremie or slickline to pass within reinforcing cages without causing damage. The internal face, of the pipe shall be free from projections. The tremie or slickline shall not contain aluminum parts which will be in contact with the concrete. The pipe shall extend to the base of the bore and a sliding plug or barrier shall be placed in the pipe to prevent direct contact between the first charge of concrete in the pipe and the water or support fluid. The bottom end of the pipe must be square to the axis of the pipe and its circumference must be continuous. The tremie must be fully charged with concrete before it is lifted off the base of the pile. The support fluid shall not prevent free flow of concrete from the tremie pipe or slickline.

The volume of concrete placed and the depths to the surface of the concrete shall be measured, and the length of the tremie tubes or slickline recorded at regular intervals corresponding to the placing of each batch of concrete. The depths measured and volumes placed shall be plotted immediately on a graph and compared with the theoretical relationship of depth against volume.

The pipe shall at all times penetrate the concrete which has previously been placed with a minimum embedment of 5m and shall not be withdrawn from the concrete until completion of concreting. A sufficient quantity of concrete shall be maintained within the pipe to ensure that the pressure from it exceeds that from the water or support fluid.

Temporary casings shall be extracted while the concrete within them remains sufficiently workable to flow into good contact with the bore wall. During extraction the motion of the casing shall be maintained in an axial direction relative to the pile. When the casing is being extracted, a sufficient quantity of concrete shall be maintained within it to ensure that pressure from external water, support fluid or soil is exceeded and that the pile is neither reduced in section nor contaminated. An additional height of concrete shall be placed to compensate for the concrete volume displaced during extraction of temporary casing.

Concreting shall continue until sound concrete rises above the specified cut-off so that, after trimming to remove all debris and contaminated concrete, a sound concrete connection with the pile-cap can be made.

5.5.8.3 Concrete trimming

When cutting off and trimming piles to the specified cut-off level the Contractor shall take care to avoid shattering or other-wise damaging the rest of the pile. Any cracked or defective concrete shall be cut away and the pile repaired in a manner approved by the Engineer to provide a full and sound section at the cut-off level.

Piles shall be cut back to the levels shown on the Drawings or as otherwise directed by the Engineer. The cut shall be clean and horizontal. Cut material shall not be dumped on the river bed but shall be removed from site.

5.6 Integrity Testing

Integrity testing by sonic coring using cross-hole seismic measurements between vertical tubes shall be carried out for the full depth of all bores including trial piles, load test piles and production piles. Six vertical tubes shall be provided for the testing spaced evenly around the pile at a radius of 0.45 times the pile diameter. The tubes shall be installed as part of the reinforcement cage. The tubes shall be threaded at the top and plugged at the bottom so as to be usable for the final stage of base grouting as described in Article 5.7. During cage installation, the tubes shall be filled with water to resist buoyancy. During concrete placement, the tubes shall be provided with a venting cap to exclude concrete from the tube but prevent buildup of water pressure within the tube. Tubes placed within load test piles shall extend through the bottom plate of the lowest Osterberg load cell. The vertical tubes shall be made of steel, have an inside diameter of 38 to 50mm, and have sufficient strength to resist external pressure before and after concrete placement. The tubes shall be round, and the interior of the tube shall be free of defects or obstructions, including pipe joints, to permit free, unobstructed passage of source and receiver probes. The tubes shall be watertight. The tubes shall extend one meter above the top of the pile.

Details of the specialist contractor to undertake the testing shall be submitted to the Engineer for approval with information on the equipment to be used, the experience of the personnel for carrying out each of the testing and interpretation and the reports to be submitted.

The details shall provide evidence of the suitability of the Contractor's proposals for the diameter and depth of the piles to be tested. Suitability will be confirmed or otherwise by the trial pile programme. Any deficiencies in the testing equipment and procedures revealed by the preliminary trial programme shall be corrected by the specialist contractor and re-tested on the trial piles.

Cross-hole seismic measurements shall be obtained between 3 and 30 days after placement of the pile concrete. Seismic readings shall be taken sequentially between all tubes in the pile. Seismic measurements shall be taken at depth increments not more than 60mm. The seismic measurement data shall be recorded on digital disk for long-term data storage. The seismic measurement data shall be presented in a hard copy report using a format approved by the Engineer. The seismic measurement data along with an interpretation of the test findings shall be submitted to the Engineer not more than 48 hours after completion of test.

5.7 Base Grouting

The Contractor shall use an approved system to inject grout under pressure through sleeved grout pipes uniformly spaced over the base of the pile in order to recompact any soil loosened during boring and to mobilise the working toe resistance of the pile. Grouting shall commence a minimum of six weeks after completion of concreting. An approved non-shrink bentonite/cement grout incorporating an appropriate plasticizer and retarder shall be used having a minimum compressive strength at 7 days of 5 Mpa.

A minimum of six grout line circuits each permitting grout to return to the pile top and suitable flushing shall be provided. Each circuit shall have two sleeved sections below the pile base. The sleeved sections shall be positioned on a frame at the end of the reinforcement cage assembly so as to be placed in close contact with the cleaned soil surface. Each sleeved section shall have two 6mm dia holes covered by tightly-fitting rubber sleeves.

An initial cracking open of the sleeves shall be carried out within 48 hours, but not less than 24 hours of concreting. Pressure shall be released immediately when cracking is achieved to limit water injection to a minimum.

Grout shall be injected in doses through each grout line circuit in turn in successive rounds of grouting. Individual doses shall not exceed 50 litres from each grout line in each round. Lines shall be thoroughly flushed after each injection to allow later injections to be made. All the lines shall be injected in turn with the specified dose or until a maintained pressure of 100 bars is held for 10 minutes. Not less than six hours after completing a round of grouting the next round shall commence. The rounds of grouting shall continue in this manner until a total of 1500 litres has been injected, or until all lines are sustaining the required pressure or until pile uplift exceeding 15mm has been detected. Each of these indicators shall determine the end of sleeve grouting.

Not less than 5 days after completing the sleeved pipe grouting, the plugs in the integrity test tubes shall be drilled out and the holes advanced in turn to 3m below the pile base by drilling or driving. Within each integrity test tube the Contractor shall install a grout line circuit to the bottom of the drilled hole to permit grout to return to the pile top and flushing of the grout line. Each grout line shall have three equally spaced sleeved sections below the bottom of the pile. The sleeved sections for grout injection shall have two 6mm holes covered by tightly fitting rubber sleeves. After placing the grout line to the bottom of the drilled hole, the void around the grout line circuit shall be completely filled by cement grout placed by tremie method to the top of the pile. An initial cracking open of the sleeves shall be carried out as specified above. After the grout line circuits are set, grout shall be injected with grout at a pressure of 100 bars maintained for 10 minutes or until 300 litres has been injected. Injection in any tube shall be terminated if uplift of 5mm is detected and shall not resume in remaining tubes until the injected grout has set. When directed by the Engineer, the Contractor shall perform additional rounds of grouting within the integrity test tubes.

plans to use before commencing grouting. The method statement shall comprise at least the following information:

- (i) Details of specialist contractor for grouting, names of key personnel and their curricula vitae and previous experience on similar types of work.
- (ii) Details of grout pump, mixer, agitator and any other equipment used for mixing and injection of grout.
- (iii) Full details of grout to be used, including additives.
- (iv) Method of quality control on grout, including details of number of cubes taken and checks on density, flow and bleed of the grout.
- (v) Method of measuring grout take, which should be automatic and include a physical method of checking grout take at the end of injection of each grout line circuit.
- (vi) Method of measuring grout pressures which should include a continuous record. Calibration certificates for pressure gauges. A pressure gauge shall be provided for each end of the grout line circuit.
- (vii) Typical record sheet for grouting, which shall include records of grout take, grout pressure residual pressure, times of grouting and pile uplift for each grout line circuit and each grouting round.
- (viii) Methods of grout injection for both the sleeve grout lines and the integrity test tube grouting, including full details of any packers.

The grouting tubes shall be tested to determine any grout leakage in joints under pressure prior to installation into the piles. The grout tubes must be capable of withstanding the pressures to which they will be subjected.

Robust threaded caps shall be provided to protect the top of the grouting tubes during concreting and afterwards.

The Contractor shall provide an engineer experienced in pressure grouting to monitor grout pressures and grout takes and uplift of the piles during grouting.

The pile uplift shall be monitored with an appropriate level reading of a graduated scale attached to the pile head and by at least two dial gauges attached to a reference frame and positioned on opposite sides of the pile diameter. A continuous record of pile uplift shall be made using a displacement transducer also attached to the reference frame. The accuracy of measurement shall be a minimum of 0.5 mm for each monitoring device. The design of the reference frame shall be submitted to the Engineer.

Close control of the mixing of the grout shall be carried out. The Contractor shall provide and maintain on site all test facilities required to test and control the grout mixes.

The Contractor shall provide duplicate copies of all grouting records for each pile within 24 hours of the completion of grouting that pile.

The records shall comprise the following information:

- (a) Pile number.
- (b) Date.
- (c) Grout mix.
- (d) The sequence of grouting operations carried out.
- (e) For each grout circuit line the initiating and maintained grout pressures and the volume injected in each grouting round.
- (f) For each integrity test tube injected the maintained grout pressure and the volume injected.
- (g) The total pile uplift and the uplift after each grouting stage.
- (h) All tests made on grout.

5.8 Preliminary Trial Piling

5.8.1 Purpose

The purpose of the trial piling shall be to confirm or other-wise the design toe depths of the piles and that the equipment and methods proposed by the Contractor are adequate for the purpose of installing all the piles required for the bridge in accordance with this Specification. The trial shall include cleaning, placing reinforcement cages, concreting and base-grouting. The trial and test piles shall be installed at the locations shown on the Drawings unless otherwise approved by the Engineer, and close to the positions of boreholes made as part of the contract soil investigations. The Contractor shall furnish, install and monitor all instrumentation for the load test piles in accordance with the requirements specified herein and as approved by the Engineer.

5.8.2 Trial Pile Requirements

The two full diameter trial piles to verify construction procedures shall be identical to the piles required for the permanent works. The toe levels of the full diameter trial piles shall be as shown on the Drawings. The piles shall use the same equipment and methods proposed for the permanent works.

Base grouting shall be performed in the trial piles in accordance with the requirements specified in Article 5.7, except as noted herein. During base grouting operations, the uplift of the trial piles shall be monitored by at least two dial gauges mounted to reference beams and positioned on opposite sides of the pile diameter.

Installation of the two trial piles for test loading shall not begin until the installation of the two full diameter piles is completed to the satisfaction of the Engineer.

The two trial piles for test loading shall be vertical and have an external diameter of half that of the full size piles. Four integrity test tubes shall be installed and measured and used for final grouting. Grouting within the vertical holes below the pile base shall be performed in accordance with the requirements specified in Article 5.7. Three grout line circuits shall be used for the sleeve grouting at the base of the bored piles and the limiting total for grout injected during sleeve grouting shall be 600 litres. The piles shall be constructed to toe levels shown on the Drawings. The load test piles shall be tested with the use of Osterberg load cells as shown on the Drawings and specified herein. Load tests shall be performed not less than one week after completing base grouting. The maximum test load required shall be as shown on the Drawings.

Load test pile B-2 will require the installation of an outer, isolation casing. The isolation casing

shall have a diameter not less than 1.0m greater than the diameter of the load test pile, and shall have a toe level as shown on the Drawings. The top of the outer, isolation casing shall be not less than 0.5m above river level at the time of installation and pile testing. Prior to installing the test pile at this location the soils within the outer, isolation casing shall be removed to not less than 8m above the toe of the isolation casing. The inner casing shall then be installed to the toe level shown on the Drawings, using centralizer rollers to maintain the alignment and position of the inner casing. After drilling and concrete placement operations are completed and the pile concrete has set, the soil in the annular space between the inner casing and isolation casing shall be removed to the bottom of the isolation casing using jetting, airlifting or other method approved by the Engineer. The method used shall avoid disturbance to the soil below the bottom of the isolation casing. The top of the test pile and isolation casing shall be laterally braced to prevent lateral displacement of the test pile and isolation casing due to stream flow, boat impact, floating debris, construction equipment and other sources.

The Contractor shall obtain the services of a professional testing laboratory, or Professional Engineer with satisfactory experience in load tests using the Osterberg load cell, to conduct the load tests in compliance with these Specifications, record all data and furnish reports of the test results to the Engineer. The Engineer will require up to two weeks after receipt of the Contractor's load test report to evaluate the adequacy of the piles and authorize production pile installation. Installation of the production piles shall not begin until authorized by the Engineer.

Integrity testing of all the trial piles, including those designated for load testing shall be carried out in accordance with Article 5.6.

Records shall be provided of boring, casting and grouting of the trial piles as specified for bridge piles.

All work in connection with the trial piling shall be carried out in the presence of the Engineer.

5.8.3 Confirmation of Construction Methods

The procedures proposed are to be demonstrated and proven first at reduced depth on the first full diameter pile before undertaking the full diameter, full depth pile. Any inadequacies in the procedures or the equipment shall be corrected before attempting these operations at full depth. If it is shown that full size piles can be constructed to the required depth without difficulty, the test will be deemed satisfactory in respect of the adequacy of the plant, equipment and methods. If the full depth trial pile cannot be installed to the required depth using the intended plant, equipment and methods, the Contractor shall propose revisions. The adequacy of these shall be proved on the partly constructed trial pile, or on an additional full diameter, full depth trial pile as directed by the Engineer and at the Contractor's expense.

If full depth working still reveals inadequacies the Contractor shall devise and test revised procedures until techniques that are proven to the satisfaction of the Engineer are established for the required depth.

5.8.4 Test Loading

a) Description

This work shall consist of furnishing and installing the required materials, and providing the labor necessary for conducting and monitoring Osterberg load cell (0-cell) load tests at the two load test

pile locations shown on the Drawings. The load test piles shall be instrumented as specified herein and shown on the Drawings.

Load tests shall not begin until laboratory unconfined compression tests on concrete cylinders indicate that the concrete has attained a compressive strength of 30N/mm^2 . The shorter of the two load test piles shall be the first pile to be tested.

b) **Materials**

The Contractor shall install 0-cells and load test instrumentation in accordance with the 0-Cell supplier recommendations, instructions, and procedure manual(s), as approved by the Engineer. The Contractor shall be responsible for coordinating with the 0-Cell supplier to determine and/or verify all required equipment, materials, quantities, procedures, and all other applicable items necessary to complete the 0-Cell load testing shown on the Drawings.

The Contractor shall employ the speciality load test subcontractor. The 0-Cell supplier shall ensure that the test equipment is set up properly, activate the test cell, monitor and acquire the data from the test.

Materials supplied by the Contractor which do not become a part of the finished structure become the responsibility of the Contractor at the conclusion of each load test and shall be removed from the job site.

The Osterbeig Load Cells shall be obtained from the following supplier:

Loadtest, Inc
2631 NW 41st Street, Suite E-2
Gainesville, FL 32606
USA
Phone: 904-378-3717
Fax: 904-378-3934

The 0-Cell shall have a diameter of 870mm and a capacity of 27MN. The Contractor shall furnish an acceptable pressurized gas source, a hydraulic pump, hydraulic lines, calibrated hydraulic gauge and other equipment and material necessary to perform the 0-Cell load test.

The Contractor shall furnish fresh, potable water from an approved source to mix with a water-soluble oil, to form the hydraulic fluid used to pressurize the 0-Cells.

The Contractor shall furnish electric power, as required for lights, welding, instrumentation monitoring and other test related uses. A shed or tent shall be provided to protect the work area and monitoring equipment from rain and direct sunlight.

The Contractor shall furnish, install and monitor vibrating wire strain gauges. The strain gauges shall be placed in pairs on opposite sides of the reinforcing cage at the elevations shown on the Drawings. Strain gauges shall be Geokon model 4911 vibrating wire strain meters. A portable computer and electronic logging equipment shall be furnished to simultaneously monitor all strain gauges at time intervals designated by the Engineer.

Two LVDT vibrating wire displacement gauges shall be attached to each 0-Cell to monitor the expansion and contraction of the 0-Cell. In addition, two LVDT gauges shall be mounted on an

independent reference beam and set on opposite sides of the top of the pile to monitor axial pile displacement.

Two telltale rods shall be set on the top of each 0-Cell to monitor the displacement of the top of the 0-Cell. The telltale shall consist of a 10mm diameter stainless steel rod placed, greased for reducing friction and corrosion, inside a constant 20mm diameter pipe. The telltale rods shall be secured to the reinforcing cage to protect them from damage during concreting operations. Individual sections of telltales shall be joint coupled flush so that each rod is of uniform diameter throughout its length.

The Contractor shall furnish and install an acceptable work platform to permit safe access to the top of the pile and all exposed instrumentation. The platform shall be a minimum of 1m wide around the entire perimeter of the test pile or isolation casing.

The Contractor shall furnish and install dial gauges, steel reference beams and reference beam supports to measure axial displacement of the test piles. The steel reference beams, as approved by the Engineer, shall be attached to independent supports installed into the ground at a distance not less than three test pile diameters from the pile to be tested. For over-water test sites, the reference beam supports shall be protected from displacement due to river current, waves, wind and other sources; such protection shall include an outer, isolation casing or use of batter piles, or other method approved by the Engineer. The reference beam and reference beam supports shall be covered to protect against exposure to direct sunlight.

c) Construction Procedure

The 0-Cell(s), piping and other attachments shall be assembled and made ready for installation under the direction of the Engineer. The following guidelines shall be followed.

- Steel top and bottom bearing plates, as required, shall be welded to the 0-Cells.
- The upper surface of the bottom steel bearing plate shall be coated with grease prior to installation into the shaft, to prevent concrete bonding with the bottom plate.
- Attach the 0-Cell(s) and plate assembly to the reinforcement cage. All hydraulic hoses, telltale casing, slip joints, etc. shall be securely fastened to rebar cage. Prior to installation into the bored pile, the top of any piping should be protected to keep dirt, concrete or other deleterious materials from entering the piping.
- The Contractor shall limit the deflection of the cage to 700mm between pick points while lifting the cage from the horizontal position to vertical. Provide additional support, bracing, strong backs, etc. to maintain the deflection within the specified tolerance.

Concrete shall be placed by pumping or with a tremie pipe in accordance with the requirements specified in Article 5.5.8.2. The tremie pipe or slickline shall extend through the bottom plate of the lower 0-Cell to permit an initial charge of concrete to fill the void beneath the lower 0-Cell. The tremie pipe or slickline shall not be raised above the bottom of the pile excavation until there is a sufficient height of concrete above the lower 0-Cell. Following initial concrete placement, the tremie pipe or slickline shall at all times have a penetration of not less than 5m below the top of concrete level.

Base grouting shall be performed in accordance with the requirements specified in Articles 5.7 and 5.8.2.

d) Testing Procedures

For each 0-Cell load test (including tests on shafts with multiple 0-Cells), the load shall be placed on the pile in increments of 0.5MN until the failure load (assuming that the failure load is less than the maximum test load), as indicated by the instruments, is approached. Increments of 0.25MN shall then be applied until the limiting load is attained or the pile top displacement reaches 50mm, or a base settlement equal to eight to ten percent of the pile diameter is reached. The Engineer will determine the loading increments to be applied and the maximum test load. Each subsequent load increment shall be applied immediately after that complete set of readings is recorded and verified from all gauges and instruments. Each increment of load shall be applied within the minimum length of time practical and the instrument system readings shall be taken immediately. It is intended that the addition of a load increment and the completion of the instrument system readings shall be completed within 5 to 15 minutes. The Engineer may elect to hold the maximum applied load for up to one hour.

The load shall be removed in decrements of about 10 percent of the maximum test load. Each decrement of load shall be removed within the minimum length of time practical and the instrument system readings shall be taken immediately. It is intended that the removal of a load decrement and the completion of the instrument system readings shall be completed within 5 to 15 minutes. The Engineer may also require up to two reloading cycles with ten loading increments and five unloading decrements. The final recovery of the shaft shall be recorded for a period up to one hour after the last unload interval

5.8.5 Removal of Trial Piles

After completion of trial piles to the satisfaction of the Engineer, all trial piles, including load test piles and isolation casing, shall be cut off at bed level or -2.0m PWD, whichever is the lower and the off-cut shall be removed from site. Where bed level is above -20m PWD, the vicinity of the pile may be dredged locally to achieve the specified cut off level. The removed pile sections shall be disposed of off-site and shall not be dumped on the river bed.

