

## **DIVISION 6 WATER SYSTEM**

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### **6.1 WATER SUPPLY SYSTEM**

#### **6.1.1 GENERAL**

##### **6.1.1.1 DESCRIPTION**

The work shall consist of furnishing all labor, materials, equipment and other incidentals necessary to complete the water supply system in accordance with the specification. The construction of the water supply system shall composed of the following components, namely:

**1. Construction of Cistern**

The work includes excavation, backfilling, reinforced concrete construction, cistern waterproofing and the delivery and installation of complete pipes, fittings and valves for the cistern as shown on the drawings and as directed by the Engineer.

**2. Elevated Water Tank on Roof Deck**

The work to be undertaken in this component includes the supply and installation on roof deck of cylindrical stainless steel water tanks with concrete saddle supports and complete delivery and installation of pipes, fittings and valves as shown on the drawings.

**3. Water Supply and Distribution Lines**

The work involves the excavation and backfilling of pipe trenches, furnishing, laying and jointing of PVC pipes, valves and fittings and the construction of thrust blocks and concrete saddles. The work will also include the furnishing and installation of water meter (except where deep wells shall be used as source of water supply) including accessories to the water distribution line at the locations and elevations indicated on the drawings, or as maybe directed by the Engineer and in accordance with the requirement of the Specifications.

**4. Pumping Equipment**

The work involves the furnishing of labor, materials, equipment, tools and incidentals necessary to provide and install pumping equipment and appurtenances in accordance with the approved drawings and specifications.

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## 5. Well Drilling

The work shall include the conduct well drilling, construction of deep well including all auxiliary equipment and other incidental to complete the work in accordance with these specifications.

### 6.1.2 MATERIAL REQUIREMENTS

#### 6.1.2.1 SUBMITTAL

The Contractor shall prepare and submit shop drawings and construction methodology he proposes to employ and the list of all materials he intends to use including the name of the manufacturer for the Engineer's approval twenty eight (28) days before the start of any work described in this Section.

The Contractor shall not place any order for materials without prior approval of the Engineer.

#### 6.1.2.2 CISTERN

##### 1. Reinforced Concrete Materials

Concrete for the cistern shall be cast in-place and shall be Class C with 28 days compressive strength of [21] MPa ([3,000] psi).

##### 2. Waterproofing Materials

- a. For exterior walls and top slab of cistern use Integral waterproofing.

The dosage shall be per manufacturer's recommendations.

- b. For Interior lining of the cistern use epoxy tank lining waterproofing to be applied on top of capillary type waterproofing.

##### 1) Capillary Type Waterproofing

Cementitious powder consisting of active chemicals wherein crystals are formed once in contact with water. These crystals will follow the water through 38.1 cm of solid concrete structure thus filling the voids and capillary tracts resulting in the prevention of seepage of water in the area while still allowing the substrate to breathe. This is applied in the interior of the cistern with the application of epoxy tank lining waterproofing.

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## 2) Epoxy Tank Lining Waterproofing

The number of coatings to be applied on top of capillary type of waterproofing shall be per manufacturer's recommendations.

Refer to Section 4.9, "Concrete Waterproofing" for the requirements on submittals, product handling, alternative and minimum guarantee period.

## 3. Mortar Materials

Portland cement, sand and water for mortars shall comply with the requirements in Section 3.2 "Concrete Works."

## 4. Valves and Fittings

### a. General

- 1) All valves and fittings to be installed may be inspected at the site of manufacture.
- 2) In the presence of the Engineer, the pipes, valves and fittings shall be subjected to an internal hydraulic pressure bursting test which shall not be less than  $2.07 \text{ N/mm}^2$ . Checking of dimension and weights shall likewise be done. The necessary certificate as to acceptance to satisfactory compliance with the above-mentioned test shall be issued by the Engineer.
- 3) The Contractor shall submit a list of materials to be furnished, the name of suppliers, and the date of delivery on site to the Engineer for approval twenty eight (28) days before the commencement of work.

### b. Gate Valves

- 1) Gate valves shall be the outside screw and yoke flanged type.
- 2) Gate valves shall conform to Standard Specification AWWA C500, insofar as applicable. Valves shall have flanged joint ends, and shall be of iron body, bronze mounted, disc, parallel seat, non-rising stem type.
- 3) Extension stems shall be provided where required, of sufficient length so that the operating nuts are within 25 mm of finished grade. Valves shall open to the left or counterclockwise. The stuffing box construction shall be of the "O-Ring" type.  
Operating nuts shall be 50 mm square. Furnish 2 valve

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wrenches each in 1.2 m, 2 m, and 2.5 m lengths. Valve wrenches shall be standard steel "T" wrenches with socket for 50 mm square operating nut.

c. Float Valve

Float valves shall conform to AWWA C500 or ISO Specifications.

d. Fittings

All fittings shall be cast iron fittings, with a minimum working pressure of 1.04 N/mm<sup>2</sup> and shall conform to AWWA Specifications for cast iron fittings.

#### 6.1.2.3 ELEVATED CYLINDRICAL STAINLESS STEEL WATER TANK

1. The materials and fabrication requirements of elevated cylindrical stainless steel water tank supported on [21] MPa ([3000] psi) reinforced concrete saddles as indicated on the drawings shall conform to Section 4.6, "Steel and Metal Works" and Section 3.2, "Concrete Works."
2. All structural design analysis shall conform to the latest Building Code and National Structural Codes for Building (NSCB) and AWWA-D-100.
3. Piping, fittings and miscellaneous metal works.
  - a. Furnish and install all pipes, fittings, valves, pipe supports, miscellaneous metal works and all required appurtenances as shown on the drawings and as required to make the entire piping system operable.
  - b. All materials furnished and installed shall be new and guaranteed free from defects in design, materials and workmanship.
  - c. Adequate protective measures shall be provided to protect pipes, fittings, valves and all other materials from damage or injury during storage and installation.
4. Flanges, gaskets and bolts
  - a. Flanges shall conform in dimensions and drilling to ANSI B-16.1 Class 125.
  - b. Gaskets shall be ring-type.
  - c. Bolts shall be standard square head machine bolts with heavy, hot, pressed hexagon nuts. Threads shall conform to ANSI B-1.1, coarse thread series, Class 2 fit.

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5. Steel ladder, railings and platform shall be hot-dip galvanized structural steel which shall conform to Section 4.6, "Steel and Metal Works." Inside tank ladder shall be made of stainless steel with dimension indicated on the drawings.

#### 6.1.2.4 GALVANIZED IRON (G.I.) PIPES AND FITTINGS

##### 1. Pipes and Fittings

G.I. pipes and fittings shall be hot-dip galvanized iron (G.I.) conforming to ASTM A 53 subject to the specific exceptions or additional requirements noted in this Section. All G.I. pipes shall be schedule 40. Ends shall be threaded according to ANSI B 2.1.

The pipe shall meet the requirement of the National Sanitation Foundation for potable water use as tested by the Department of Science and Technology or other testing laboratories authorized by the Government and shall be made from non-toxic materials.

##### 2. Jointing

Galvanized iron pipe shall be furnished with flanged joints. At the option of the Contractor, a mechanical joint maybe substituted on all galvanized iron pipe and fittings. The mechanical joint shall conform to the requirements of the AWWA C 110 and AWWA C 115.

#### 6.1.2.5 POLYVINYL CHLORIDE (PVC) PIPES AND FITTING

##### 1. Pipes and Fittings

Pipes shall conform to AWWA C900 and shall be plain end or gasket bell end with pressure Class 150 (DR 18). Fittings shall be made of polyvinyl chloride and shall conform to the same requirements for PVC pipes.

##### 2. Joints and Jointing Materials

Joints for pipes shall be push-on joints as specified in ASTM D 3139. Joints between pipe and fittings, valves, and other accessories shall be push-on joints as specified in ASTM D 3139 or shall be compression-type joints/mechanical-joints as respectively specified in ASTM D 3139 and AWWA C111. Each joint connection shall be provided with an elastomeric gasket suitable for the coupling with which it is to be used. Gaskets for push-on joints and compression-type joints/mechanical-joints for joint connections between pipe and fittings, valves, and other accessories shall be as specified in AWWA C111 respectively for push-on joints and mechanical-joints. Mechanically coupled joints using a sleeve-type mechanical coupling, may be used as an optional

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jointing method in lieu of push-on joints on plain-end PVC plastic pipes, subject to the limitations specified for mechanically coupled joints using a sleeve-type mechanical coupling and to the use of internal stiffeners as specified for compression-type joints in ASTM D3139.

3. Bedding materials shall conform to sub-section 6.3.2.8.

#### 6.1.2.6 WATER METERS

##### 1. Submittal

- a. At least twenty eight (28) days prior to the start of the work, the Contractor shall submit a manufacturer's test data and material certification that the water meters including accessories meet the requirements specified herein. Together with this certificate, the Contractor shall submit manufacturer's drawings, information, shop drawings, brochures, descriptions and manufacturer's specifications.
- b. For each consignment the Contractor shall submit, in triplicate a certificate certifying that water meters have been inspected, tested and accepted from the approved manufacturer's in accordance with these Specifications.
- c. Shop testing and inspection of water meters shall be as indicated in accordance with respective reference standard.
- d. The equipment together with accessories shall be made by a reputable firm with at least five (5) years experience in the field and having maintenance and repair facilities in Metro Manila, Philippines.

##### 2. General

The meters to be supplied in 3 m<sup>3</sup> and 10 m<sup>3</sup> size shall be the multi-jet type. They shall be suitable for domestic cold water use, with magnetic coupling and a register, that will continually ensure a day dial lens and these shall be complete with couplings and tail pieces. They shall be able to withstand shock during transport, handling, delivery and installation.

The multi-jet meter shall have a revolving element in the form of a bladed rotor mounted on a spindle within a cylindrical measuring chamber. The liquid enters the chamber through a number of tangential openings around the circumference of one level and leaves through similar openings of another level. The basic principle of design is that over the working range of the meter, the speed of rotation of the rotor bears a linear relationship to the velocity of flow through the meter.

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### 3. Materials and Workmanship

Unless otherwise specified, all materials and components for multi-jet meters under this Contract shall be suitable for and where necessary or desirable, specially treated and processed for delivery, storage and service under tropical conditions of high temperature, high humidity, heavy rainfall, and mildew and fungus-conducive environment. The material and processes used for tropicalizing shall be in accordance with the best commercial and industrial practices.

All materials shall be new and free from all imperfections. Materials shall be carefully selected for their suitability in the intended application.

### 4. Meter Body

The meter body (or case) shall be cast from copper alloy containing not less than 75% copper, or a copper alloy containing not less than 57% copper with an anti-corrosion treatment. Castings shall be smoothly finished free from defects. Castings which have been repaired are not acceptable.

Meter bodies shall have a common inlet-outlet axis and shall be suitable for horizontal installation.

All external fasteners and seals shall be designed for easy disassembly, after long in-service use, without the need for special tools or equipment.

Meter bodies shall have integral connection spuds which shall be threaded parallel, right hand external in accordance with ISO Recommendation R228, as follows:

<b>Meter Size</b>	<b>Meter Spud Required Thread ISO R228 Designation Nominal Size</b>
3 m <sup>3</sup> & 5m <sup>3</sup> 7 m <sup>3</sup> 10 m <sup>3</sup>	19 mm (¾") 25 mm (1") 32 mm (1 ¼")

### 5. Register Bonnet

The register bonnet (or box ring) shall be made of copper alloy containing not less than 57% copper or of a suitable synthetic polymer that will neither warp nor deform when exposed to temperatures of up to 50°C.

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## 6. Dial Lens

The lens covering the register dial shall be securely fastened and shall be of clear glass of 5 mm minimum thickness, tempered or otherwise hardened such as to be resistant to impact and abrasion.

Impact resistance shall be such as to resist the impact of a 25 mm diameter steel ball dropped from a height of one (1) meter, without sustaining any evident damage.

Meter lenses shall be covered by a hinged lid or similar protective device or a suitable synthetic polymer.

## 7. Register

The type of register compartment shall be such that there will be no occurrence of moisture condensation on the dial lens that will make meter reading difficult or obscure the meter register when placed in service under conditions stipulated in Sub-section 6.1.2.6.3.

The meter register shall be straight reading in cubic meters (m<sup>3</sup>) that is, with an in-line row numerals appearing on number wheels revolving on a common horizontal axis and framed in a rectangular shaped aperture.

## 8. Measuring Chamber Assembly

The measuring chamber shall be a self-contained unit cast independently of the meter body either in copper alloy containing not less than 75% copper with suitable amounts of tins, lead and zinc, or in a suitable synthetic polymer, to withstand all normal conditions of operation without change in form or dimension. It shall be smoothly finished, firmly seated and easily removed, and be secured so that the meter's accuracy will not be adversely affected by any distortion of the meter body.

Multi-jet adjustable rotors shall be smoothly finished, of vulcanized hard rubber or suitable synthetic polymer.

Rotor spindle or pivot shall be of phosphor bronze, stainless steel, nickel or nickel alloy or suitable synthetic polymer with nut for adjusting rotor.

Diaphragms, thrust roller and thrust roller bearing plates shall be of phosphor bronze, monel, stainless steel or a suitable synthetic polymer.



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The movement of the measuring element shall be transmitted to the register magnet by means of a permanent drive magnet on the upper end of the elements spindle. The magnet shall be of graphite or other suitable non-corrosive magnetic material. The entire magnetic coupling shall be protected from external magnetic fields by suitable shielding on all the sides of the meter.

No part of the measuring chamber assembly should be deformed when exposed to 50°C.

#### 9. Strainer

Each meter shall have a rigid strainer screen on the inlet. The screen shall be a snug fit and yet easy to remove. The effective open straining area of the screen shall be at least twice that of the meter inlet bore. Screen shall be on stainless steel, a suitable synthetic polymer or other approved material. Strainer shall conform to AWWA C708.

#### 10. Tailpieces

Each meter shall have a pair of tailpieces. Tailpieces shall be of copper alloy containing not less than 57% copper.

The end of the tailpiece joining the meter spud shall have a shoulder and gasket. The opposite end of the tailpiece shall be threaded right hand external taper in accordance with ISO Recommendation R7, as follows:

Meter Size	Required Thread ISO R228 Designation Nominal Size
3 m <sup>3</sup> & 5 m <sup>3</sup>	19 mm (½")
7 m <sup>3</sup>	25 mm (¾")
10 m <sup>3</sup>	32 mm (1")

The length of tailpieces shall be to suit the meter length (face to face of spuds) such that the overall length of the assembly (meter plus two tailpieces) will be equal to the present meter assemblies in the system, which are based on AWWA dimensions as follows:

Meter Size	Overall Length of Assembly
3 m <sup>3</sup> & 5 m <sup>3</sup>	12 ¼ inches = 311.15 mm
7 m <sup>3</sup>	14 inches = 355.60 mm
10 m <sup>3</sup>	16 inches = 406.40 mm

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## 11. Coupling

Coupling nuts for joining the body spuds and tailpieces shall be made of a copper alloy containing not less than 57% copper, and shall have internal parallel pipe threads conforming to the meter spud threading.

The coupling shall have sealing wire holes of not less than 2 mm diameter.

Coupling gaskets shall be made of paraffined leather, rubber, composition fiber, or a suitable synthetic polymer.

## 12. Sealing

Each meter shall be supplied with copper wire and lead seal system to discourage unauthorized opening or removal of the meter and also to indicate if such unauthorized action has occurred. All elements of the sealing system, including length of wire, location of wire holes, etc., shall be suitable for covering all possible means of tampering, in particular disturbance of the coupling nuts, accuracy of the adjustments device or of the register assembly. The lead seal shall be blank and suitable for sealing by a compression tool, supplied by others, containing a unique embossing symbol.

## 13. Tamper-Resistant Device

Each meter shall incorporate a tamper-resistant device which shall function separately from the wire and lead seal, and which is intended to deter entry into the register assembly.

## 14. Shop Testing

The approved manufacturer shall perform the following test for every water meter.

- a. After machining each body, casing and each tailpiece shall be subjected to air or water hydrostatic pressure of 200 meters of water column for one (1) minute. Should any leakage be observed, the body or tailpiece shall be rejected.
- b. After assembly, each completed meter shall be subjected to a hydrostatic pressure of 200 meters of water column for one (1) minute. Should any leakage be observed the necessary adjustments shall be made to stop the leakage or the meter shall be rejected.

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- c. Each assembled meter shall be tested for accuracy and adjusted as necessary to meet the guaranteed performance. Test results of each meter shall be certified by the manufacturer as correct and submitted to the Engineer.

#### 6.1.2.7 VALVES AND APPURTENANCES

##### 1. General

Valve ends shall be at the Contractor's option except as specified by the Engineer and where specifically called for on the drawings. Caulked-typed bell ends shall not be allowed for 200 mm and larger valves.

All valves shall have the direction arrow for opening, the name for manufacturer and the working pressure for which they are designed, cast in raised letters upon an appropriate part of the body. In addition, valves designed for one-way flow only shall have a direction arrow cast on the body.

All interior part of valves manufactured of bronze (except valve stems) shall conform to the requirements of ASTM B62 unless otherwise stated.

Gate and check valves shall be suitable for use under operating conditions of 100 meter water column. Operating nuts and valve operators shall turn counterclockwise to open.

The Contractor shall submit manufacturer's certified drawings showing the principal dimensions, construction details and materials used for all parts of the valve and full details of valve stem extensions, including materials, dimensions, fabrication, torque limits, method of connection to the valve and box and stem guides when required to avoid buckling.

##### 2. Gate Valves

Gate valves with a diameter of 75 mm above shall be flanged type and made of cast iron in accordance with AWWA C 500. The waterway shall be unobstructed and of a diameter not less than full diameter of the valve when in the open position.

The valves shall have a 50 mm square operating nut with the work "OPEN" and an ARROW cast on showing that the valve opens by turning the operating nut counterclockwise.

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Valves shall be of the non-rising stem type, with a minimum of two (2) “O” ring seals, of which at least one (1) shall be above the stem collar and replaceable under full working water pressure while the valve is in the fully open position.

Gate valves with a diameter of 75 mm below shall be bronze type with threaded connection designed for a water working pressure not less than 1.0 MPa (150 psi) in accordance with GRADE 1 of ASTM B62 and threaded to ANSI B2.1.

### 3. Check Valves

The check valve shall be of the swing type and shall be borne as brass with screwed connection designed to prevent the reversal flow of water. The swing type check valve shall be designed for a water working pressure of not less than 1.04 N/mm<sup>2</sup>.

## 6.1.2.8 PUMPING EQUIPMENT

### 1. General

- a. All equipment shall be supplied from reputable firms engaged in the manufacture of each particular item. The entire assembly as installed shall be given a start-up and test run to prove that all the Specifications have been met before acceptance by the Engineer. The test duration shall be 24 hours. Submittal of the Certificate of Test to the Engineer shall be a condition of final payment.
- b. The Specifications stated herein are basic guides only. Other items not so indicated but which are obviously necessary for the proper operation of system as intended shall be supplied in accordance with accepted engineering standards.
- c. The equipment shall be guaranteed for a period of at least one year of trouble free operation. The Supplier of equipment shall certify to the availability of spare parts locally and service in case of system breakdowns within a period of at least three years. Manuals of operation and maintenance and lists of spare parts shall be supplied together with the equipment. Submittal of warranty certificates shall be a condition for final payment.
- d. The Supplier shall submit at least two copies of pump performance curves showing, among others, the pump rating and pump efficiency properly marked thereon.
- e. Pump and motor installation dimension drawings shall be submitted and verified in the site.

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- f. The brands, names and place of manufacture of pump and motor, and all accessories where applicable shall be indicated in the quotation. Also, a description of pump impellers being offered shall be included.
  - g. A metal nameplate indicating in indelible letters the correct Specifications of the pump and motor shall be properly attached to the assembly at a location such that the information written thereon can be conveniently read by all concerned.
  - h. Preparation and submittal of As-built drawings.

2. Booster Pumps for Elevated Water Tank on Roof Deck

The pumps shall consist of [ ] set of centrifugal pump with a capacity of [ ] ppm driven by [ ] watts electric motor and one (1) set of hand pump for manual operation whenever there is no electric power supply. Pump and motor shall be mounted on a common steel base.

a. Pump Operation - Alternative manual operation of 2 pumps

Electric Motor Pump

- 1) Design Capacity : \_\_\_\_ lpm
- 2) Total Dynamic head : \_\_\_\_ m
- 3) Electric Motor : \_\_\_\_ watts
- 4) Pump Speed : \_\_\_\_ rpm

b. Priming

All pumps shall be self priming.

c. Base

A common steel base, rigid in construction shall be provided to contain the pump and electric motor only.

d. Electric Motor

The pump shall be driven by a [ ] watts, 220 volts, 60 Hz, single phase electric motor.

e. Material

- 1) Casing - Cast Iron
- 2) Impeller - Bronze
- 3) Shaft - High Carbon Steel
- 4) Seal - Gland Packing

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#### 6.1.2.9 WELL DRILLING

The Contractor shall submit his proposal to the Engineer for approval, of all materials and equipment of well including their installation.

### 6.1.3 EXECUTION

#### 6.1.3.1 CISTERN

##### 1. Excavation and Backfilling

All excavation and backfilling to be undertaken shall be in accordance with Section 4.2, "Excavation and Backfilling for Buildings."

##### 2. Reinforced Concrete Work

Cutting, bending and fixing of reinforced steel shall conform with the requirements of Section 3.2, "Concrete Works" and as shown on the drawings. Concrete work shall conform with the requirements of Section 3.2, "Concrete Works" and as shown on the drawings.

Concrete cover to reinforcement nearest to the surface shall be as shown on the drawings, but in no case shall be less than 40 mm.

##### 3. Waterproofing

###### a. Application for Integral Waterproofing:

Application procedure shall be in accordance with the manufacturer's recommended system of work.

Manufactured materials shall be delivered to the site in their original packages or containers bearing the manufacturer's name and brand designation.

###### b. Surface Preparation/Application of Capillary Type Waterproofing and Epoxy Tank Lining Waterproofing:

###### 1) Surface Preparation for Capillary Type Waterproofing

All concrete to be treated must be structurally sound. Remove all forms of scale, oil, form release agents, laitance and any foreign materials which will impair the bond, penetration and performance of the waterproofing. Rout out visible cracks exceeding 0.01" in size, 19 mm deep, also honeycombed pockets and faulty construction joints. Form tie holes shall be left approximately 25 mm back of surface. Rinse all surfaces

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thoroughly with water the day prior to the capillary type waterproofing application.

2) Application of Capillary Type Waterproofing

The manner of installation shall be as per manufacturer's standard procedure.

3) Surface Preparation for Epoxy Tank Lining Waterproofing

All waterproofing treated surfaces to receive epoxy coating must be neutralized with a solution of capillary type waterproofing cleaner. The capillary type waterproofing application has to aged for a minimum period of two (2) weeks before application of epoxy.

4) Application of Epoxy Tank Lining Waterproofing

Moisture must be present in the concrete strata to assure maximum chemical penetration. Surfaces shall be moist only, not wet when coatings are applied.

Mixing : Mixing proportions and procedures as recommended by the Manufacturer.

Curing : Moisture cure waterproofing treated surfaces for a period of three (3) days starting with water fog spraying the day following the completion of waterproofing application. Backfill materials can be placed on the application after moisture curing has been completed and no protection boards are required.

The waterproofed cistern shall be flood tested in accordance with Sub-section 6.1.3.1.6

4. Installation of Valves and Fittings

- a. Valves shall be inspected in opened and closed position to ensure that all parts are in good working condition and interiors cleaned of all matters before installation.
- b. Valves and fittings shall be installed at the points and manner as shown on the drawings and in accordance with the requirements of the approved installation instructions recommended by the approved manufacturer.

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## 5. Installation of Pipes

- a. All pipes shall be carefully placed and supported at the proper lines and grade where possible shall be sloped to permit complete draining.
- b. Piping runs shown on the drawings shall be followed as closely as possible, except for minor adjustments to avoid adverse-effect on architectural and/or structural features. If major relocations are required, they shall be subject to the approval of the Engineer.
- c. Carefully inspect all pipes and fittings before installation. Inspection of pipe shall include light tapping with a hammer to detect cracks or defects. No pipe fittings or valves which are cracked or showing defects shall be used.
- d. Piping shall be properly supported by suitable anchor, brackets or hangers. Vertical pipes shall be anchored by suitable galvanized steel straps. Pipe supports shall be provided as shown on the drawings.

## 6. Test for Watertightness and Disinfection of Cistern

- a. The cistern shall be subjected to leakage test after concrete has attained a compressive strength of [21 MPa (3,000 psi)] and waterproofing process has been completed. After cleaning out all debris and dirt from the inside tank, the cistern shall remain filled with clean water for a minimum of 24 hours reckoned from the time the free-board line was reached during filling up. After the 24-hour period there shall be no drop in water level in the tank more than 40 mm, otherwise the leak shall be located and plugged properly and the test for watertightness is repeated. Should the test disclosed any leakage the Contractor shall correct the defect at his own expense.
- b. Before the cistern can be placed in service, the structure shall first be chlorinated to avoid pollution of the potable water supply. The cistern shall be continuously flushed and scrubbed with clean water so that all solid pollutants or pollutants of any physical form shall be washed away.

After flushing, such that the flushing water runs clear, the cistern shall be flushed and scrubbed with HTH solution (High Test Hydrochlorite) of a least 50 parts per million available chlorine strength. After flushing with HTH solution and after solution has been removed by flushing with potable water, samples of new water stored in the cistern shall be taken and tested bacteriologically.



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#### 6.1.3.2 ELEVATED STAINLESS STEEL CYLINDRICAL WATER TANK

1. An elevated stainless steel cylindrical water tank on roof deck shall be installed on the reinforced concrete saddle after the concrete has attained its design compressive strength. The tank shall be fastened to the R.C. saddle by means of 25 mm G.A. 18 stainless steel strap bolted on the R.C. saddle. Refer to the drawings for the details.
2. All the necessary pipes, fittings and valves shall be installed at the points and in a manner shown on the drawings.
3. Test for Watertightness of Completed Tank

The completed stainless steel water tank shall be tested for watertightness by filling it up with clean water after cleaning out all dirt and debris from inside the tank. The water shall be allowed to stand for a minimum period of 24 hours reckoned from the time the maximum water level line was reached during filling up. After the 24 hour period there shall be no drop in water level in the tank more than 40 mm, otherwise, the leaks shall be located and plugged properly and the test for watertightness repeated.

4. Defective Work
  - a. If the inspection and test show any leaks, such leaks shall be repaired by welding. The tank shall be re-tested and repaired until satisfactory results are obtained and no leaks occur.
  - b. All repairs shall be made with new material at the expense of the Contractor.
  - c. No caulking of screwed joints or holes will be accepted.

A test certificate shall be filled out and signed by the Engineer's and Contractor's representative.

5. Disinfection of Water Tank

Before the elevated stainless steel water tank is placed in service, the tank shall be disinfected in the same manner as that discussed in Sub- section 6.1.3.1.6.

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### 6.1.3.3 DISTRIBUTION LINES

#### 1. Handling and Protection

- a. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipes or coatings. Pipes or fittings shall not be dropped. All pipes or fittings shall be examined before laying, and no piece which is found to be defective shall be installed.
- b. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractors at his own expense. All pipes and fittings shall be thoroughly cleaned before laying, and shall be kept clean until used in the completed work, and shall be laid to conform to the lines and grades required.
- c. After installation, all pipes shall be protected from damage during subsequent construction activities.

#### 2. Trench Excavation and Backfilling

- a. The minimum width of excavation for all pipes shall be 300 mm. The ground adjacent to all excavations shall be graded to prevent water from running in. The Contractor shall remove, by pumping or by other means approved by the Engineer, any water that has accumulated in the excavation. Pumping shall be at the expense of the Contractor. All other excavation related to the work shall comply with the requirements of structural excavation under Section 4.2 "Excavation and Backfilling for Buildings."
- b. Backfilling shall be done only after leakage test on the installed pipelines have been completed, inspected and approved by the Engineer.

Sand bedding materials shall be placed evenly and carefully around and over the pipe, hand tamped in 100 mm maximum layers up to 300 mm cover over the pipe, then followed by 600 mm minimum cover of ordinary well compacted materials unless otherwise shown on the drawings.

#### 3. Installation of G.I. Pipes and Fittings

The pipes shall be accurately installed to the line, levels, grades and positions set out by the Contractor based on survey to be conducted by the Contractor and referred from data shown on the drawings, under the direction and approval of the Engineer.

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Prior to installation of a pipe, adequate inspection of the pipe body for cracks or other defects shall be performed. The inside of the pipe shall be thoroughly cleaned prior to installation.

Straight piping shall not be inclined more than a definite angle limit as directed by the Engineer.

At any place where the pipe is to cross an existing buried structure, there will be a separation of at least 300mm.

Pipes, valves and fittings shall be carefully examined on defects at the time of installation. Any defective material discovered before, during or after being installed shall be permanently marked, removed from the jobsite, and replaced with sound material.

Where it is required to join pipes, valves, or fittings of different type, size, or joint combination, adapters shall be used of a class and type appropriate to the connecting ends as shown on the drawings.

All pipe joint preparation and jointing operations shall comply with the instructions and recommendations of the approved pipe manufacturer.

Piping shall be properly supported by suitable anchor, bracket or hangers. Vertical pipes shall be anchored by suitable galvanized steel straps. Pipe supports shall be provided as shown on the drawings.

The Contractor shall be responsible for taking the measurements required to determine the lengths of cut portions of pipes for insertion as closing lengths in pipelines. The pipe and methods of jointing shall be such that the locations of fittings and lengths of pipe can be adjusted in the field to suit field conditions and variations in stationing and not extra payment will be made for such adjustments. The Contractor shall make all closures with suitable pipe and approved connections to compensate for cumulative errors in pipeline installation. The Contractor shall take every precaution to ensure that both the measurement and the cutting of pipes are to the accuracy required and should any errors occur the Contractor shall remedy same at his own expense and to the satisfaction of the Engineer.

#### 4. Installation of PVC Pipes and Fittings

Install pipe and fittings in accordance with the general requirements for installation of pipelines and with the requirements of UNI B-3 for laying of pipe, joining PVC pipe to fittings and accessories, and setting valves, and fittings. Pipe, fittings, valves, and accessories will be carefully inspected by the Engineer before and after installation and those found defective will be rejected. Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, accessories and maintain in a clean condition. Provide proper facilities

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for lowering sections of pipe into trenches. Do not under any circumstances drop or dump pipe, fittings, valves, or any other water line material into trenches. Cut pipe accurately to measurements established at the site and work into place without springing or forcing. Replace by one of the proper dimensions any pipe or fitting that does not allow sufficient space for proper installation of jointing material. Blocking or wedging between bells and spigots will not be permitted. Lay bell and spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines, taking care to avoid the formation of any dips or low points. Support pipe at its proper elevation and grade, taking care to secure firm and uniform support. Wood support blocking will not be permitted. Lay pipe so that the full length of each section of pipe and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports where indicated and where necessary for fastening work into place. Make proper provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been properly made. At the end of each day's work, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather are unsuitable.

#### 5. Jointing for PVC Pipes

Make push-on joints with the elastomeric gaskets previously specified for this type of joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. Use push-on joint having factory-made bevel on pipe ends for pipe to pipe joint connections only; for push-on joint connections to valves and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for connection to B-3 for laying the pipe. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of UNI B-3 for jointing PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical-joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type of joint; assemble these joints in accordance with the requirements of UNI B-3 for jointing PVC pipe to fittings and accessories, with the applicable requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut-off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer, as approved, using internal stiffeners as previously specified for compression-type joints.

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## 6. Valve Box

Valve boxes shall be cast iron or concrete as shown in the drawings, except that concrete boxes may be installed only in locations not subjected to vehicular and with flared base. The minimum thickness of metal shall be 5mm (3/16 inch). Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The work "WATER" in English shall be cast on the cover. The boxes shall be of such length as will be adapted, without full extension to the depth of cover required over the pipe at the valve location.

## 7. Thrust Blocks

- a. Longitudinal thrust along pipelines of bends, tees, reducers, and caps or plugs shall be counteracted by thrust blocking, pipe harnesses or other suitable means approved by the Engineer.

Where bends are in a vertical plane, the thrust shall be counteracted by enough weight of concrete to counterbalance the vertical thrust forces. Where undisturbed trench walls are not available for thrust blocking, the Contractor shall furnish and install suitable pipe harnesses or ties designed and manufactured specifically for this purpose. Harnesses and/or ties shall be approved by the Engineer.

- b. In lieu of thrust blocking and with the approval of the Engineer, the Contractor may elect to provide pipe harnesses and/or ties or restrained push-on or restrained mechanical joints.
- c. Concrete for thrust blocking shall conform to provision of Section 3.2, "Concrete Works."

## 8. Field Testing

### a. General

- 1) The Contractor shall furnish all necessary equipment and labor for carrying out a pressure test and leakage test on the pipelines. The procedures and methods for carrying out the pressure and leakage test shall be approved by the Engineer.
- 2) The Contractor shall make any taps and furnish all necessary caps, plugs, etc., as required in conjunction with the testing of a portion of the pipe between valves. The Contractor shall also furnish a test pump, gauge, and any other equipment required in conjunction with carrying out the hydrostatic test.

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b. Pressure Test

- 1) Pipeline tests shall be made on a portion of the pipeline between valves but shall not exceed 300 meters of the length of pipelines.
- 2) After the pipes have been laid, the joints completed and the trench partially backfilled but the joints exposed for examination, all newly laid pipes or any valve section thereof shall be subjected to hydrostatic test pressure not less than  $1.04 \text{ N/mm}^2$  for any and all kinds of pipes, fittings and valves, for at least 30 minutes unless otherwise directed by the Engineer.
- 3) Pressure tests shall be made only after completion or partial backfill and at least seven (7) days after the last concrete thrust block has been cast.
- 4) Each length of pipeline to be tested shall be slowly filled with water and the specified test pressure measured at the point of lowest elevation shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. During the filling operation of the pipe and before applying the test pressure, all air shall be expelled from the pipeline. To accomplish this, taps shall be made, if necessary at points of highest elevation, and after completion of that test, the taps shall be tightly plugged.
- 5) During the test, all exposed pipes, fittings, valves joints and couplings will be examined. If found to be cracked or defective, they shall be removed and replaced by the Contractor at his expense. The test shall then be repeated until satisfactory results are obtained.

c. Leakage Tests

- 1) Leakage tests shall be conducted after satisfactory completion of the pressure tests and shall consist of an examination of all exposed joints for leakage as well as an overall leakage test of the completed pipeline.

The pressure to be maintained during the test shall be the average pressure to which the pipe will be subjected under normal conditions of service for at least two hours unless otherwise directed by the Engineer. The length of pipeline to be tested shall not exceed 300 meters. Each length of pipeline to be tested shall be slowly filled with water and the specified test pressure, measured at the point of lowest

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elevation, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer.

Before starting the leakage test, all air shall be expelled from the pipe as specified under paragraph 2, "Pressure Test" above.

- 2) All exposed pipes, fittings, valves and joints shall be examined for leakage during the test. Any pipeline found with leakage in excess of the allowable rate specified in the following table shall be rejected.

Allowance Leakage Rate per 100 Points per Inch of Pipe Diameter at Pressure Stipulation

Pressure (N/mm <sup>2</sup> )	Leakage Rate	
	Liters/Hours	Liters/2 Hours
.31	1.36	2.72
.34	1.44	2.88
.41	1.57	3.14
.44	1.65	3.30
.48	1.70	3.40
.51	1.76	3.52
.55	1.82	3.64
.69	2.04	4.08
.86	2.29	4.58
1.04	2.52	5.04

- 3) Should any test of a section of pipeline disclosed joint leakage greater than that permitted, the Contractor shall at his expense repair or replace the defective joints until the leakage is within the permitted allowance.

d. Disinfecting Pipeline

- 1) Before being placed in service, all potable water pipelines shall be chlorinated in accordance with AWWA 601, "Standard Procedure for Disinfecting Water Mains" unless otherwise specified herein. The procedure shall be approved by the Engineer.
- 2) The location of the chlorination and sampling points will be determined by the Engineer at the site. Taps for chlorination and sampling shall be uncovered and backfilled by the Contractor as required.

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3) The general procedure for chlorination shall be first to flush all dirty or dissolved matter from the lines, for at least an hour to assure that all solid pollutants shall have been washed away. After flushing, and after flushing water runs, clear chlorine shall be introduced in approved dosages through a tap at one end, while water is being withdrawn at the other end of the line. The dosages of chlorine should provide an HTH solution (High Test Hydrochlorite) of at least 50 parts per million available chlorine strength. The chlorine solution shall remain in the pipeline for about 24 hours.

4) Following the chlorination period, all treated water shall be flushed from the lines at their extremities and replaced with water from the distribution system.

Bacteriological sampling and analysis of the replacement water shall be made by the Engineer in full accordance with the AWWA Manual C601. The Contractor will be required to rechlorinate, if necessary, and the line shall not be placed in service until approved by the Engineer.

5) Special disinfecting procedures shall be used where the method outlined above is not practicable.

#### 6.1.3.4 WATER METERS

Water meters shall be installed in accordance with AWWA specifications and as shown on the drawings or as directed by the Engineer.

#### 6.1.3.5 INSTALLATION OF PUMPS

The booster pumps including accessories/appurtenances shall be installed in accordance with the approved manufactured recommended installation.

#### 6.1.3.6 INSTALLATION WELL

1. When the Engineer decides to construct a deep well at specified location, the Contractor shall submit shop drawings of deep well construction to the Engineer for approval.
2. The well shall be drilled with the diameter and to the depth as shown on the drawings. The bore of the well shall be plumb and straight, and shall be checked for the verticality after completion of the drilling procedure by means of an approved method.
3. The well casing shall be set round, true to line and centered.



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4. Where individual pieces of casing are installed, accurate record shall be kept of the grade, sizes and lengths, and the exact position shall be measured and reported by the Contractor.
  5. After the casing is installed, the well shall be cleaned by approved methods acceptable to the Engineer. Cleaning shall be continued until all clogging mud has been washed from the wall of drilled well and the surrounding formations have stabilized.

#### **6.1.4 MEASUREMENT AND PAYMENT**

1. Payment for all fees for water service connections shall be paid at lump sum basis as approved by the Engineer.
2. Payment for Well shall be in lump sum.
3. PVC Water Pipe connection from either existing water source or proposed well to cistern shall be the length of pipe installed in linear meters measured along the axis of pipe as shown in the drawings, installed in place. Such payment shall include the cost of valves and fittings, trench excavation, backfilling and bedding for embedded pipe.

Such payment shall also include the construction of thrust blocks and concrete saddles/craddles where necessary.

4. The quantities of water meters including accessories be paid for shall be measured by the number of sets supplied, installed complete, tested and accepted by the Engineer Payment shall includes furnishing of all labor, materials, equipment and incidentals necessary to complete the installation.
5. Lump sum price will be provided for the complete plumbing system from the cistern to elevated water tank to include G.I. pipes, fittings, check valve and gate valves to complete the installation works.
6. The prices quoted for each type of pump (electric water pump and hand pump) shall include cost of delivery and all incidental necessary to complete the installation.
7. Measurement for concrete and reinforcement works for the construction of cistern shall be made in accordance with Section 3.2, "Concrete Works" and payment shall be included under Bill of Quantities for the Construction of Toilet with Pump Room.
8. Measurement for waterproofing of cistern shall be made by the area in square meters of waterproofing installed, tested and accepted by the Engineer and payment shall be included under Bill of Quantities for the construction of toilet with pump room.

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9. The quantities of elevated stainless steel cylindrical water tank to be measured and paid for shall be made by the number of elevated stainless steel cylindrical water tanks supplied and installed with stainless steel strap and other accessories to complete the installation works, ready for use and accepted.

Concrete saddles used as support for the elevated tank shall be included under the Bill of Quantities for the construction of toilet with pump room (Concrete Works).

10. Lump sum price will be provided for the complete plumbing system from elevated stainless steel water tank to the building to include G.I. pipes, fittings, and accessories.
11. Disinfection and leakage tests will not be measured separately. Cost for such work shall be included in the unit price of its item where such work shall be performed.
12. The quantities determined as provided above shall be paid for at the unit price for the pay items shown in the Bill of Quantities which price and payment shall constitute full compensation for all the cost of labor, materials, equipment, required tests as specified in these specifications and all incidentals as required for the proper completion of the work considered in this Section.