2 IRRIGATION SYSTEM

2.1 GENERAL

2.1.1 Description

1 The purpose of this project is to supply, install and commission an automated irrigation system with all related components for the “Project” consisting of field remote control valves, control wires, filter, integrated dripper lines, drippers, flush valves, sprinklers, bubblers and control system.

2.1.2 Scope Of Work

1 The scope of work shall be read in conjunction with the contract material specifications, contract drawings, bill of quantities, contract documents and installation details and it includes but not limited to the following:

(a) The contractor shall prepare the shop drawings showing but not limited to The Main line, Laterals, solenoid valves, control wires route and numbers, Irrigation Controllers, integrated dripper lines, on line drippers, Bubblers and flush valves.

(b) All equipment and materials shall be supplied, installed, tested and commissioned by an irrigation specialist employed by the contractor and approved by the engineer.

(c) The contractor shall submit for Engineer’s approval the technical information and samples of the material he intends to use which should be in accordance with the material specifications of this project.

(d) It shall be the responsibility of the contractor specialist to ensure that the plant and equipment supplied by them produces the desired results. The Specialist shall include all equipment, materials, accessories, finishing materials etc., required so as to have a complete functional system. This shall include all items of a minor nature necessary to complete the installation and usually included in similar work whether or not specifically mentioned in the contract documents.

(e) All materials and workmanship not fully specified herein or covered by QCS, BS or BSCP or approved alternative shall be of such a kind as is used in first class work and is suitable for the climatic conditions of the state of Qatar.

(f) The complete irrigation system for each site shall be fine-tuned to efficiently and evenly irrigate all areas in accordance with the engineered design and shall be complete in every respect. The system shall be set in operation and adjusted to the satisfaction of the Engineer.

(g) All irrigation equipment and components shall be the product of a manufacturer having a local representative Engineer capable of advising and assisting in making the required adjustments to the system.

(h) The contractor shall commission the irrigation system upon completing the work and then shall be handed over.

(i) The contractor and upon completing the work shall provide the Engineer with four original sets of As-Built drawings accurately reflecting the executed works and installation details.

(j) The contractor shall upon completing the works provide the Engineer with detailed Operation and Maintenance Manuals (With applicable Arabic translations) in four originals. The manuals shall include but not limited to; complete and marked literature of all products used on the project and its reordering part numbers. It shall also include a list of the recommended spare parts for a period of 5 years. It shall include original color print and softcopy of the As Built drawings.

(k) The Engineer prior to issuing the Project Handing over Certificate shall approve the As-Built Drawings and the Operation & maintenance Manual.

(l) The details pertaining to this scope of work are herein Appendix A and Appendix B. The Contractor shall execute his work as per the details in Appendix A and Appendix B.

2.1.3 Quality Assurance

1 Manufacturers: Firms regularly engaged in the manufacture of irrigation equipment, control systems, pumps, pipes and fittings whose products have been in satisfactory use in similar service for not less than 5 years and backed by a recognized local agent or to the approval of the engineer.

2 Installers: Firms regularly engaged in the installation of irrigation works of a similar quality and scope as this project and to be approved by the Engineer.

2.1.4 References

ASTM D2241.....Specifications for Polyvinyl Chloride (PVC) pressure rated pipes.

ASTM B3.....Bare soft and annealed copper un-insulated uncoated 14-4 AWG solid wire.

ASTM B8.....Class B concentric-lay-stranded copper conductors

ASTM D2466.....Specification for uPVC pipe Fitting Schedule 40.

ASTM D2467.....Specification for uPVC pipe Fitting Schedule 80

ASTM D1248.....Standard specification for polyethylene plastic

ASTM D1785.....American standard for testing of material for PVC pipes.

ASTM D2219.....Specification for PVC insulation for wire and cable

BS 1780 .....Specification for bourdon tube pressure and vacuum gauges. (EN 837-1)

BS 3505 .....Specification for uPVC pressure pipes for cold potable water. (ISO 1452-5: ISO 1452-1: ISO 1452-3: ISO 1452-4: ISO 1452-2)

BS 4346 .....Joints and fittings for use with uPVC pressure pipes.

BS 5150 .....Specification for cast iron wedge and double disk gate valves for general purposes.(EN 1171)

BS 5154 .....Specification for copper alloy globe, globe stop and check, check and gate valves for general purposes.

BS 8010 .....Code of practice for pipelines.

Din 8061.....Confirming to German Standards Din 8061.

Din 8062.....uPVC pipes Dimensions According to German Standard.

Din 8063..... Pipe joint Assembly and fitting for uPVC pressure pipe.

ISO 1452 .....Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U)

2.1.5 Submittals

1 Prior to start of any work at site the contractor has to approach all Service Authorities in Qatar to get their no objection for the work included in this contract and record drawings for their existing services. Copy of these drawings and no objection certificate shall be submitted to the Engineer before starting the actual work at site.

2 Shop Drawings - The contractor shall submit shop drawings in 3 sets of black hardcopies, one set colored hardcopy and a soft copy, which to be approved by the Engineer representative prior to commencing installation work. The shop drawings shall show but not limited to valves, control wires route and numbers, controllers' location and flow balancing.

3 Please note that the contractor shall prepare detail survey of existing levels in the contract area.

4 Trial pits should be taken at every 50 meter interval. All the existing services shall be marked in reference to the road edge & building line along with these depths from existing ground level & the proposed Landscape finish level. Contractor to check availability of all the existing ducts that are marked on the tender drawings. Contractor to propose the route of Irrigation piping based on this information. All this information regarding trial pits, existing and proposed levels, availability of existing ducts shall be made available to the Engineer within mobilization period of the contract. All information shall be made available on hardcopy & in Digital format to the Engineer as it is required for adjusting landscape and pipes/services alignment.

5 Any delay to provide the above-mentioned information regarding trial trenches, existing services & levels which affect the progress of works shall be the responsibility of the Contractor

6 The successful contractor shall submit shop drawings, for approval by the Engineer, for the following:

(a) In case of any conflict between contract drawings and any existing or future services which may necessitate re-routing the proposed irrigation Main or laterals, the contractor has to prepare the shop drawings accordingly and submit it to the Engineer for approval. This shall be considered as integral part of the contract.

(b) The Pump /Filtration Chamber mechanical, electrical and civil works shop drawings. Necessary modifications to the existing feeding chambers (civil and mechanical). Valve chambers including valves, pipe works and civil works. Electrical control equipment with circuit diagrams

(c) Details of mainline, Profile drawings for Mainline, lateral pipes and other typical connections

(d) Wiring diagrams including conduits, pull boxes, sizing and calculations to verify that cable sizing is in accordance with Kahrama regulations and equipment manufacturers recommendations

(e) Electrical power and control wiring diagrams for irrigation controllers, field wiring and grounding.

(f) Layout plans for drip line layout.

(g) Layout plans for Sprayer and Sprinkler layouts

(h) Detail of valve chambers and any modification to the existing feeding chambers

(i) The approval shall not relieve the Contractor of any of his responsibility under the contract for successful completion of the work

7 Products

(a) The contractor shall submit for Engineer's approval prior to commencing installation works; the products he intends to use with all technical details and literature in accordance with the specifications below. Material submittal shall include all irrigation system component, fitting and accessories including but not limited to warning tape, PVC cement and cleaner, wires, Teflon tape. A sample board shall be submitted for approval. A material submittal list must be arranged by the contractor as below (Table 1):

Table 1:
Material Submittal List

Item	Description
1	Air Release Valve
2	Screen Filter
3	Polyethylene In Line Drip
4	On Line Drippers
5	Pressure Compensating Bubbler
6	Rotor Sprinkler
7	Pop Up Spray
8	Central Irrigation System
9	Irrigation Controller
10	Weather Station
11	Irrigation Control Wire
12	Flow Meter
13	Solenoid Valves
14	Quick Coupling Valve
15	Gate Valve
16	Check Valve
17	Valve Boxes
18	PVC Pipes
19	PVC Fittings
20	PVC Cement
21	PVC Cleaner
22	DC Aluminium Cover
23	Shop Drawing Submittal
24	Flow Balance Submittal
25	Irrigation Pumps & Panels
26	Submersible Pump

Abbreviations	
AP	Approved
AN	Approved As Noted
AI	Additional Information
NA	Not Approved
SR	Sample Required
GR	Guarantee Required
NS	Not Submitted
TR	Test Required
OT	Others

Item	Description		Abbreviations
27	Water Tanks		
28	Water Cooler		

(b) Operation and Maintenance Manuals-The contractor shall submit 4 sets of black hardcopies, one set colored hardcopy and a soft copy of detailed Operation & Maintenance Manual and one softcopy with equipment reordering codes and literature.

(c) As-Built Drawings- The contractor shall submit 3 sets of black hardcopies, one set colored hardcopy and a soft copy of the complete project as-built drawings reflecting the actual site installation.

(d) Calculation: The contractor shall submit a friction loss calculation for the irrigation system installed including a full system flow balance calculation.

(e) Guarantees: The contractor shall submit manufacturer and supplier material guarantees for materials submittal as specified in the material specification below.

(f) Origen catalogue cuts, diagrams, samples, drawings and such other data may be required to demonstrate compliance with the specification.

2.2 PRODUCTS

2.2.1 Pipe And Fittings

1 All primary distribution pipe work shall be non plasticized Polyvinyl Chloride (uPVC) class E or equivalent for all lateral and mainlines.

2 PVC pipes shall be manufactured according to ASTM D1785 or equivalent.

3 All primary distribution pipe fittings shall be solvent welded uPVC 15 bars or equivalent.

4 All non plasticized Polyvinyl Chloride Pipe fittings shall be manufactured to ASTM D1785 or Equivalent and class E or equivalent.

5 Polyethylene pipes and fittings:

6 Flexible Pipes for irrigation on line drippers shall be in the required sizes as shown on the drawings and extruded from linear low density polyethylene version raw material. Pipes shall be resistant to algae and ultraviolet deterioration with Carbon Black content not less than 2.25%.

7 Pipes and fittings manufacturer should be ISO certified with 5 years manufacturing experience, test certificate from reputable labs should be available prior to material ordering.

2.2.2 Application Devices

1 Spray Pop-Up Sprinkler

(a) The spray pop-up sprinkler shall be equipped with an adjustable arc (25-360°) nozzle discharging at half circle as shown in design drawings

(b) The spray pop-up sprinkler nozzle shall automatically adjust the flow depending on the arc setting in order to have a matched precipitation rate.

(c) The sprinkler shall have arc and radius reduction capability. It shall also be possible to adjust arc and radius from the top of the riser assembly, using an adjustment key.

(d) The sprinkler shall have an inlet screen. The body and riser of the sprinkler shall be constructed of non-corrodible, heavy duty A.B.S or UV R.P.

(e) The sprayers shall be located 25 cm from grass edge or as noted on design drawings

(f) Refer to design drawing for exact radius of coverage and flow needed for each sprayer.

(g) Sprinkler flow and radius coverage should be as per design drawings.

(h) The sprinkler shall carry a one-year manufacturer and supplier exchange warranty (not prorated).

2 Rotor Pop-Up Sprinkler

(a) The rotor pop-up sprinkler shall be of the gear-driven, closed case rotary type or as specified in the design drawings.

(b) The rotor pop-up sprinkler shall have a gear drive reversing or non reversing mechanism.

(c) The rotor pop-up sprinkler shall be available with standard nozzles.

(d) The sprinkler shall have minimum 25% radius adjustment capabilities by means of a stainless-steel nozzle retainer/radius adjustment screw.

(e) The sprinkler shall be available in both full-circle and adjustable part-circle configurations. The adjustable part circle unit shall be minutely adjustable from 40° to 360°. The adjustable unit shall be adjustable in all phases of installation (i.e., before installation, after installation while static, and after installation while in operation).

(f) The sprinkler shall have a constant rotation speed irrespective of the nozzle installed.

(g) The sprinkler shall have a minimum of 4-inch (10 cm) pop-up stroke to bring the rotating nozzle turret into a clean environment.

(h) The sprinkler shall have a thick rubber cover firmly attached to the top of the sprinkler riser.

(i) The sprinkler shall be equipped with a drain check valve to prevent low head drainage, and be capable of checking a minimum of 7 feet (2.1 m) in elevation change.

(j) The sprinkler shall be serviceable after installation in the field by unscrewing the body cap, removing the riser assembly, and extracting the inlet filter screen.

(k) The body and riser of the sprinkler shall be constructed of non-corrodible, heavy-duty A.B.S or durable plastic. It shall have a stainless steel spring for positive retraction of the riser when irrigation is complete.

(l) Sprinkler flow, radius coverage, and operating pressure should be as per design drawings.

(m) The sprinkler shall carry a one-year manufacturer and supplier exchange warranty.

3 Integrated Dripper Line

(a) The dripper line shall consist of on ultra violet resistant low density Linear polyethylene tube with internal pressure compensating continuously self cleaning integral flat or cylindrical drippers welded to the inside of wall of the tube at the specified spacing as an integral part of the tubing assembly.

(b) The tube shall have a 15 to 17 mm outside diameter.

(c) The dripper shall be constructed of plastic with a hard plastic diaphragm retainer and a self cleaning diaphragm extending the full length of the dripper. It shall have an inlet filter raised from the wall of the tubing. It shall have the ability to independently regulate discharge rates with a constant flow at an inlet pressure of 7-60 psi.

(d) The dripper discharge shall be as specified on the design drawings utilizing a combination turbulent flow/reduced pressure compensation cell mechanism and a diaphragm to maintain uniform discharge rates. It shall also be continuously self-cleaning during operation and under pressure.

(e) The dripper flow versus pressure shall be tested by an independent reputable organization, and shall have available reports to be presented upon request by the Engineer.

(f) The dripper flow shall not be affected by temperature up to 60 degrees Celsius and shall not have a spike at start up.

(g) The filtration requirement of the dripper shall be a maximum of 120 mesh.

(h) The dripper line shall have a 2 years guarantee against solar radiation and 1 year manufacturer and supplier warranty against manufacturing defects.

4 On- Line Dripper For Irregularly Layed-Out Shrubs

(a) Single outlet, pressure compensating drippers are acceptable.

(b) Pressure compensating design deliver uniform flow at a pressure variable from 15 to 50 psi.

(c) Made of durable plastic construction and UV resistant.

(d) Diaphragm resistant to chemicals.

(e) Built in self flushing action

(f) Available in self piercing inlet barb.

(g) The flow is as per design drawing.

(h) On-line dripper shall be extended with a distribution component made of a UV resistant polyethylene resin materials, 4 mm inside diameter.

(i) Polyethylene and UV resistant pipe 16 mm is used to insert in the on line drippers, this pipe is laid underground at 5 cm depth including the online dripper, only the distribution component is extended out the ground to a maximum of 25 cm length.

(j) The dripper line shall have a 2 years guarantee against solar radiation and 1 year manufacturer and supplier warranty against manufacturing defects.

5 Bubblers

(a) The bubbler shall be of the pressure compensating type having a fixed flow under a pressure range of 20 to 70 PSI. It shall be constructed of corrosion and UV resistant plastic material.

(b) The bubbler shall have an integral flow bushing to maintain a constant flow at different pressure range.

(c) The bubbler shall have a plastic screen filter to protect it from debris that could be available in the water.

(d) The bubbler shall be available in 0.25 to 2.0 GPM flow rates.

(e) Bubblers flow and numbers are as per design drawing details and two bubblers are needed for palm trees and one bubbler for trees.

(f) The bubbler shall carry a two years manufacturer and supplier replacement warranty.

6 Electrical Control Solenoid Valves

(a) The electrical control solenoid valves shall be of the electronically actuated, diaphragm operated.

(b) The valve's body and bonnet shall be molded of non-corrodible, glass filled nylon, rated at an operating pressure of 200 PSI. The body of the valve shall have brass inserts, with through holes, which will accept the bonnet Stainless steel bolts.

(c) The valve shall be equipped with an internal filter as well with a self-cleaning metering rod, so that only clean water can enter the solenoid chamber. A filter cleaning system, that continuously cleans the filter when the valve is operating, shall be available.

(d) The valve shall be equipped with a flow control mechanism with handle, which regulates the flow from full on to completely off. It shall have an accurate set pressure regulator, to keep the downstream pressure constant after setting it. The regulator shall be of the top dial model with clearly shown pressure values in bars and PSI. It shall regulate the flow at a pressure range of 20 to 100 PSI.

(e) The valve shall be available in 1, 1.5, 2 and 3" inch sizes and it shall have a BSP female thread inlet and outlet.

(f) The valve shall be equipped with automatic self-cleaning system for filter.

(g) The valve sizes, number and flow rate are shown on the design drawings.

(h) The valve shall carry a 3 years manufacturer and supplier exchange warranty.

7 Quick Coupling Valves

(a) The Valve shall be operated by insertion of a compatible hollow coupler key.

(b) The valve shall be operated by a 90º turn in clockwise direction with reverse turn for closure and be capable of 360-swivel action.

(c) The valves shall be of the low-pressure loss type.

(d) The Valve Body shall be made from brass material and have the one or two-section type with removable upper body. It shall be supplied with spring loaded locking cover made from thermoplastic rubber. The cover spring shall be of stainless steel material.

(e) The valve size is 1".

(f) The valve shall carry a 3 years manufacturer and supplier exchange warranty.

8 Gate Valves

(a) Gate valves shall be designed for a working pressure of not less than 10 bars and water operating temperature of 45° C.

(b) Valves shall be the same size as the incoming line size with a clear waterway equal to the full nominal diameter of the valves and shall be opened by turning counterclockwise.

(c) The operating nut or wheel shall have an arrow cast in valve indicating the direction of opening.

(d) Valves smaller than 4” shall be all bronze or brass conforming to BS or ASTM with screwed end connections. Valves 4” and larger shall be cast iron body, and shall conform to BS or ASTM with flange end connections.

(e) The valve shall carry a five years manufacturer and supplier exchange warranty.

(f) PVC valves up to 4" diameter, with working pressure of not less than 10 bars and watering temperature of 50° C are acceptable with 3 years manufacturer and supplier exchange warranty.

9 Air/Vacuum Release Valves Specifications

(a) Air relief valves shall be (1”-3”) size as shown on the Drawings and shall be of the kinetic/automatic type that will automatically release air when the lines are being filled with water and when air entrapment occurs while the system is working.

(b) The Valves shall be of plastic or brass male base.

(c) The body of the valve shall be constructed of heavy duty plastic or 100% corrosion resistant materials.

(d) The valve working components shall be constructed of 100% corrosion resistant materials to ensure maximum life and minimum water loss due to leaks.

(e) The Valve shall remain open even when pipeline air pressure reaches (3-10) psi.

(f) The air release valve shall employ rolling seal mechanism made of EPDM.

(g) The valve shall carry a 3 years exchange warranty.

10 Check Valves

(a) The valve shall be having constructed of Brass, Cast Iron, Ductile Iron and stainless steel materials, 100% non-corrosive.

(b) The valve shall allow flow in one direction by the action of a spring loaded flap which closes against a rubber seal.

(c) The spring and the flap shall be connected via a moment arm in order to ensure that the spring pressure is maximum when the valve is closed.

(d) The valve shall have a pressure rating of 16 bars

(e) The valve shall have an external position indicator.

(f) The valve shall be available in 3”, 4”, and 6”size.

(g) The valve shall carry a 3 years exchange warranty.

11 Valve Boxes

(a) The valve boxes shall have enclosures, which are injected molded plastic or HDPE with ultra violet additives. It shall be light in weight with reduced side angles and increased break resistance.

(b) The valve box shall be non-conductive or sparking.

(c) The valve boxes shall be available in sizes to fit the solenoid valve assembly including the union fittings and allow for easy removal of valves for maintenance.

(d) The valve box should have a two years replacement warranty against buckling and five years against cracking. All valve boxes should be name tagged with aluminum or brass name tags, placed inside the valve box and riveted to the outside box cover. The name tag size should be 2" by 3" and 2mm thick.

12 Filters

(a) Use a 3” disc filter on all distribution chambers with a disc filters of 120 mesh size of 0.10 mm.

(b) Disc filters shall be corrosion resistant, with minimum pressure and high particle retention filter area.

(c) Filters shall handle a pressure of 8 bars minimum.

(d) The filter shall carry a 1 year manufacturer and 2 years supplier warranty.

13 Controllers

(a) The controllers should be capable of running the irrigation system as scheduled; it should have a seasonal adjustment option, 4 programs, running 2 solenoid valves at the same time using one station. ,reading 2 sensor minimum at the same time .

(b) The controllers should have a stainless-steel or plastic pedestal and should be weatherproof and resists the elements.

(c) The number of stations for each controller should be equal to the total of existing stations for all used solenoid valves, the extra spare wires for future use and wires for future flow meter and master gate valves at each chamber.

(d) Additional 2 numbers of 10 gauge wires should be laid as provisional for future installation of flow sensor and master gate valves at each distribution chamber.

(e) The controller should have 2 years minimum warranty against malfunctioning and 10 years available software upgrade. Irrigation schedule should laminated and placed in each controller cabinet.

(f) The controller in Government projects must be centre control system.

14 Power Source

(a) The contractor shall be responsible for providing the electrical power source to the controller from any nearby distribution panel board.

(b) The location of the controllers should not be changed and the power sourcing should be done to suit that condition. All coordination and permits should be arranged by the contract and at his own expense.

15 Trench Marker Tape

(a) Furnish and install trench marker above all buried irrigation pressure Pipelines and electric power cable.

(b) Provide tape manufactured from low density polyethylene material or equivalent approved material.

(c) Provide tape 150mm wide and a minimum thickness of 100 micron.

(d) Print tape in both Arabic and English. CAUTION: IRRIGATION LINE BURIED BELOW / ELECTRIC CABLE BURIED BELOW (or) equivalent text that is applicable for usage.

16 Water Wire Connector & Sealant

(a) Wire connector shall be waterproof underground wire connections.

(b) Splices of wire shall be accomplished using 3M or equivalent epoxy type compound.

17 Power Cable For Irrigation Controller And Control Panel

(a) Selection of power cable for irrigation controller and panel as per the manufacturer recommendation.

(b) The detail of Voltage, Ampere and size of cable as per the manufacturer recommendation and technical data.

(c) The cable shall carry a 1 year manufacturer and 2 years supplier warranty.

18 Irrigation Control Cables

(a) Electrical materials for irrigation purposes shall comply with the relevant provisions of Section 21, Electrical Works.

(b) Irrigation control cables shall be used between the solenoid valves and the irrigation controllers. The cables shall be of the single conductor type UF and they shall be engineered for direct burial use. The common wire shall be gauge 12 and the control wire shall be gauge 14.

(c) For master control valves and flow meter wires use 10 gauge wires.

(d) The wires shall be of the solid or stranded construction with soft bare copper conductor. They shall have extra heavy thickness of special polyvinyl chloride insulation highly resistant to the saline, acid or alkaline contaminants.

(e) The copper conductors of the wires shall meet the requirements of ASTM B-3, B-8.

(f) The thermoplastic insulation shall meet U L standard 493 and 83. All irrigation wires shall have surface printing on insulation.

19 Irrigation Pump

(a) The irrigation pumping system shall consist of a main irrigation pump, a booster pump. The size of the pump is as specified in each project specification.

(b) The irrigation pump should have a variable frequency drive that controls and keep pressure constant with a variable drive system.

(c) The pump should be made of the best materials and made by a reputable manufacturer.

(d) The operation and maintenance schedule should be submitted.

(e) The minimum replacement warranty for the pump should be 2 years if defect occurs more than twice per year.

(f) The supplier should submit a guarantee of 2 days maximum repair time for the pump including availability of spare parts.

(g) The pump warranty should cover all parts of the pumping system including the control board piping and check valve to a minimum of five years against manufacturer defects.

20 Pressure sensor

(a) The pressure sensor shall be analog or digital type with signal convertor and transmitter and be compatible to work with the proposed and existing irrigation controllers.

(b) The devise shall be extreme robust made in stainless steel housing for rough environment.

(c) The wetted parts shall be non corrosive and high grade stainless steel material to suitable for treated sewage effluent water and enclosure protected to IP67 or latest.

(d) The pressure sensor shall be capable of measuring the mainline water pressure ranges of 0.5 to 16 bar and transferring the date to field satellite controller and relaying this information to the central control point computer to provide pressure information of each valve.

(e) The method of communication between the sensors to controller shall be via hardwire (or as recommended by the manufacturer) for monitor and control the pressure.

(f) The sensor shall be supplied with a threaded / flanged adaptor for installation in to the irrigation mainline. Sensors shall be positioned in a location accessible for safe maintenance.

(g) The warranty shall include the pressure sensor, transmitter and the signal converter should be for 5 years suppliers' warranty.

21 Flow Sensor

(a) The flow meter shall be of an Electromagnetic insertion type, operated with 24 V direct current.

(b) It shall be compatible with the irrigation control system. And Capable of reading flow from 0 to 25% higher than the maximum flow in the largest mainline pipe.

(c) Frequency of sampling and reading flow shall be selectable from 10 times per second to one time in 10 minutes or (As per manufacture requirements).

(d) The wire of flow sensor should be minimum 20 AWG.

(e) The warranty shall include the flow meter and the signal converter and should be for 5 years suppliers' warranty.

22 Master Control Valve

(a) The master control valve should be cast iron compatible with the existing controller and operated with 24 V direct Electrical current.

(b) The warranty should be for 3 years suppliers warranty and 1 years minimum manufacturer warranty.

(c) The local supplier should be an existing Qatari firm with minimum 5 years of operational history.

23 Miscellaneous

(a) Irrigation Drip Line Stakes: Stakes for securing flexible pipes shall be heat resistant plastic.

(b) Keys: the Contractor shall provide Keys for all valves, controller cabinets, boxes, quick couplers, etc. The number of keys to be provided to the Engineer for each type of fitting shall be six (6).

(c) Hoses: Hoses, quick couplers and appropriate connectors shall be provided by the Contractor for quick coupling valves, drain down points, etc. The number of hoses/connectors shall be: 1 (one as sample) the hose should be fifty (50) meters of industrial weight double nylon cord reinforcement or double tire cord reinforced of an untangling and high pressure type.

(d) Quick couplers Swivel end unit: One (1) quick coupler with swivel end unit shall be provided for each installed eight (8) quick coupling valves.

(e) Distribution chamber: Should be made of reinforced concrete as specified and approved by the drainage department, it should allow for easy installation and removal of component inside and should be water proofed with waterproofing paints and membrane. The membrane should be protected with a protection board.

(f) Chamber Aluminum cover: The aluminum cover should be made to fit the new chambers shown on the project details drawing and it should have the following:

(i) Hinged aluminum access cover shall be obtained from an approved experienced manufacturer and shall be fabricated from checker-plate. The cover shall be capable of withstanding a load of 750 kg/m2 without deflecting more than 1% of the span, and without damage or permanent deflection.

(ii) Hinges shall not stand proud of the cover, and sealed lifting eyes shall be provided completed with two lifting keys for each cover.

(iii) Covers should open to approximately 10 degree past the vertical, and stays should be provided to hold the cover in this position.

(iv) All joints shall be welded/soldered in an inert atmosphere.

(v) The faces of the frame which will come into contact with the cement mortar or concrete shall be painted with two coats of bituminous paint before installation of the frame.

24 Connection to Existing Services

(a) The Contractor shall co-ordinate and provide water and electrical connection points as follows:

(i) connections to water sources

(ii) make all connections to electrical panels or transformers

(b) The Contractor shall be responsible for making connections to existing piping, valves, conduit, and appurtenances utilising proper adaptation tools and procedures.

2.3 EXECUTIONS

2.3.1 Protection

1 All materials shall be handled and shipped in accordance with the relevant provisions of Part 9 of Section 1, General.

2 All materials shall be shipped or otherwise conveyed in such a manner as to assure no damage. All boxes shall be securely sealed and clearly marked with the name of the manufacturer. All pipes shall be protected from crimping, crushing and splitting. All non-metallic system components shall be protected from sunlight exposure as per the manufacturer's recommendations.

3 Work and materials shall be protected from damage during storage, handling and construction. Particularly, non-metallic pipes and fittings shall be protected from direct sunlight during storage. Facilities of the necessary dimensions shall be provided and maintained for storage of all non-metallic irrigation materials in their entirety. All non-metallic materials shall be handled carefully and stored under cover to avoid damage. Pipes that have been damaged or dented will not be used in this work.

4 In addition to the provisions for the protection of non-metallic components, special attention shall be given to the protection of the control system components; protection shall be provided as per the manufacturer's written recommendations.

5 Openings into the system, apparatus and equipment shall be securely covered, both before and after being set in place, to prevent obstruction in the pipes and the breakage, misuse or disfigurement of the apparatus or equipment.

6 Barricades, guards, warning signs and lights as necessary or required, for the protection of the public and the work force shall be provided.

7 Utilities: The location of existing underground utilities shall be determined and the works performed in a manner which will avoid possible damage. Hand excavation, as required shall be carried out to minimize the possibility of damage to existing underground utilities.

2.3.2 Performance

1 The Contractor shall stake-out the locations of all pipe and valves and the layout of work as accurately as possible.

2 The Contractor shall verify all horizontal and vertical site dimensions prior to staking.

3 The Contractor will be responsible for relocating any existing services after first obtaining the Engineer's approval. The Contractor shall remove and relocate such services, at his own expense, if so directed by the Engineer.

4 Before starting work on irrigation systems, the Contractor shall carefully check all grades to determine that work may safely proceed, keeping within the specified material depths.

5 Fittings installed on pipes beneath pavements or walls shall be shown on drawings.

6 All changes shall be recorded daily on the “As-Built" worksheets.

2.3.3 Inspection

1 The Contractor shall inspect all products for damage immediately before installation. Any products that are found to be damaged or not in accordance with the specifications shall immediately be repaired or removed from the site and replaced. Repairs shall not be undertaken without the Engineer's approval of Contractor's proposed action.

2.3.4 Installation

1 Excavation and backfilling shall be in accordance with detail drawings.

(a) Mainline shall be placed at 70 cm deep and warning tape 20 cm above pipe as shown in design drawings.

(b) Lateral lines should be placed at 40 cm deep without warning tape above.

(c) Width of trench to be 40 cm minimum width.

2 Sand bedding layer of 15 cm minimum is required under the irrigation pipe.

3 Sand surround to a minimum 15 around the irrigation pipe is required.

4 In bedding and backfilling granular material shall be used below and above the pipes. The backfill material shall be free of stones bigger than

5 Cast-in-place concrete shall be in accordance with the common civil works standards covering the concrete class, shattering work, curing procedures etc.

6 All products shall be installed in accordance with the manufacturer's instructions and the Drawings.

7 Location of Irrigation Lines

(a) Where the location of an irrigation line is not clearly dimensioned on the Drawings, the irrigation line shall not be laid horizontally closer than 3.0 meters from a sewer.

(b) However, where the bottom of the irrigation line will be at least 0.3 meters above the top of the sewer pipe, the irrigation line shall not be laid closer horizontally than 1.5 meters from the sewer.

(c) Where irrigation lines cross under gravity-flow sewer lines, the sewer pipe shall be fully encased in concrete, for a distance of at least 3.0 meters each side of the crossing or shall be made of pressure pipe with no joint located within 1.0 meters horizontally of the crossing.

(d) Irrigation lines shall, in all cases, cross 0.6 meter above sewage pressure mains.

(e) Lateral lines shall be 2 meters away from center of trees, palms and large shrubs.

(f) Generally, where the irrigation distribution or secondary main with accompanying cable bundle is running under hard surfaces or landscaped areas the pipe and the cables will be directly buried in a clean sand bed with a marker tape above. At road junctions or other locations where pipes cross the road they shall be contained in a direct buried PVC sleeve. The sleeve shall extend beyond the road crossing by at least one meter on both sides. The sleeve shall be a minimum of 100 mm diameter and for larger pipes will be at least 25mm greater in diameter than the pipe running through it.

8 Placing and Laying

(a) Pipes shall not be laid in water or when trench conditions are otherwise unsuitable for the work. Water shall be kept out of the trench until the material in the joints has hardened or until caulking or jointing is completed. When work is not in progress, open ends of the pipe, fittings, and valves shall be securely closed so that no substance will enter the pipes or fittings.

(b) Pipe ends left for future connections shall be valved, plugged or capped, and anchored, as shown or as directed. Pipes that have the grade or joint disturbed after laying shall be taken up and re-laid.

(c) All piping with the exception of the flexible irrigation drip line shall be surrounded by a sand bed to the dimensions as shown on the Drawings.

9 Plastic pipes: Pipes with threaded joints shall be snaked from side to side of the trench to allow for expansion and contraction.

10 Jointing

(a) Pipe joints of UPVC shall be installed in accordance with recommendations of the manufacturer. Excess jointing material shall be removed. Heavy duty jointing material will be used only.

(b) UPVC male adaptors with specified threaded joint compounds to make connections between plastic pipe and valves shall be used as detailed, and tightened with light wrench pressure.

11 Concrete thrust blocks shall be constructed on main pipelines at all changes in direction or size. The thrust blocks shall be non reinforced concrete and shall have a minimum dimension of 300 mm. The pipelines shall be located centrally in the thrust blocks.

12 Irrigation piping from the remote control valve boxes to the end of the irrigation drip lines shall be buried to the depths as shown on the Drawings.

13 Closing of Pipe and Flushing Lines

(a) Closing: Openings in piping systems shall be capped or plugged, leaving caps and plugs in place until removal is necessary for completion of the installation. Dirt and debris shall be prevented from entering pipe or equipment.

(b) Flushing: All pipes and tubing shall be thoroughly flushed out before installation of the emitter control valves. Butt joints, fittings and connections shall remain visible.

14 Tagging and Identification: All remote control valves, motor-operated valves, pressure reducing valves, manually-operated gate valves and controllers shall be tagged and identified. All identifying numbers shall be consistent with like designations indicated on the irrigation controller schedule.

15 Site Equipment Installation

(a) Isolation Valve/Gate Valve: Shall be installed as detailed and where indicated on Drawings.

(b) Remote Control Valve Assembly: Shall be installed in the positions as indicated in the details, remote control valve assembly comprising gate valve, remote control valve with pressure regulator, and all appurtenances. Valve boxes containing the assembly shall not be placed closer than 300mm to paved areas. When the pressure gauge will be properly attached, the outlet pressure shall be set as required during coverage tests.

(c) Valve Boxes: Shall be installed as detailed and where indicated on Drawings. All valves and valve assemblies shall be mounted in boxes as detailed.

(i) The top of all boxes shall be set parallel with the grade and as detailed in a neat and orderly fashion.

(ii) Shall be placed parallel to paving, kerbstone, walls or similar structures and where more than one box, parallel to each other.

(iii) All box locations shall be reviewed with the Engineer prior to installation of valves.

(iv) Valve boxes shall not rest on or come in contact with the valve, piping, hose or conduit.

(v) Solenoid valve boxes shall have a weather proof tag attached on the inside showing the valve number, controller number and station number.

(vi) A filter fabric shall cover the valve box and the soak away and taped to the valve box side just 10 cm below cover.

16 Control System

(a) Irrigation Controller

(i) An irrigation controller shall be installed in locations approved by the Engineer, with the control cables, clearly marked with identification markers, attached to the appropriate terminals in the approved manner.

(ii) Shall be secure to a concrete pad with approved anchor bolts. Chipping, cracking, or otherwise marring the finish of enclosure when securing to the concrete pad shall be avoided.

(iii) Programming of Irrigation Controller: Using the controller schedule provided on the drawings, as a guide, the irrigation controller shall be programmed to correspond with the initial irrigation sequencing and duration of the cycles for each zone. The Contractor may find that during establishment and maintenance the schedule has to be modified to achieve a correct irrigation regime in accordance with good horticultural practice, such modification shall be approved by the engineer.

17 Irrigation - Electrical

(a) All electrical work shall be in conformance with Qatar General Electricity & Water Corporation (QGEWC) Regulations and as further specified in Section 21, Electrical Work, inclusive of the following:

(i) The contractor shall provide, install, test and commission all items of electrical equipment associated with the irrigation systems.

(ii) All electrical works shall be in accordance with the BS and IEC.

(iii) The irrigation system shall commence at the controllers, which shall be fitted into a dwarf type distribution cabinet with solar shade and shall have a bolting down foot for mounting on a pre-formed concrete base. All incoming and outgoing cables shall be from below ground level. The cabinet shall have a hinged lockable opening door to provide full front access to the controller and equipment and shall be sized according to the equipment being installed.

(iv) All equipment, conductors, termination, etc., within the pillar and throughout the irrigation system generally shall be fully insulated such that there are no live parts or connections exposed and shall be to the complete satisfaction of the Engineer.

(v) The irrigation pillar shall have sufficient free space for fitting a kWh meter together with any additional equipment or accessories required to complete the equipment.

(vi) Each irrigation pillar shall have permanently fixed on the inside of the door, a distribution diagram showing all circuits connections, ratings, cable sizes, etc., together with a current controller schedule.

(vii) All terminals shall be of the crimped spade type with insulated grip. At all connection locations 150 mm of "slack" shall be provided.

(viii) Conductor markers shall be used throughout which shall clearly indicate the circuit reference or number. These shall be white plastic with black letters or numbers and of the type which acts as a sleeve over the conductor insulation.

(ix) Connections onto valves shall be made in a below ground PVC resin filled molded waterproof connector with integral wire clamp.

(x) Solenoid valve cables shall be laid along the mainline at a horizontal distance of 20 cm from the irrigation pipe.

(xi) Wiring under streets, driveways and other vehicular areas, and under walks, plazas and other hardscaped areas shall be installed as specified in Section 6, Roadworks:

18 Drip Line/Soft line Testing

(a) Drip lines shall be carefully uncoiled and laid in position without kinking. Any kinked section shall be cut from the line and subsequently re-joined with a line joiner section.

(b) Drip lines shall be snaked as required for maximum coverage without the use of compression fittings. Sharp bends shall be avoided where there is a likelihood of causing kinks in the line.

(c) Drip lines shall be laid on the ground surface for a minimum of 48 hours prior to the installation of irrigation emitters or stakes.

19 Concrete Pads

(a) Installation as detailed and where shown on the Drawings of controllers manufacturer.

(b) The exact location shall be confirmed to the Engineer prior to pouring.

(c) Specified non-metallic conduit shall be provided as required to penetrate boxes and enclosures as approved by the Engineer.

(d) The anchor bolts shall be set in coordination with enclosure hole locations.

2.3.5 System Testing

1 Purging

(a) Immediately prior to hydrostatic testing, all irrigation lines shall be thoroughly purged of all entrapped air.

(b) Mainline piping system may be tested in sections. Lateral Systems shall be tested valve by valve.

(c) Water shall be discharged from a single outlet by manipulation of isolation control valves and installation of temporary caps.

(d) Water shall be introduced into lines to be tested at full operating head and the water flow at end discharge point, and observed until all air and residual debris has been expelled from the line.

2 Initial System Test

(a) Individual parts of the main network between isolation valve points having a length not greater than 500 meters shall be tested together with dead legs before backfilling operation.

(b) Test shall be made only after completion of the above operations and not until at least seven days after the last concrete thrust anchor block has been cast.

(c) Contractor shall supply all testing material and equipment, including all caps, valves, pumps, tanks, water and gauges as required.

(d) Pressure gauges shall be dual reading in bar and psi units. Calibration shall be such that accurate determination of potential pressure loss can be ascertained.

(e) The section of the main pipeline to be tested shall be filled with potable water and all air expelled. After the main pipeline has been completely filled, the pressure shall be steadily and gradually increased until the specified test pressure has been reached. Simultaneous pressure and leakage tests and separate pressure test shall be made at 150 % of working pressure at the point of test, but not less than 125% of normal working pressure at highest elevation. Separate elevation test shall be made at 150 % of normal working pressure of the segment tested. The minimum pressure test for mainlines is 9 bars and leakage test for lateral lines. Duration of pressure and leakage tests shall be 4 hours. All testing shall comply with AWWA M23-80, Polyvinyl Chloride Pipe Design and Installation. Testing shall comply with AWWA specifications and requirements.

(f) Separate tests shall be applied to the lateral distribution pipe work and the irrigation pipe work from the remote control valves outwards. Test pressures for these shall be as described above.

(g) When testing the irrigation lines from the valves, discharge devices shall be replaced with temporary plugs or caps.

(h) All trenches with pipe installed shall be immediately backfilled with preliminary sand backfill sufficient to prevent arching or slipping under pressure. All joints, fittings and connections are to remain exposed until successful completion of hydrostatic testing.

(i) Other than for preliminary sand backfill over pipes, no work shall be covered before it has been inspected, tested and approved by the Engineer.

(j) During the tests, all exposed couplings, fittings and valves shall be carefully examined for defects and leakage. Leaking pipes, couplings, joints, fittings and equipment shall be repaired or replaced and the section retested as previously specified.

(k) Upon receipt of approval of the Engineer to proceed, the remaining backfill shall be placed and compacted to ninety percent (90%) of maximum dry density.

3 Final System Test: The tests as specified above shall be repeated for the entire network after pipelines have been backfilled, cleaned and inspected. Each test shall be restricted to pipes of one class and particular care shall be taken to isolate air valves, etc. and not to apply higher pressures than specified at any point on the pipeline and to ensure that the pipelines are adequately anchored before any test is carried out.

4 Test Results: Written records of every test clearly identifying the tested section of the pipe together with time of test and name of testing engineer in tabulated format shall be submitted for review and approval by the Engineer upon completion of the tests.

2.3.6 Flushing

1 General: On completion of the system test, the system is to be thoroughly flushed, the velocity of water being at least 1 m/s. Should the main water supply be unavailable or inadequate for this purpose at the time of flushing, then a swab of adequate size shall be used to remove all foreign matter from the pipeline. This process shall continue until the pipeline is completely clean. Each control valve shall be opened separately and the terminal systems also thoroughly flushed. After completion of flushing, the emitters and other discharge devices shall be fitted.

2 Operation Test: After the hydrostatic test, emitters shall be installed and the system completed and tested to demonstrate functional efficiency. This shall be prior to covering the laterals with mulch if used.

3 The lines shall be operated for a period of 24 hours, not necessarily in one continuous period, and all emitters checked for satisfactory operation. Any faulty/blocked emitters shall be replaced.

2.3.7 Testing and commissioning

1 On completion of the entire irrigation system installation, the system shall be commissioned to demonstrate the proper functioning of the system. The process of commissioning shall be carried out in the presence of the Engineer's Representative.

2 Adjustment and re-testing of emitters, control valves etc., shall be carried out until satisfactory result is obtained and the whole system is functioning to the design requirement.

2.4 OPERATION AND MAINTENANCE

2.4.1 Maintenance Program

1 Maintenance Personnel: to have experience in Qatar based landscape contracting company specializing in installing irrigation system for landscape.

2 Maintenance Manual: Upon completion of work and prior to initial acceptance, provide the Engineer with Four (4) copies of a bound maintenance manual and one (1) softcopy.

(a) The manual shall contain a list of all irrigation system components including:

(i) Component description.

(ii) Supplier name, address, telephone, email and contact person.

(iii) Warranty start and end date.

(iv) Spare parts available for each component.

(v) Maintenance program by date for each component and the description of the maintenance procedure, cleaning, flushing, lubricating, changing parts, updating etc.

3 The general manual headings and descriptions shall be both Arabic and English.

4 PENALTY FOR NON-PERFORMANCE/ DELAY: Due to the nature of the soft landscaping and the effect it has on the public appearance, the contractor must carry out the irrigation maintenance work as scheduled and direct by the Engineer. Failure to do so will have severe consequences on the contractor and the Engineer may take action the maintenance work. The Main Contractor shall bear all the cost implications arising from this action and no payment shall be processed until the Main Contractor processes the payment due to the new contractor that carried out the work.

5 The Contractor shall execute the required maintenance work in accordance with the approved maintenance program / schedule without any delay and to the satisfaction of the Engineer. In the event the Contractor fails to carry out the work specified, The authorized person shall employ persons other than the Contractor's staff to carry out the work and shall recover from the Contractor such costs incurred thereby from any monies due, or which become due, to the Contractor. In addition the Contractor shall be liable to Penalties as follows:

(a) Delay in replacing damaged sprinklers.

(b) Delay in replacing damaged manual valves.

(c) Delay in replacing damaged remote valves.

(d) Delay in replacing damaged valve boxes .

(e) Delay in replacing damaged pipes .

(f) Delay in cleaning 2" Y strainer .

(g) Delay in cleaning 3" disc filters.

(h) Delay in repair of pumps beyond 2 days- Replacement of the pump in addition to cost of irrigating by hand.

(i) Delay or manual operation of controllers.

(j) Delay in replacement of controllers.

(k) Delay in watering plants.

(l) Not following the approved irrigation schedule.

(m) Opening irrigation valves outside the irrigation schedule.

(n) Water leaks to the street.

(o) Due to non availability of TSE water the contractor shall deliver and properly irrigate the area.

2.4.2 Operational Personnel and Manual

1 Operational Personnel: to have experience in Qatar based landscape contracting company specializing in installing irrigation system for landscape.

2 Operational Manual: Upon completion of work and prior to initial acceptance, provide the Engineer with Four (4) Hard copies of a bound operational manual and one (1) softcopy.

(a) The manual should contain a list of all irrigation system components including:

(i) Original operational manual.

(ii) Operational schedules.

(iii) The general manual headings and descriptions shall be both in Arabic and English.

2.4.3 Operation Program

1 The contractor shall operate and maintain the irrigation system throughout the maintenance period, and shall provide staff in full time attendance throughout the period.

2 The maintenance of the irrigation system shall cover all work necessary to adequately operate and keep all irrigation equipment, valves, pipelines and appurtenances in proper operating condition, all to the satisfactory of the engineer.

3 Maintenance shall include but not limited to the following:

(a) Supply of irrigation water of suitable quality and adequate quantities to meet the irrigation requirements. The contractor shall arrange to obtain water from an approved source. A full analysis of the irrigation water shall be submitted to the engineer for approval and then at one month intervals thereafter during the maintenance period.

(b) Irrigation of areas forming part of the works at a frequency and depth as required for every season in the maintenance period.

(c) Maintenance and repair of all irrigation equipments, pipes , valves and all appurtenances; records shall be kept of all maintenance ,repairs and operation activities carried out during the maintenance period.

(d) The contractor shall provide to the engineer at the end of the maintenance period a report which shall include details of the date, location and type of work performed , all repairs and replacements , the amount f water applied and the duration of each irrigation cycle , results of water analysis and all other relevant information of work and activities carried out during the maintenance period.

4 Layout work

(a) The contractor shall be responsible for the accuracy of all layout work.

(b) Drawings are diagrammatic to the extent that swing joints offsets and all fittings are not shown and shall be the responsibility of the contractor to incorporate as needed and as compatible or acceptable with other included items.

(c) Lines are to be in common trenches wherever possible.

(d) Remote controls valves shall be grouped wherever possible and aligned at a set distance from road edges, footpaths and buildings.

2.5 SPARE PARTS

2.5.1 General

1 The Contractor shall submit to the Engineer a list of all spare parts to be required for a further two years operation from the date of issue of the Maintenance Certificate or otherwise specified herein after.

2 Spare parts required include but not necessarily limited to those listed below, provided specified in the Project Documentation or where quantities for each item or equipment is recommended by the manufacturer

3 Spare parts are to be delivered to central stores.

4 The tenderer shall submit with his offer detail prices of the spare parts he is required to provide under the Contract indicating the quantity and the unit rate of each item.

5 The Contractor shall provide sufficient spare parts as follows.

(a) Air Release Valve: 10 % spare, but in any case not less than 1 nos as specified and used in the project or in this section & shall carry a 3 years exchange warranty.

(b) Screen Filter: 10 % spare, but in any case not less than 2 nos of cartridges as specified & used in the project or in this section.

(c) Polyethylene In Line Drip: 10 % spare, but in any case not less than 1 roll as specified & used in the project or in this section with 2 years guarantee against solar radiation and 1 year manufacturer and supplier warranty against manufacturing defects.

(d) On Line Drippers: 20 % spare from the different flow size, as specified & used in the project or in this section with 2 years guarantee against solar radiation and 1 year manufacturer and supplier warranty against manufacturing defects.

(e) Pressure Compensating Bubbler: 20 % spare from the different flow size used in the project, with all fittings and accessories specified by the manufacturer for a proper usage with two years manufacturer and supplier replacement warranty.

(f) Rotor Sprinkler: 10 % spare from the different flow sizes and ranges & 25 % of the required nozzles, spare parts must be from the same brand used in the project or equivalent up to engineer's approval with all fittings and accessories specified by the manufacturer for a proper usage with two years manufacturer and supplier replacement warranty.

(g) Pop Up Spray: 10 % spare from the different flow sizes and ranges & 25 % of the required nozzles, spare parts must be from the same brand used in the project or equivalent up to engineer's approval with all fittings and accessories specified by the manufacturer for a proper usage with two years manufacturer and supplier replacement warranty.

(h) Irrigation Control Wire: 10 % from the total length used in the project, the detail of Voltage, Ampere and size of cable as per the manufacturer recommendation and technical data and shall carry a 1 year manufacturer and 2 years supplier warranty.

(i) Solenoid Valves: 10 % from the total no. used in the project plus 20 % from the required coils, The valve sizes, number and flow rate must be as used & shown on the design drawings and shall carry a 3 years manufacturer and supplier exchange warranty.

(j) Quick Coupling Valve: 10 % spare, but in any case not less than 1 valve. The valve must be of the low-pressure loss type of 1 inch, brass body with all fittings and accessories used in the project or specified by the manufacturer and shall carry a 3 years manufacturer and supplier exchange warranty.

(k) Gate Valve: 10 % spare, but in any case not less than 1 valve. As specified and used in the project or in this section and shall carry a five years manufacturer and supplier exchange warranty for the bronze or brass type and 3 years manufacturer and supplier exchange warranty for the PVC types with all fittings required by the manufacturer manual.

(l) Check valve: 10 % spare, but in any case not less than 1 valve. As specified and used in the project or in this section and shall be available in 3", 4", and 6"size & carry a 3 years exchange warranty.

(m) Valve Boxes: 10 % spare, but in any case not less than 1 box. As specified and used in the project or in this section with two years replacement warranty against buckling and five years against cracking.

(n) PVC Pipes & Fittings: 10 % from the total length used in the project from different sizes with same ratio of the required fittings and accessories or equivalent all up to engineers approval.

2.6 APPENDIX A – IRRIGATION DETAILS

1 Irrigation Rates

2 Irrigation Rates Are In Two Parts

3 Details

4 Bubbler Typical Connection and Section For Trees

5 Bubbler Typical Connection and Section For Palms

6 Sprinkler Installation

7 Sprinkler Installation

8 Air Release Valve Assembly

9 Quick Coupling Valve Typical Connection and Section

10 Drip Line Poly Pipe Connection: For Elbow Connection Typical Section

11 Drip Line Poly Pipe Plan Layout

12 Drip Line Poly Pipe Connection: For T Connection Typical Section

13 Irrigation Duct: Typical Section For Under Walkways

14 Thrust Block Arrangements: Typical Plans and Section

15 Pipe Sleeve Detail For Under Asphalt and Pavement

16 Upvc Pipe Main and Sub Main Line Installation: Typical Section

17 Pipe Sleeve Detail

18 Upvc Pipe Lateral Line Installation: Typical Section

2.6.2 Irrigation Rates

1 Irrigation Rates are in two parts

(A) Part 1: Peak Rate for determination of maximum volume and pipe sizing

(B) Part 2: A graduated mean based on seasonal demand variations enabling calculation of a annual water demand budget.

Table 10 : Irrigation Requirements Ashghal Projects

Group 4: High Water Demand													
			June to October Days 153		November to December Days 61		January to March Days 90		April to May Days 61		**Peak Daily Demand**	**Total Annual Demand**	**Mean Annual Daily Demand**
Irrigation Group	Type	Age	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Peak Daily Demand l/plant/ day	Total Annual Demand (m^3/plant/ year)	Mean Annual Daily Demand (l/plant/ /day/year)
4	Palms	Mature	120	2	120	5	120	8	120	4	65	10.76	29.49
4		3 to 8 Years	100	3	100	5	100	8	100	4	65	8.97	24.58
4		1 to 2 Years	50	3	50	5	50	8	50	3	40	4.74	12.98
4	Trees	Mature	100	3	100	5	100	8	100	4	35	8.97	24.58
4		3 to 8 YEARS	100	3	70	5	70	8	70	4	35	7.81	21.39
4		1 to 2 Years	100	3	40	5	40	6	40	4	35	6.80	18.62
4	Shrubs & Small Trees	Mature	25	3	25	5	25	7	25	3	10	2.41	6.60
4		1 to 2 Years	20	3	20	4	20	7	20	3	7	1.99	5.45
			Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Peak Daily Demand l/m^2	Total Annual Demand (m^3/m^2/ year)	Mean Annual Daily Demand (l/m^2/ day/year)
4	Ground Covers		12	3	12	5	12	7	12	3	5	1.16	3.17
4	Turf Grass		15	3	15	4	15	5	15	3	7	1.57	4.30

Table 10 Continue…

Group 3: Medium Water Demand													
			June to October Days 153		November to December Days 61		January to March Days 90		April to May Days 61		**Peak Daily Demand**	**Total Annual Demand**	**Mean Annual Daily Demand**
Irrigation Group:	Type	Age	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Peak Daily Demand l/plant	Total Annual Demand (m^3/plant/ year)	Mean Annual Daily Demand (l/plant/ day/ year
3	Palms	Mature	80	3	80	4	80	6	80	3	35	8.13	22.26
3		3 to 8 Years	60	3	60	4	60	6	60	3	35	6.10	16.70
3		1 to 2 Years	40	3	40	4	40	5	40	3	30	4.18	11.46
3	Trees	Mature	80	3	80	4	80	6	80	3	35	8.13	22.26
3		3 to 7 Years	60	3	60	4	60	6	60	3	35	6.10	16.70
3		1 to 2 Years	40	3	40	4	40	5	40	3	30	4.18	11.46
3	Shrubs & Small Trees	Mature	20	3	20	5	20	7	20	4	10	1.83	5.00
3		1 to 2 Years	15	2	15	5	15	7	15	4	7	1.75	4.80
			Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Peak Daily Demand l/m^2	Total Annual Demand (m^3/m^2)	Mean Annual Daily Demand (l/m^2/ day/year)
3	Ground Cover /Grasses		10	3	10	5	10	7	10	4	4	0.91	2.50

Table 10 Continue…

Group 2: Low-Medium Water Demand													
			June to October Days 153		November to December Days 61		January to March Days 90		April to May Days 61		**Peak Daily Demand**	**Total Annual Demand**	**Mean Annual Daily Demand**
Irrigation Group:	Type	Age	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Peak Daily Demand l/plant	Total Annual Demand (m^3/plant)	Mean Annual Daily Demand (l/plant/ day/ year
2	Trees	Mature	70	4	70	5	70	7	70	4	25	5.50	15.07
2		3 to 7 Years	60	4	60	5	60	8	60	4	20	4.62	12.65
2		1 to 2 Years	30	4	30	5	30	8	30	4	15	2.31	6.32
2	Shrubs & Small Trees	Mature	20	4	20	7	20	7	20	4	5	1.50	4.11
2		1 to 2 Years	12	4	12	7	12	8	12	4	5	0.88	2.42
			Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Peak Daily Demand l/m^2	Total Annual Demand (m^3/m^2)	Mean Annual Daily Demand (l/m^2/ day/year)
2	Ground Cover /Grasses		10	4	10	7	10	10	10	5	5	0.68	1.87

Table 10 Continue…

Group 1: Low Water Demand													
			June to October Days 153		November to December Days 61		January to March Days 90		April to May Days 61		**Peak Daily Demand**	**Total Annual Demand**	**Mean Annual Daily Demand**
Irrigation Group:	Type	Age	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Quantity (l) per plant	Cycle (days)	Peak Daily Demand l/plant	Total Annual Demand (m^3/plant)	Mean Annual Daily Demand (l/plant/ day/ year
1	Trees	Mature	100	7	100	12	100	20	100	10	20	3.75	10.29
1		1 to 2 Years	50	7	50	12	50	14	50	10	10	1.97	5.41
1	Shrubs & Small Trees	Mature	25	10	25	12	25	20	25	12	5	0.75	2.05
1		1 to 2 Years	12	7	12	12	12	20	12	12	5	0.44	1.20
			Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Quantity l/m^2	Cycle (days)	Peak Daily Demand l/m^2	Total Annual Demand (m^3/m^2)	Mean Annual Daily Demand (l/m^2/ day/year)
1	Ground Cover /Grasses		12	7	12	12	12	20	12	10	3	0.45	1.23

2.6.3 Required SPECS for irrigation central control system and required sensors for it

1 Central control system should control and monitor the following:

(a) Actual & current flow along mainlines and lateral lines in real time readings.

(b) Actual & current pressure along mainlines in real time readings.

(c) Actual & current volume of water in tanks in real time readings.

(d) Control irrigation valves in each area by schedules or quantity or water depth in tanks under flow and pressure predetermined conditions.

(e) Report any alarms and problems whenever its happened and deal with it in real time with ability to deal with any number of problems by the intelligence Remote terminal units itself in sites.

(f) Control and monitoring pumps operations (Start,Stop,Trip,Auto,manual,overheat) and generate reports for each status including status time and number of happens.

(g) Monitor Power supply failures. and use the backup batteries to send signal to central.

(h) Provide information access to managers and operators, wherever they are located (At the station, the control room or any other place) from the control center's alarms & reports through SMS feature

(i) Control the elements by (IF/THEN CONDITION)

(j) Reporting based on change of state (COS) and not only sampling period

2.6.4 Required sensors for irrigation central control system

1 There are some sensors and signals should be exist at sites which use RTUs as irrigation controller for monitoring and control all the elements connected to RTU as follow

2 Firstly, sensors and signals should be exist at public gardens

(a) level Transmitter

(b) pressure Transmitter

(c) flow sensor with Transmitter

(d) rain sensor

(e) Pump status signals (BMS signals)

(i) AUTO signal

(ii) MANUAL signal

(iii) RUN signal

(iv) TRIP signal

(v) START / STOP signal

3 Float switch signals from the tank and submersible pump

(a) high level signal

(b) low level signal

(c) submersible pump float switch signal

2.6.5 Secondly sensors should be exist at roads projects

1 Pressure Transmitter

2 Flow Meter With Transmitter

3 Rain Sensor

2.6.6 Required SPECS for central control system and water management

1 There is some features should be exist at central control system and water management to achieve best performance for monitoring and control all elements which will be connected to Remote Terminal Unit (RTU)

2 Communication

(a) The system should be operational by radio in Qatar.

(b) Radio frequency should be valid and updated from ICT

(c) Communication at all stages between all components should be by Radio.

(d) Two way real-time communication.

(e) System should be operated by one radio signal frequency.

(f) All controllers should be able to store and forward information.

(g) Direct access from field controller.

3 System capabilities

(a) The system should have conditional programming if-then.

(b) The system should be able to send SMS for alarms

(c) The system should be able to accept any type of signals(analog and digital)

(d) The system should have flow and analog pressure management

(e) The system should be able to irrigate by time or quantity of water or tank depth

(f) The system should be able to read data from a weather station

(g) The controller should send information automatically without retrieving from the central system at change of state for any element.

(h) Control and monitoring pumps operations (Start, Stop, Trip, Auto, manual, overheat) and generate reports for each Pump status including total time and number of happens.

(i) The system should be able to run on weather station - ET Mode operation.

(j) Central control software should support Networking

(k) Every controller shall support many main lines

(l) The system should be able to automatically establish actual flow.

(m) The system should be able to shutoff after leak detection

4 User Interface

(a) The system should have a graphic user interface, with drawings and maps for the whole system shown at once.

(b) The system should be able to have Copy, paste features.

(c) User password levels for multi-users.

(d) One screen to view all system.

(e) The system should have ability of network for main server.

2.6.7 RTU CAPABILITY at parks

1 Ability to receive analog signals 4:20 mA from level sensor for:-

(a) Monitoring water level at the tank and get daily reports for water level

(b) Control of electrical valve which feed the tank (on/off) according to water level of the tank to avoid any increase or decrease for water at the tank

(c) Control of pumps by sending (start/stop)signal to pump panel to open pumps only at irrigation period and to avoid damage of pump if its operated during water level at tank is low

(d) Irrigation based on water level of the tank if quantity of water inside the tank is limited so RTU can receive signal from level sensor and distribute available quantity of water inside the tank for all the valves equally to avoid to irrigate some plants and the others can't get enough water.

2 Ability to receive analog signals 4:20 mA from pressure sensor for:-

(a) Monitoring actual value of pressure from the pump at real time to keep safety for irrigation network in case of high pressure or if pressure switch –which responsible for pump switching according to value of pressure – is damaged

(b) Get daily or monthly graph for values of pressure to check if output pressure from the pump is stable or not

3 Ability to receive digital signals from flow sensor with transmitter for:-

(a) Get flow rate at real time

(b) Get total accumulation for irrigation net and discharge for each valve

(c) Leakage detection at real time and close master valve automatically during leakage problem

(d) High flow and low flow detection and take action according to high or low flow

(e) Manual irrigation detection

4 Ability to receive digital signals from rain sensor for:-

(a) Stop irrigation during rains

(b) Calculate how many times of rain during the year

5 Ability to receive BMS signals from pump panel to show status signals of pump as follow:-

(a) Auto signal, to check if the pump is at auto mode and how many times the pump operated at Auto mode and the total duration of auto mode

(b) Manual signal, to check if the pump is at Manual mode and how many times the pump operated at Manual mode and the total duration of Manual mode

(c) Run signal, to check if the pump is at run mode and how many times the pump was operated and the total duration of pump operation

(d) Trip signal, to check if the pump is at trip mode and how many times the pump was tripped and the total duration the pump was tripped

(e) Start / stop signal to check if pump panel is at start or stop mode

NOTE:- Status signal of pumps doesn't need any sensors, but it needs only to be the panel of the pump included with BMS signals by adding some relays which will be actuated to show status of pump through control cable extended between pump panel and RTU

6 Ability to receive float switch signals either which exist at the tank or at submersible pump for:-

(a) Get high level signal from high level float switch to check if water level at tank is at high

(b) Get low level signal from low level float switch to check if water level at tank is at low

(c) Get submersible pump float switch signal to check performance of submersible pump

7 Ability to receive analog signals 4:20 mA from weather station for:-

(a) Calculation of ET to irrigate up to weather factors and save water

2.6.8 RTU CAPABILITY for roads

1 Ability to receive analog signals from pressure sensor for:-

(a) Monitoring pressure values for mainline because at this case the pressure is not related to pump pressure as case of public garden -which we can adjust output pressure by adjust output pressure of pump - , but its related to big irrigation network so its affected distribution of sites at irrigation network and variation of pressure at any point at irrigation network, so the control can't be through control of input pressure to irrigation network, but only by control no. of electrical valves which operated simultaneously, to make balance for irrigation network and keep its pressure at stable state

2 Ability to receive digital signals from flow sensor with transmitter for:-

(a) Get flow rate at real time

(b) Get total accumulation for irrigation net and discharge for each valve

(c) Leakage detection at real time and close master valve automatically during leakage problem

(d) High flow and low flow detection and take action according to high or low flow

(e) Manual irrigation detection

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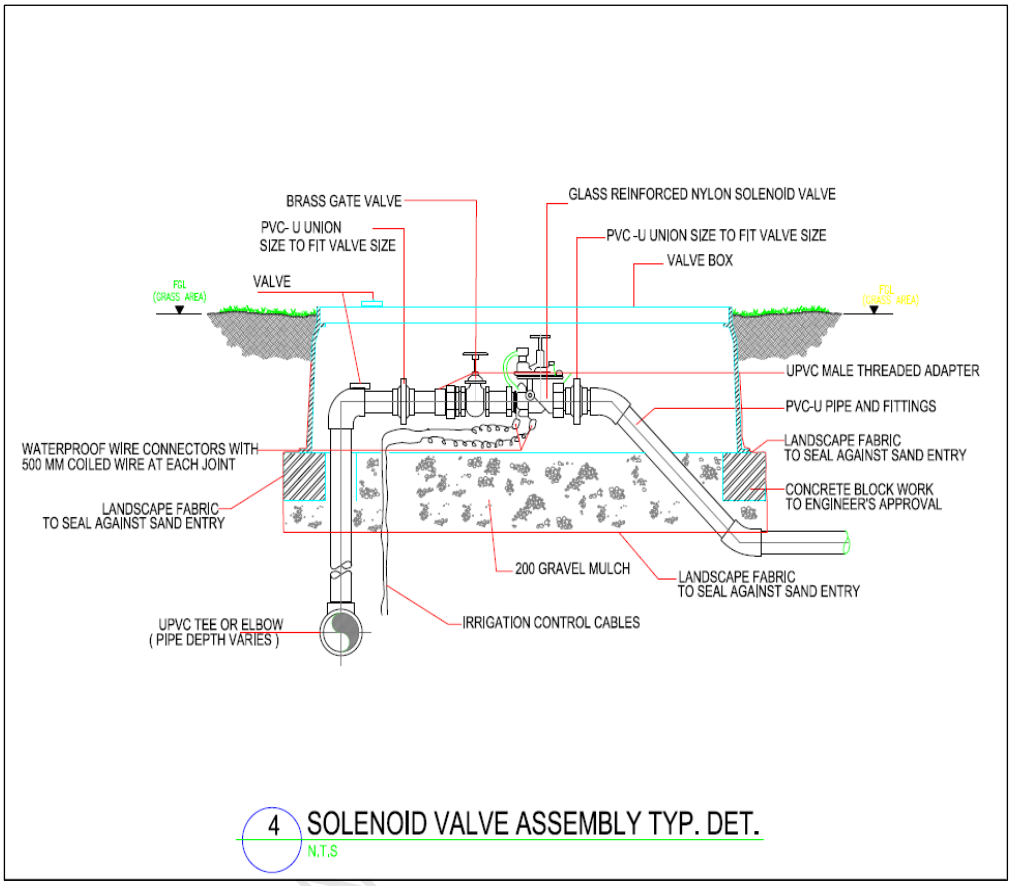
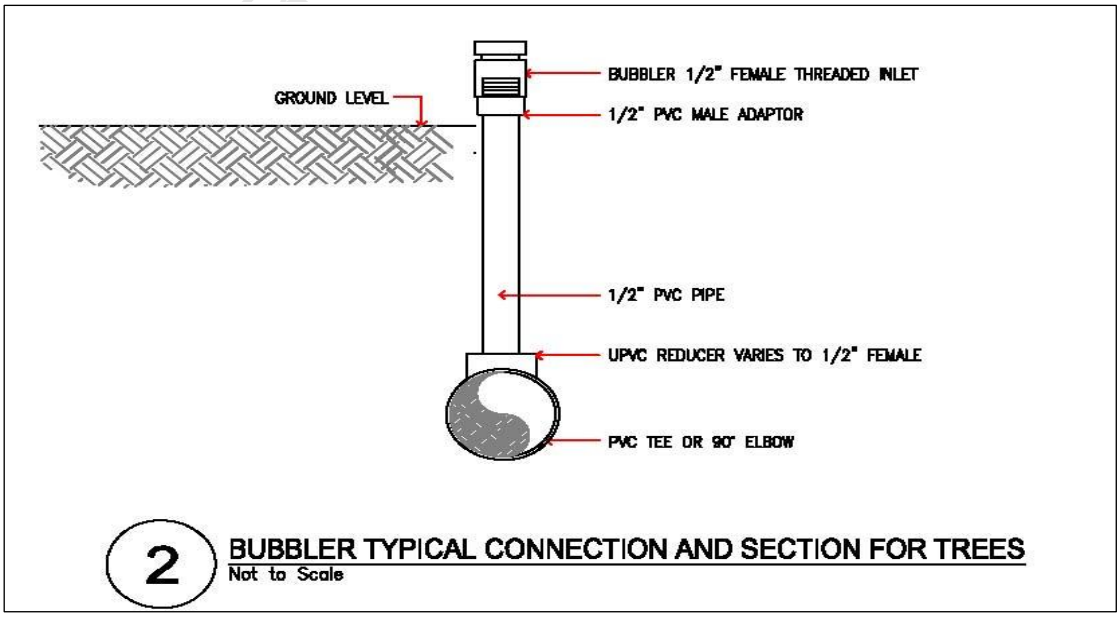
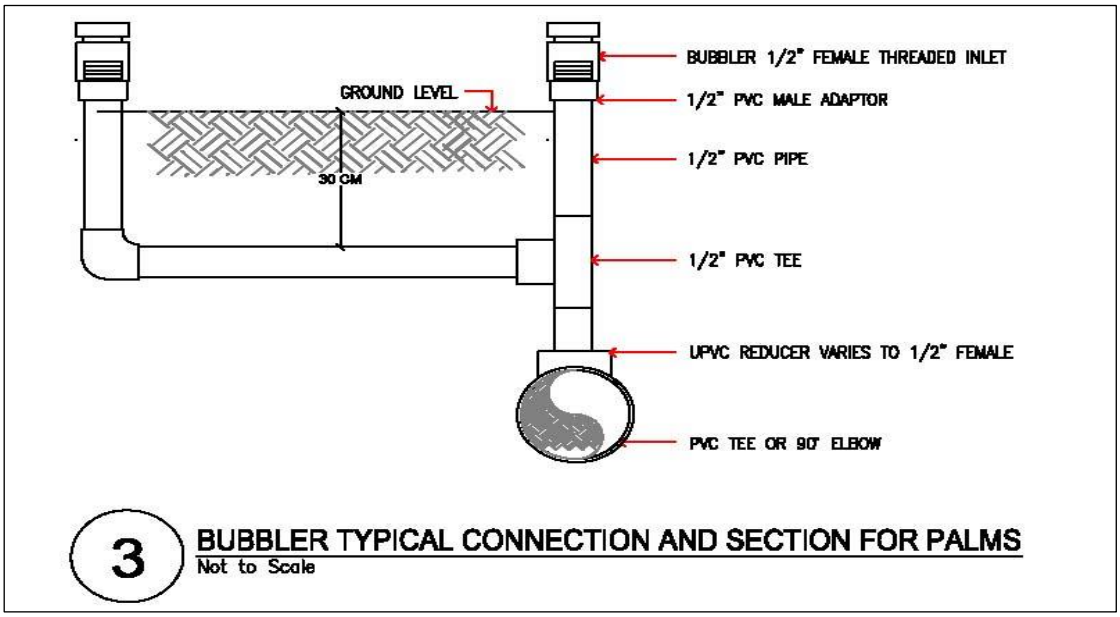
4 Bubbler Typical Connection and Section for Treessolenoid valve assembly connection and section



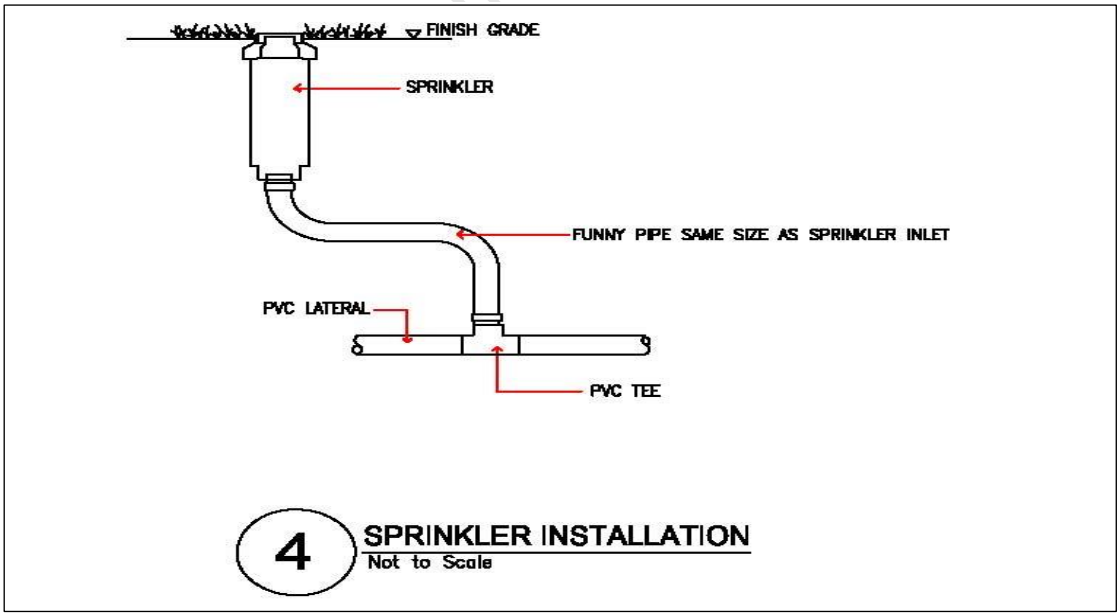
5 Bubbler Typical Connection and section for Palms



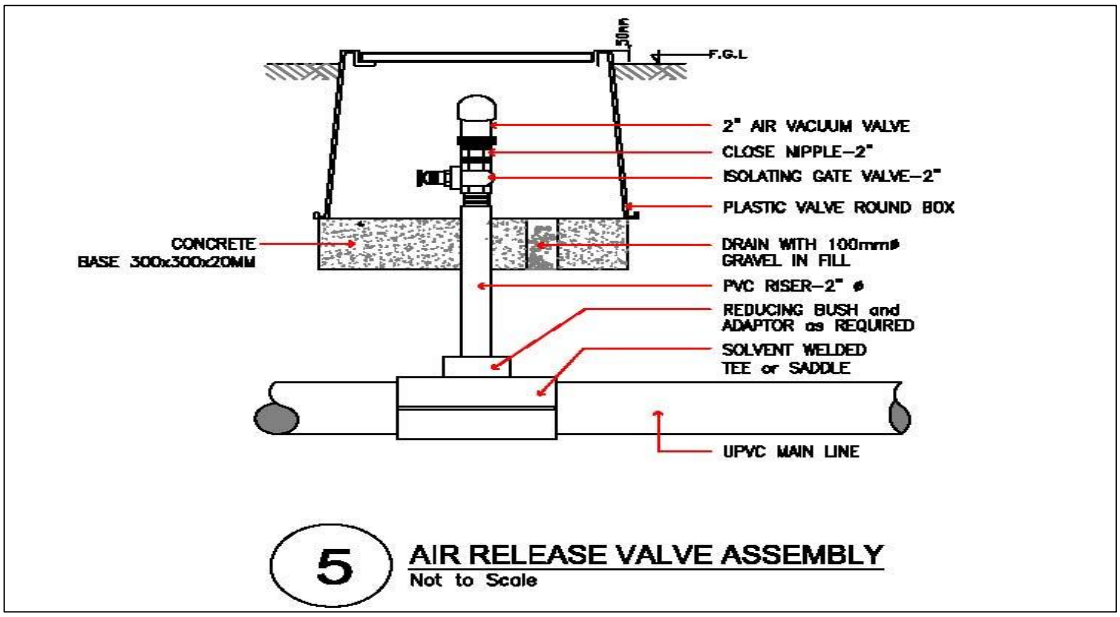
6 Sprinkler Installation



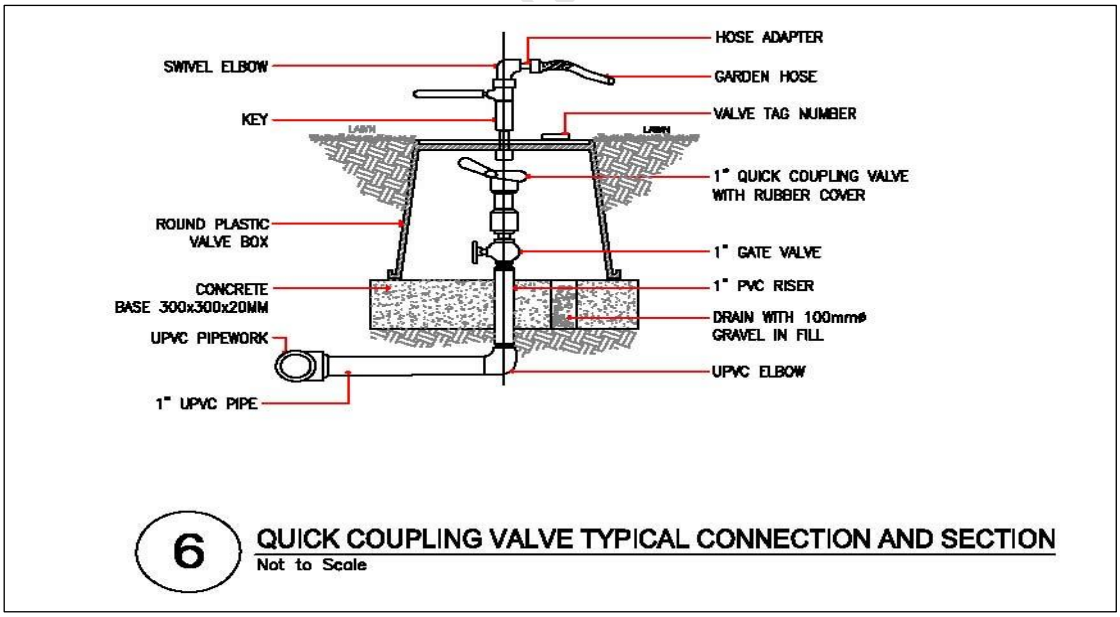
7 Sprinkler Installation



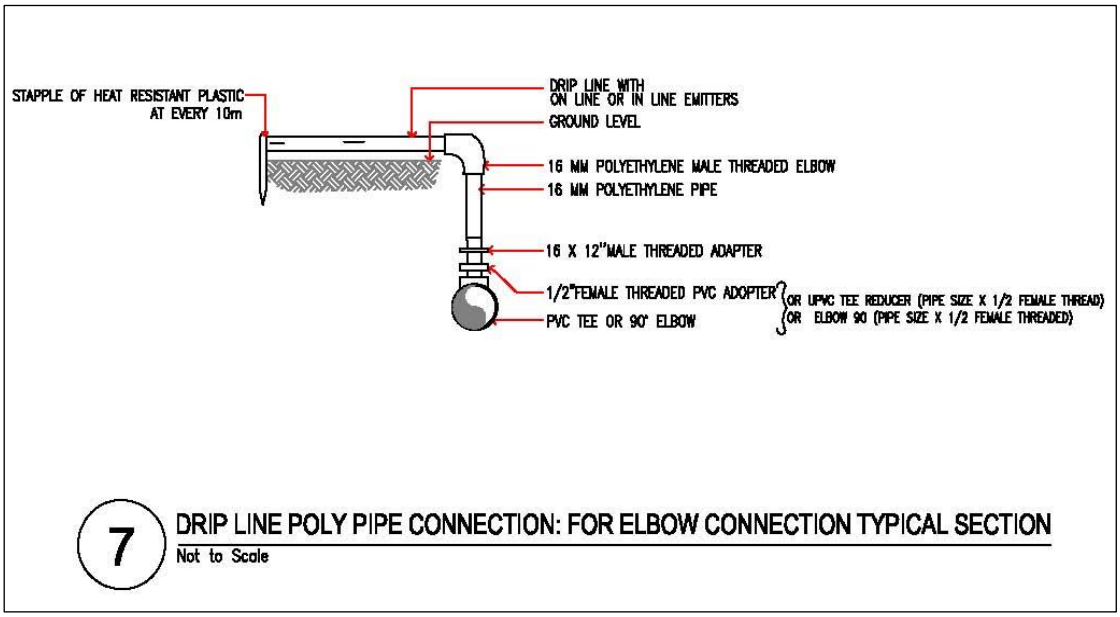
8 Air Release Valve Assembly



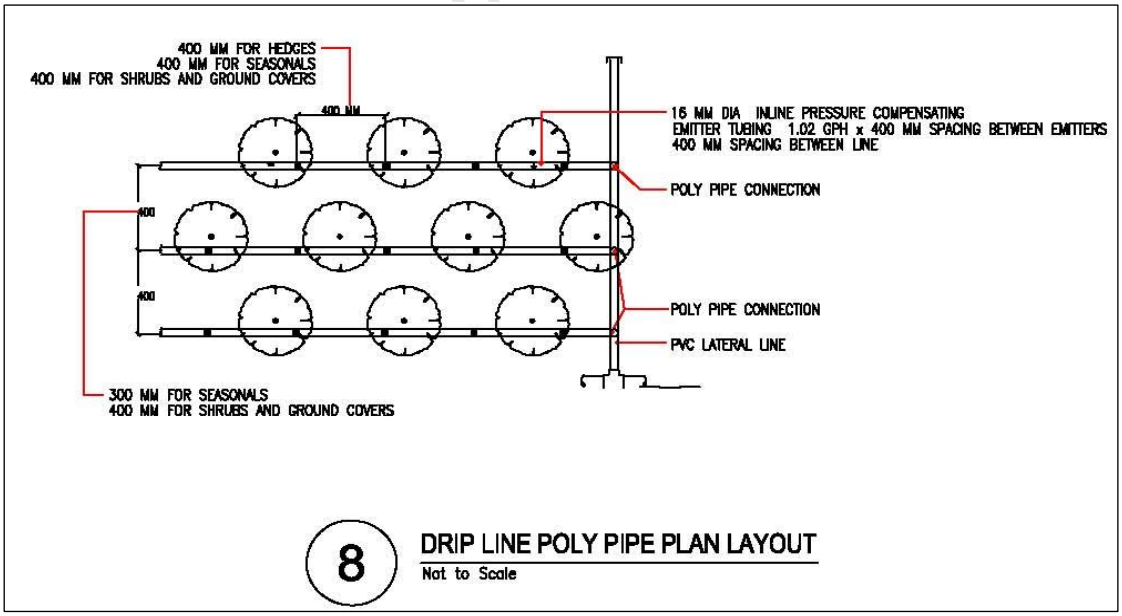
9 Quick Coupling Valve Typical Connection and Section



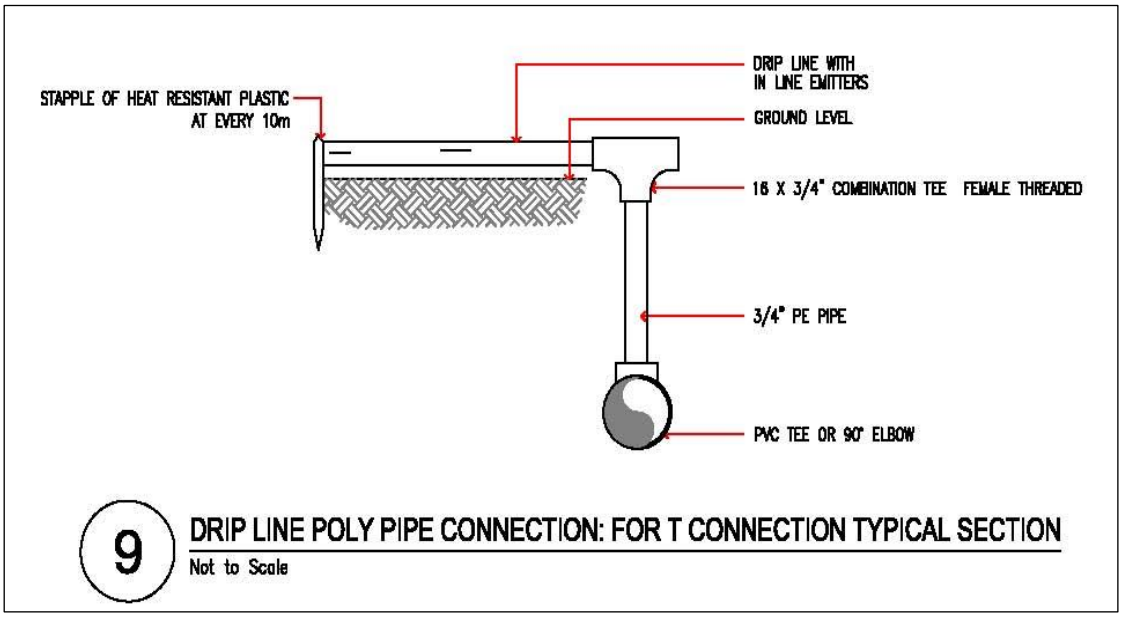
10 Drip Line Poly Pipe Connection: For Elbow Connection Typical Section



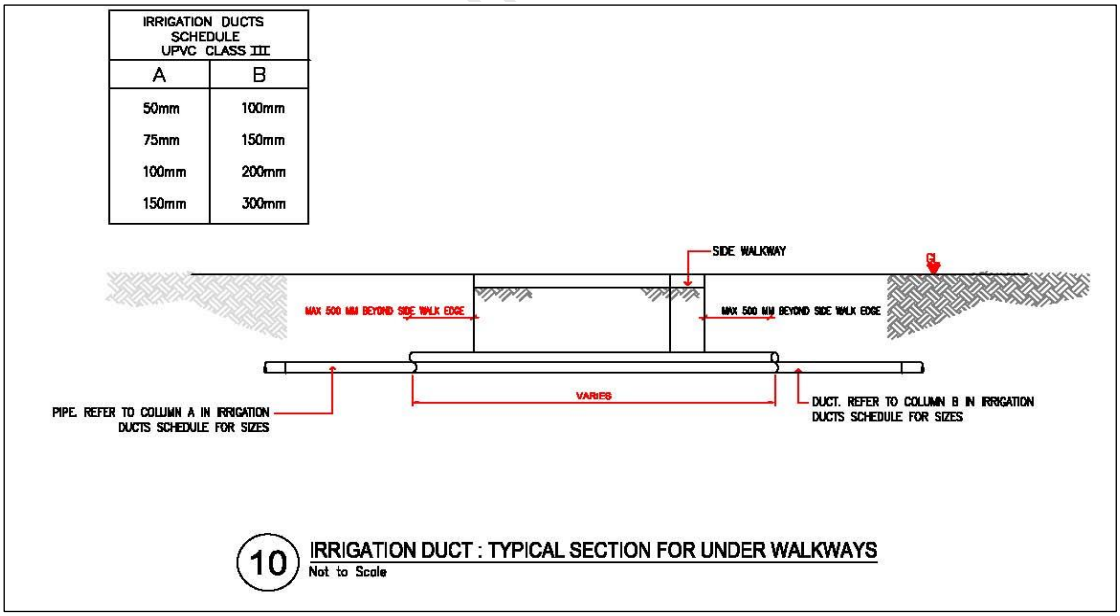
11 Drip Line Poly Pipe Plan Layout



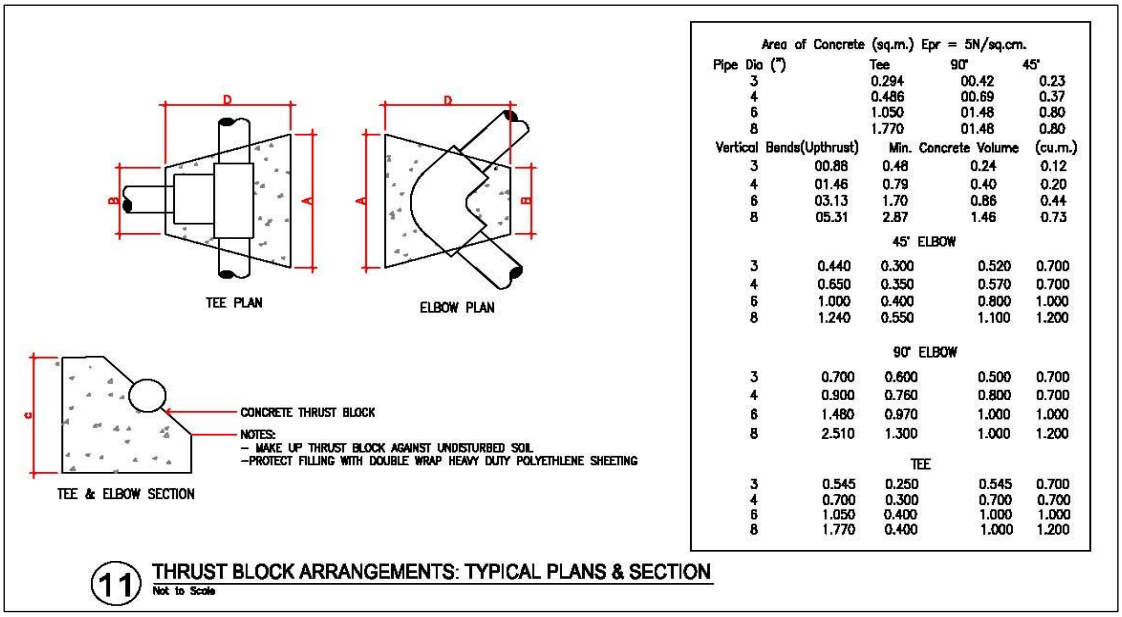
12 Drip Line Poly Pipe Connection: For T Connection Typical Section



13 Irrigation Duct: Typical Section for under Walkways



14 Thrust Block Arrangements: Typical Plans and Section



Area of Concrete (sq.m.) Epr = 5N/sq.cm.

Pipe Dia (")	Tee	90°	45°
3	0.294	00.42	0.23
4	0.486	00.69	0.37
6	1.050	01.48	0.80
8	1.770	01.48	0.80

Vertical Bends(Upthrust)		Min. Concrete Volume		(cu.m.)
3	00.88	0.48	0.24	0.12
4	01.46	0.79	0.40	0.20
6	03.13	1.70	0.86	0.44
8	05.31	2.87	1.46	0.73

45° ELBOW

3	0.440	0.300	0.520	0.700
4	0.650	0.350	0.570	0.700
6	1.000	0.400	0.800	1.000
8	1.240	0.550	1.100	1.200

90° ELBOW

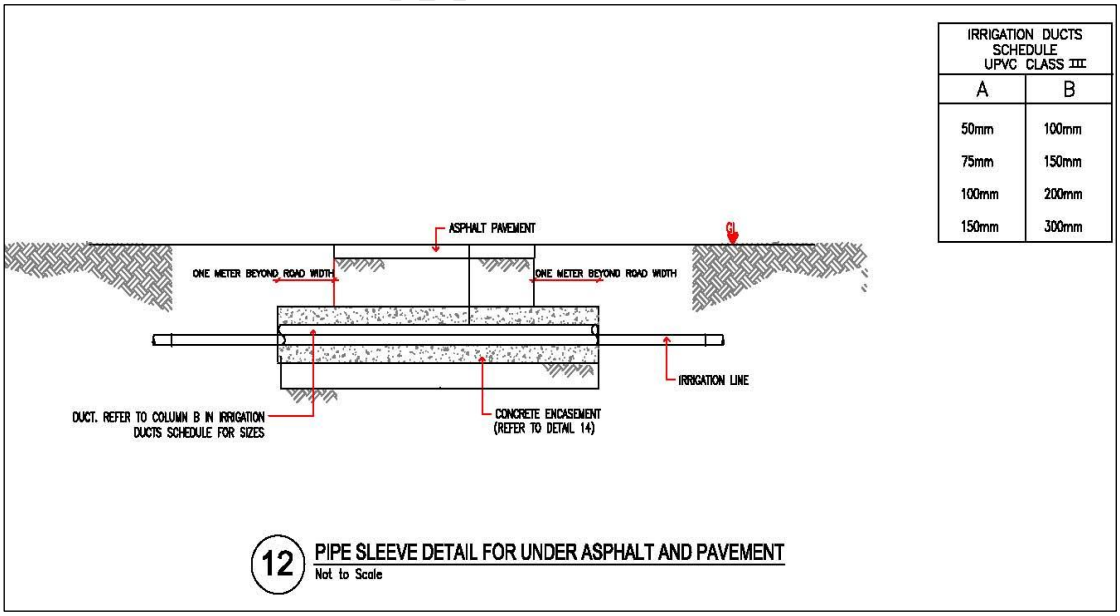
3	0.700	0.600	0.500	0.700
4	0.900	0.760	0.800	0.700
6	1.480	0.970	1.000	1.000
8	2.510	1.300	1.000	1.200

TEE

3	0.545	0.250	0.545	0.700
4	0.700	0.300	0.700	0.700
6	1.050	0.400	1.000	1.000
8	1.770	0.400	1.000	1.200

11 THRUST BLOCK ARRANGEMENTS: TYPICAL PLANS & SECTION
Not to Scale

15 Pipe Sleeve Detail for Under Asphalt and Pavement

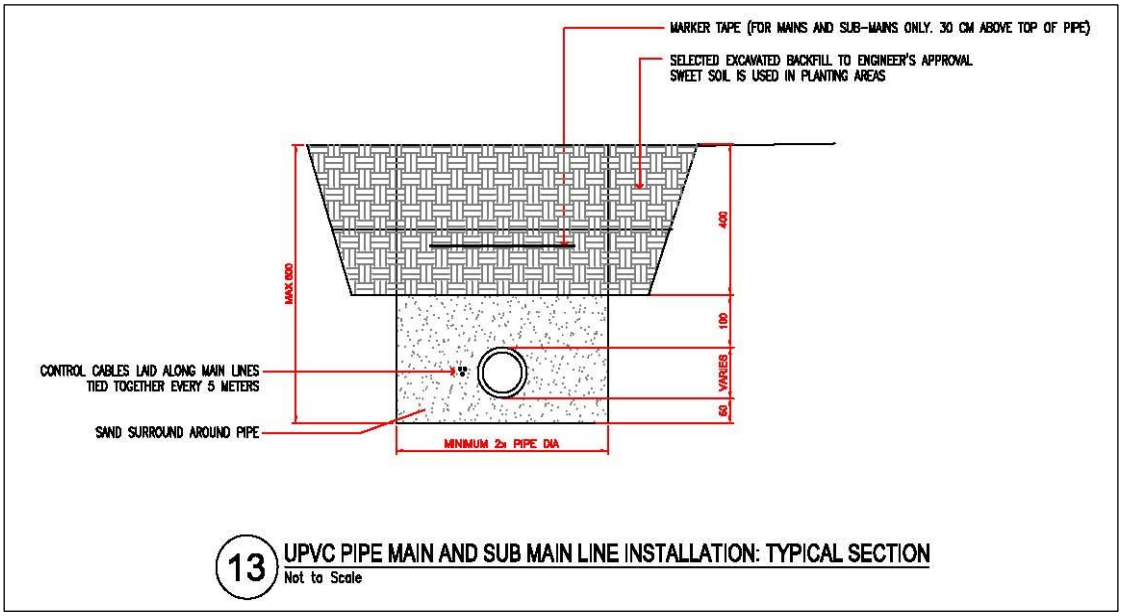


IRRIGATION DUCTS SCHEDULE
UPVC CLASS III

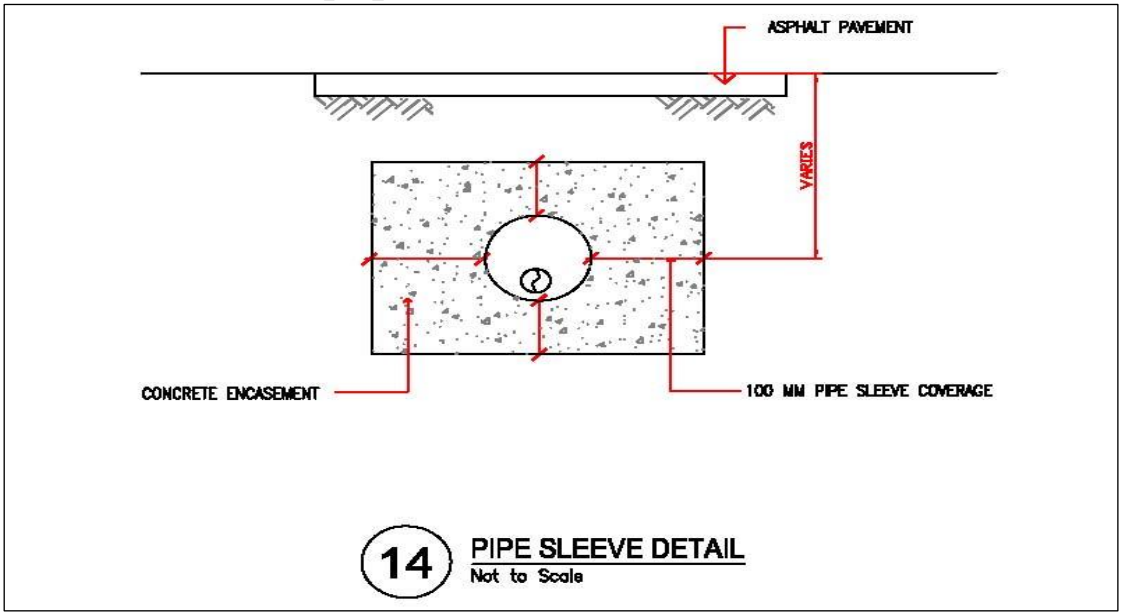
A	B
50mm	100mm
75mm	150mm
100mm	200mm
150mm	300mm

12 PIPE SLEEVE DETAIL FOR UNDER ASPHALT AND PAVEMENT
Not to Scale

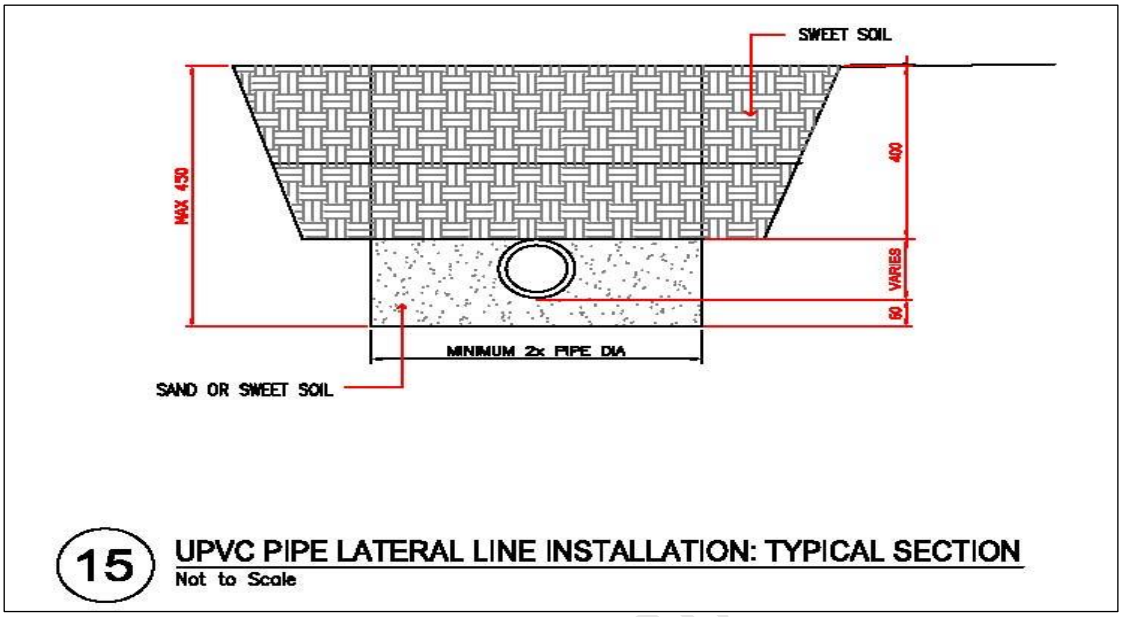
16 uPVC Pipe Main and sub Main Line Installation: Typical Section



17 Pipe Sleeve Detail



18 uPVC Pipe Lateral Line Installation: Typical Section



2.7 APPENDIX B – IRRIGATION DETAILS WITH PUMPS

Appendix B Contains The Details Listed Below:

1 Solenoid Valve Assembly Typical Connection And Section

2 Bubbler Typical Connection and Section

3 Quick Coupling Valve Typical Connection and Section

4 Sprinkler Installation

5 Disc Filter Assembly Chamber, Master Control Valve And Provision For Future Flow Meter

6 Air Release Valve Assembly

7 Disc Filter Plan View

8 Drip Line Ply Pipe Connection: For Elbow Connection Typical Section

9 Drip Line Poly Pipe Plan Layout

10 Drip Line Poly Pipe Connection: For T Connection Typical Section

11 Front Elevation

12 Side Elevation

13 Typical Pump Details

14 Irrigation Duct: Typical Section For Under Walkways

15 Thrust Block Arrangements: Typical Plans And Section

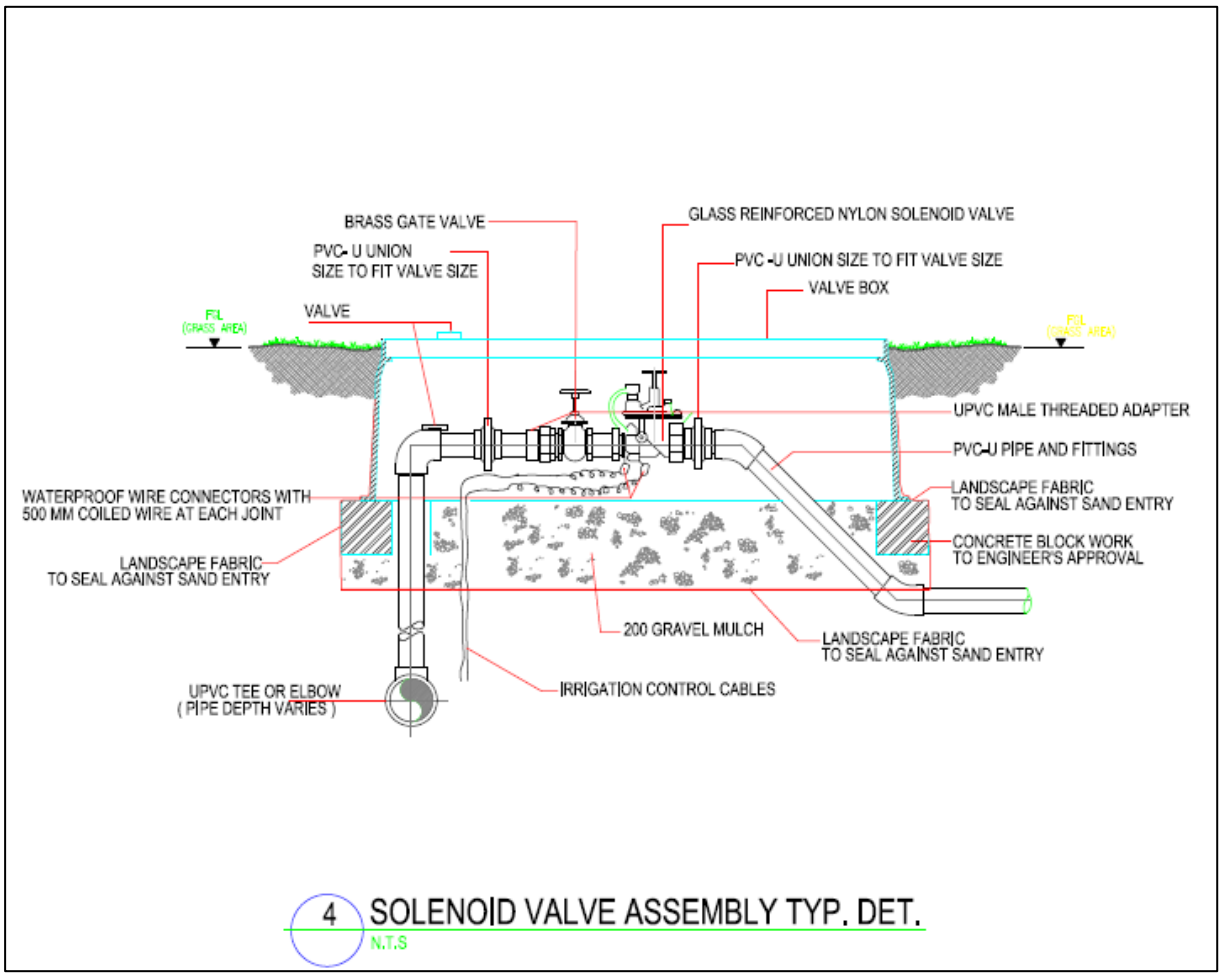
16 Pipe Sleeve Detail: For Under Asphalt And Pavement

17 Upvc Pipe Main and Sub Main Line Installation: Typical Section

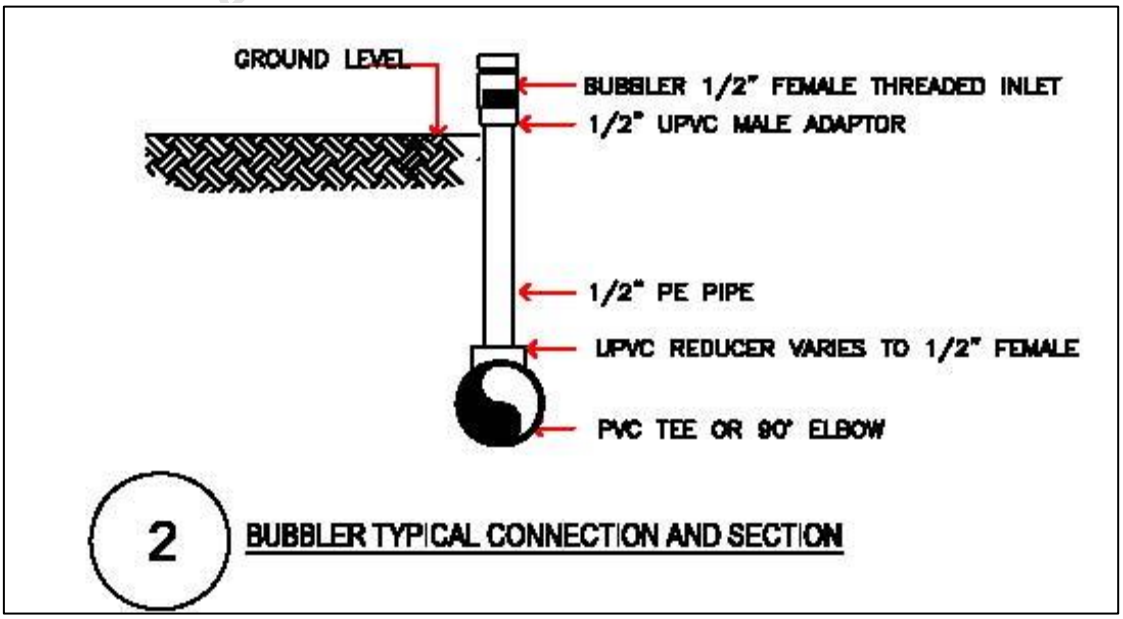
18 Pipe Sleeve Detail

19 Upvc Pipe Lateral Line Installation: Typical Section

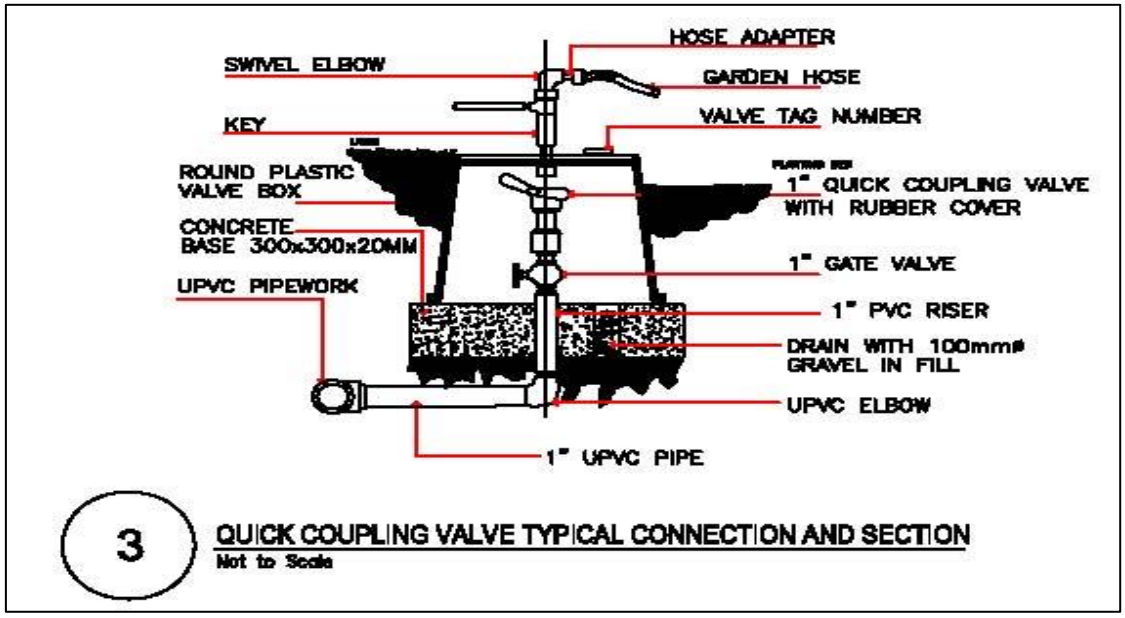
1 Solenoid Valve Assembly Typical Connection and Section



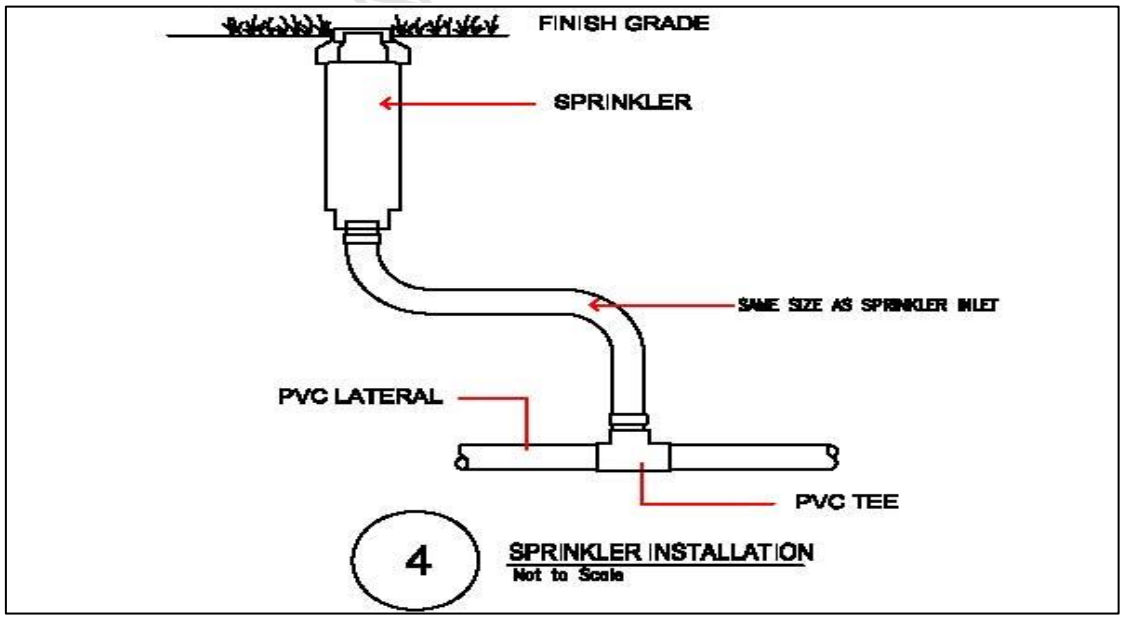
2 Bubbler Typical Connection and Section



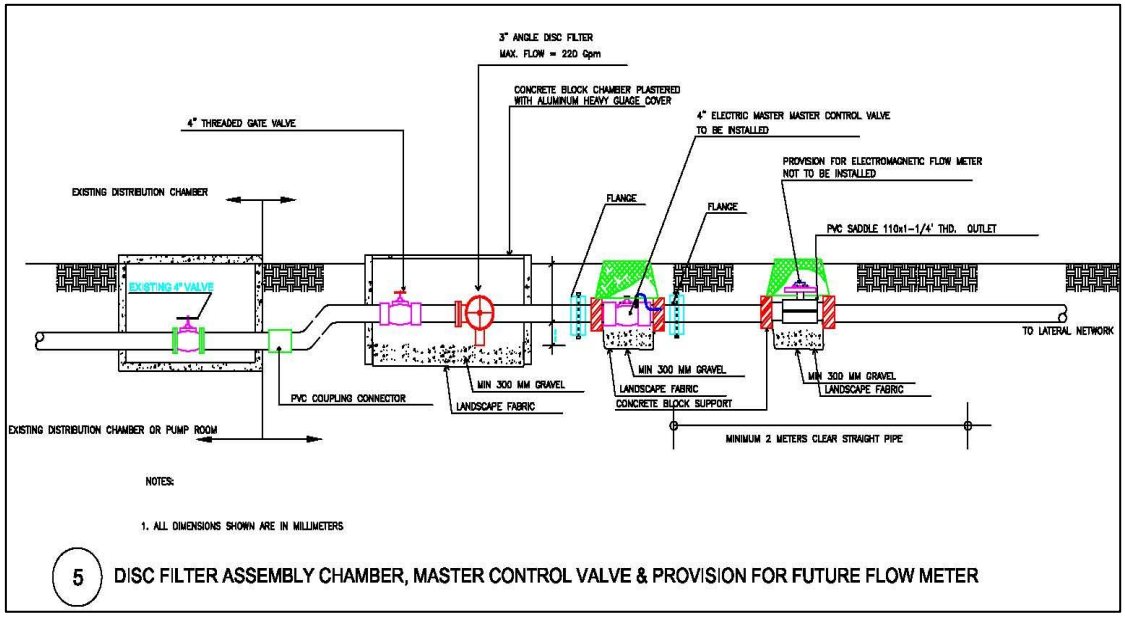
3 Quick Coupling Valve Typical Connection and Section



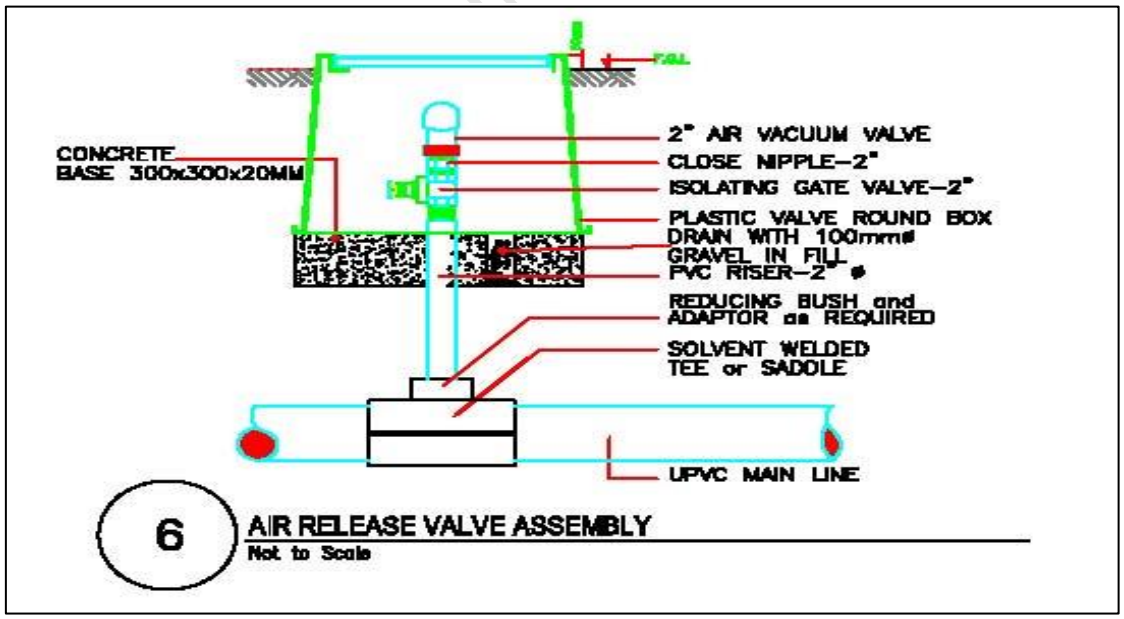
4 Sprinkler Installation



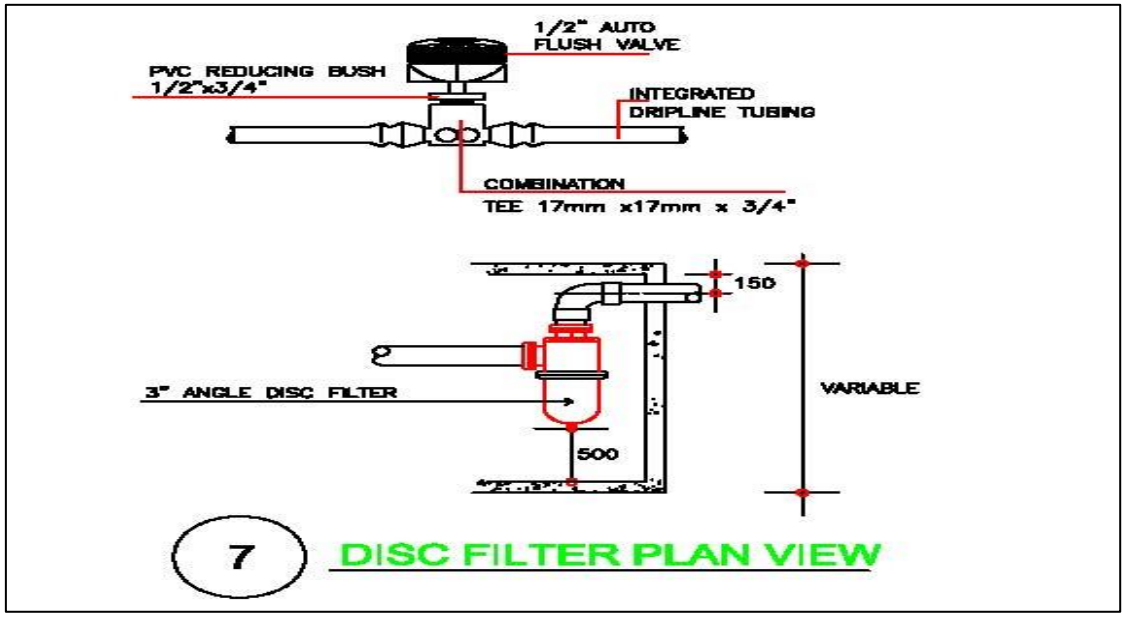
5 Disc Filter Assembly Chamber, Master Control Valve and Provision for Future Flow Meter



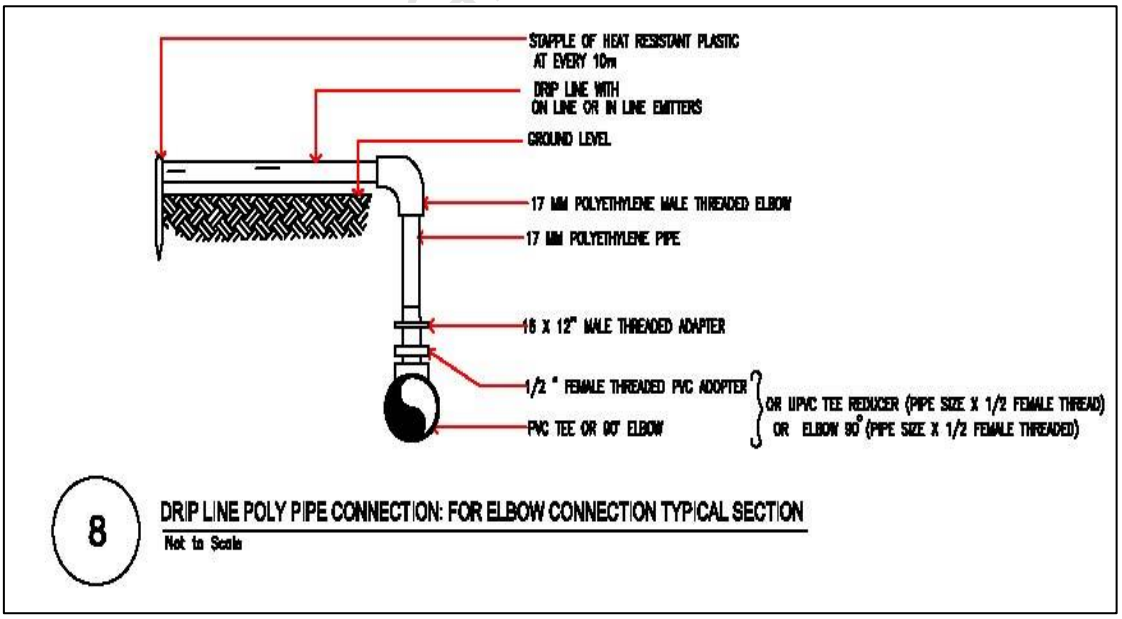
6 Air Release Valve Assembly



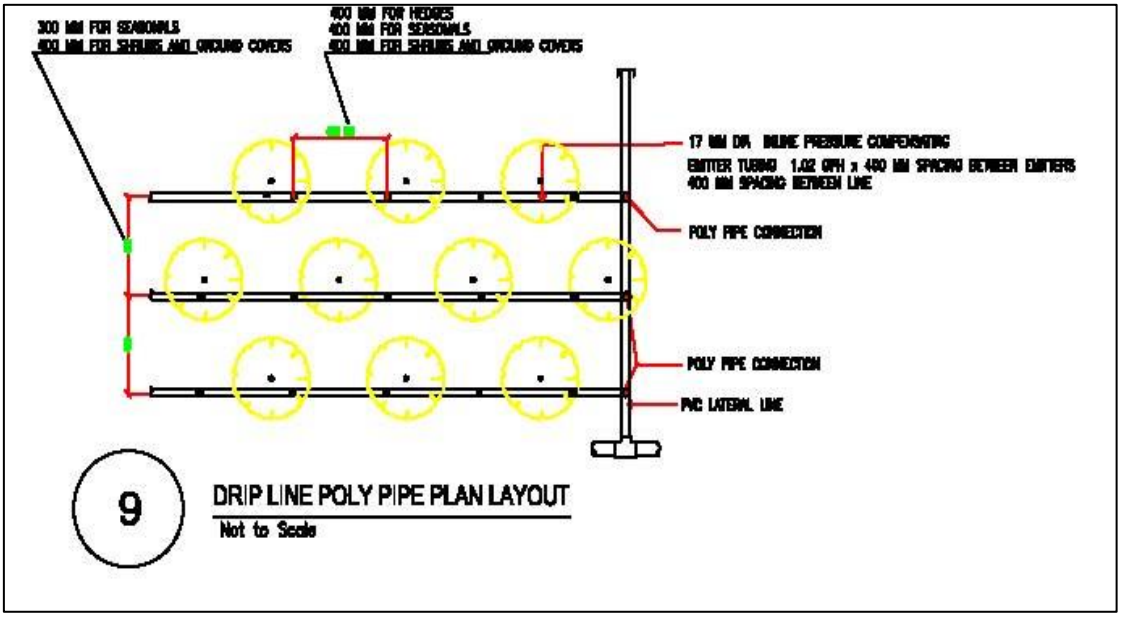
7 Disc Filter Plan View



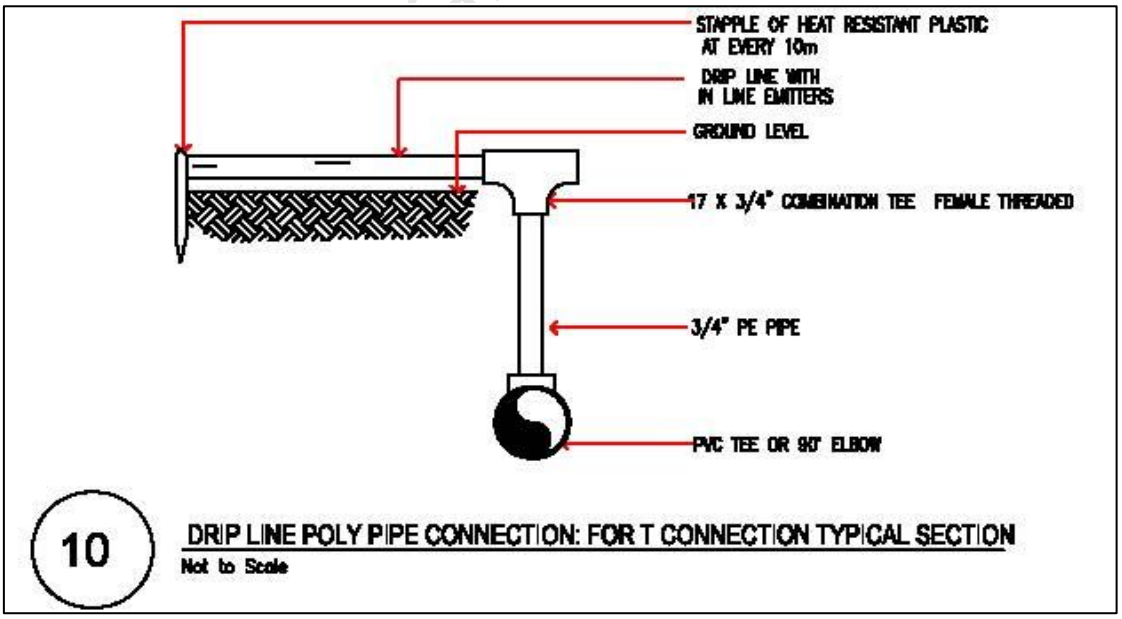
8 Drip Line Ply Pipe Connection: for Elbow Connection Typical Section



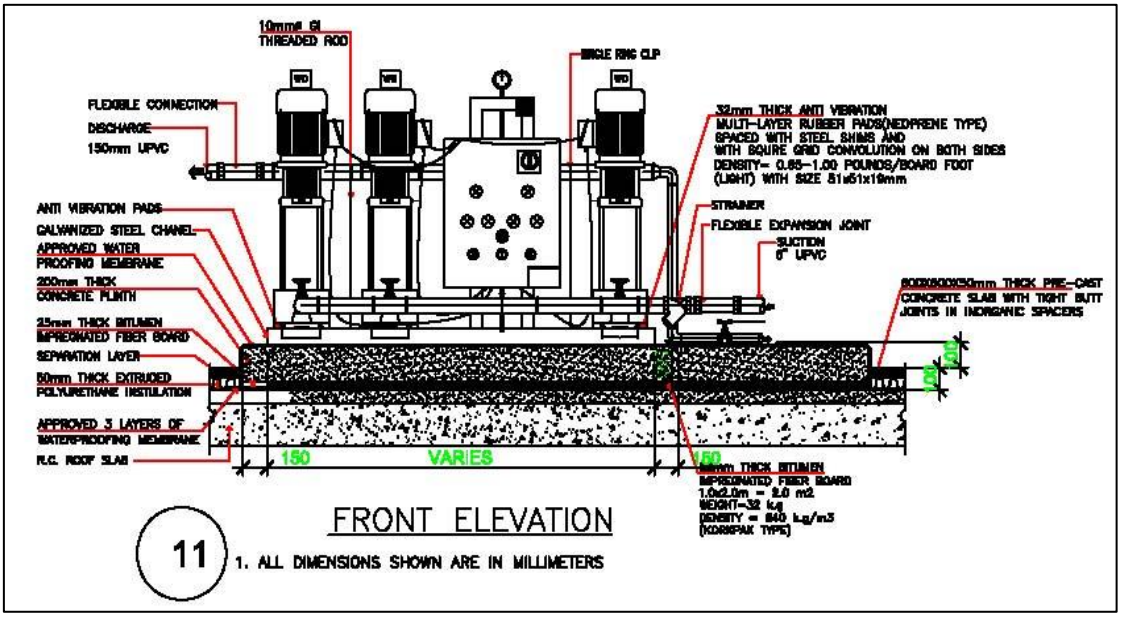
9 Drip Line Poly Pipe Plan Layout



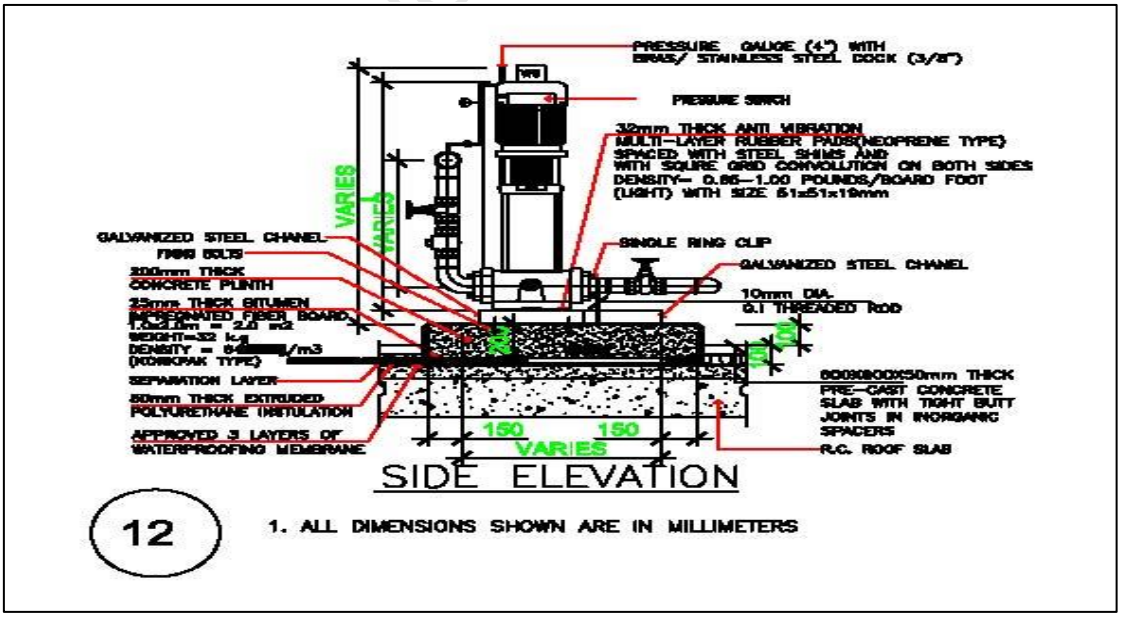
10 Drip Line Poly Pipe Connection: For T Connection Typical Section



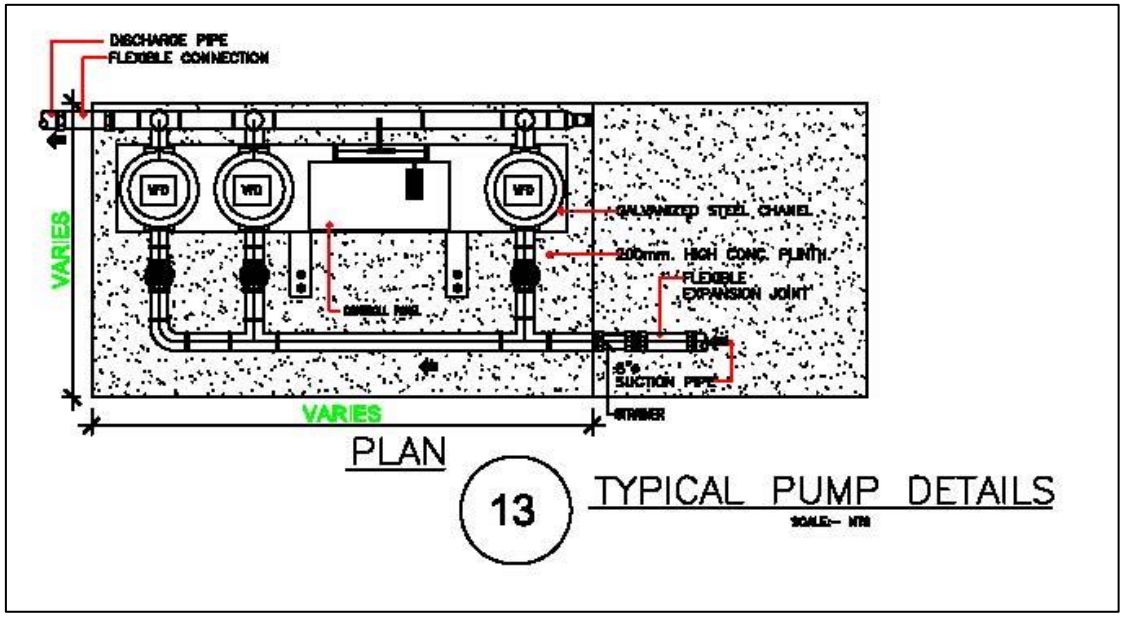
11 Front Elevation



12 Side Elevation



13 Typical Pump Details



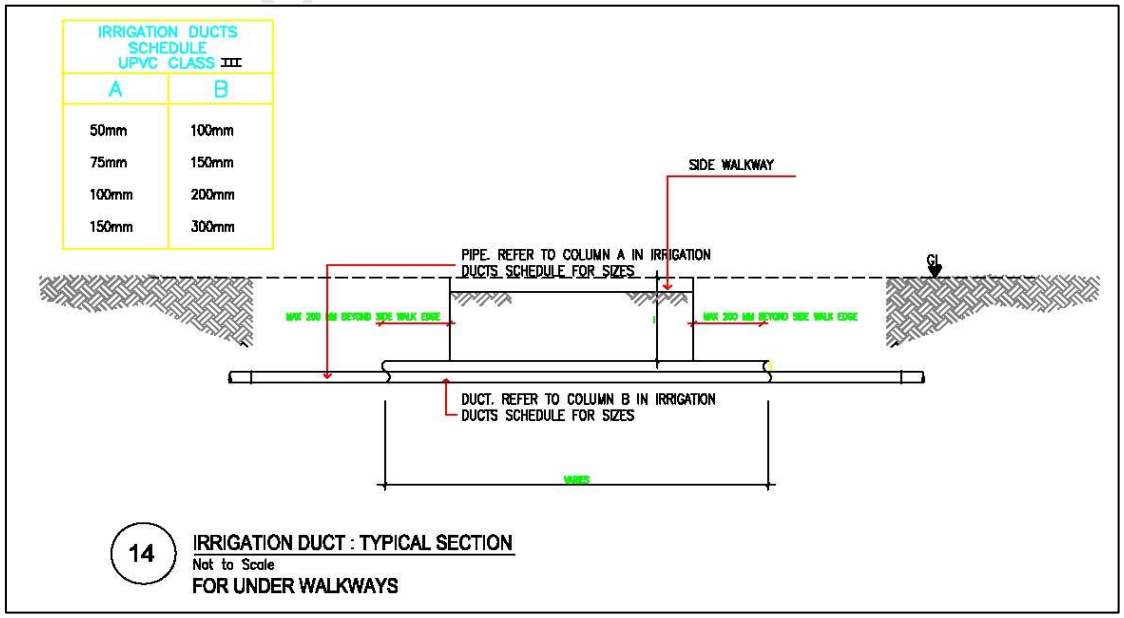
LEGEND

VFD VARIABLE FREQUENCY DRIVE

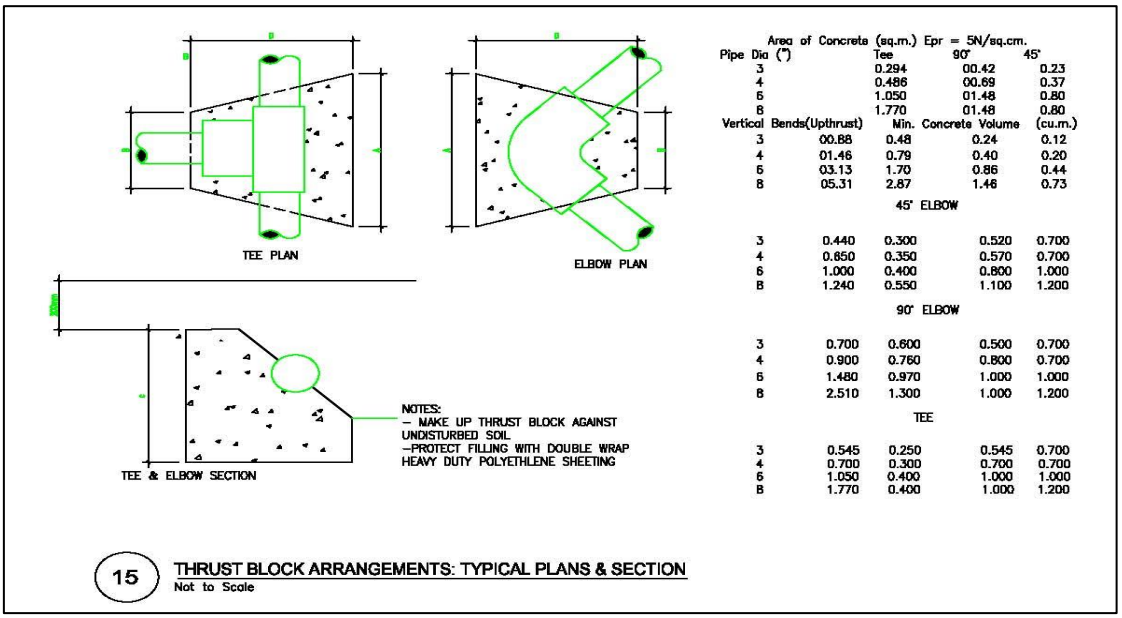
NOTES

* # OF PUMP #KW
* # QM/H
* # PUMP # DUTY # STANDBY
* 1 X AUTO CONTROL PANEL

14 Irrigation Duct: Typical Section for Under Walkways



15 Thrust Block Arrangements: Typical Plans and Section



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8	1.240	0.550	1.100	1.200

90° ELBOW

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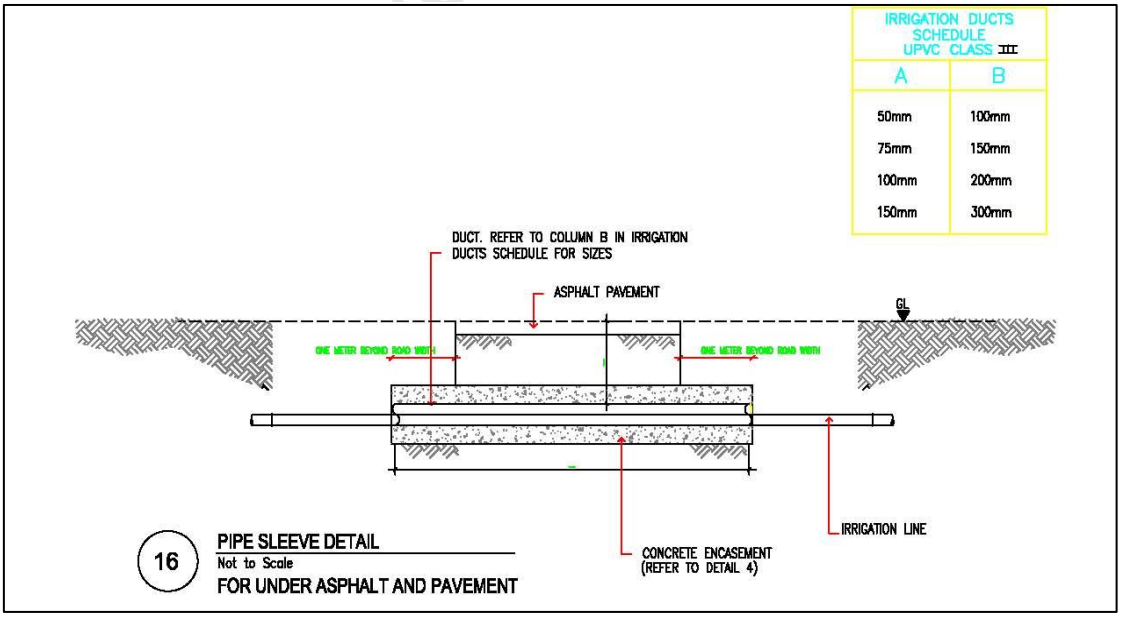
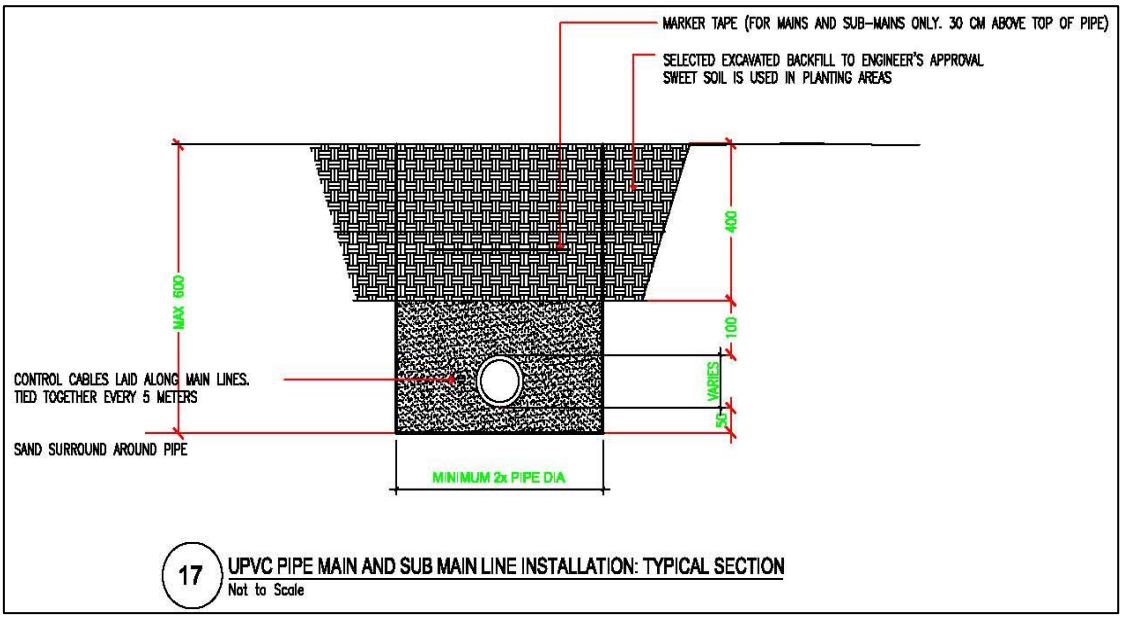
8	1.770	0.400	1.000	1.200

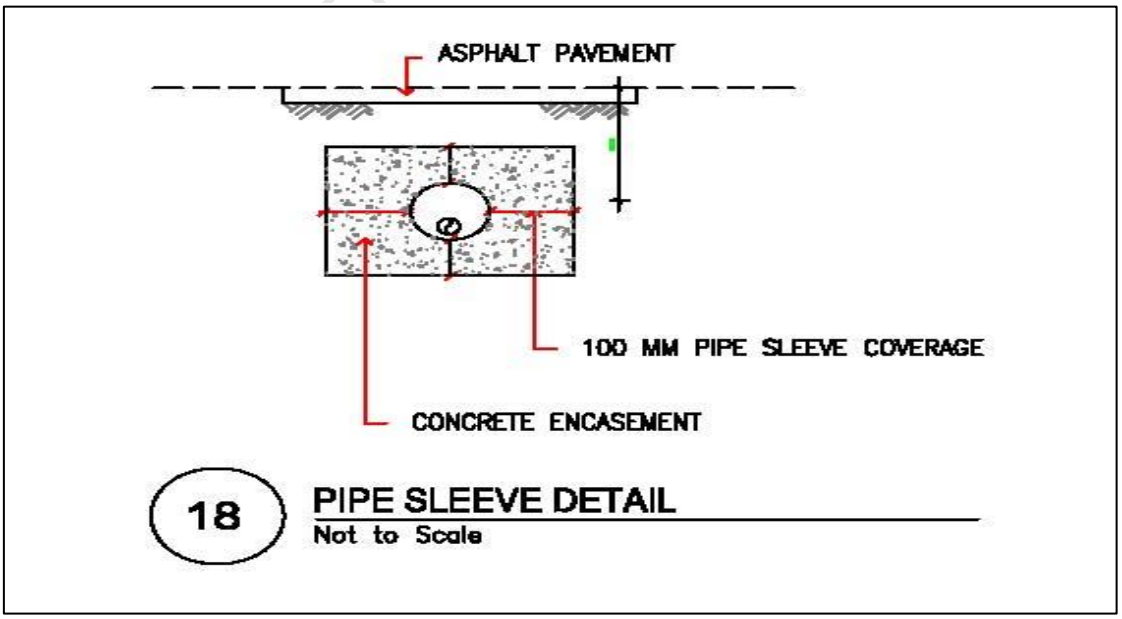
16 Pipe Sleeve detail: For Under Asphalt and Pavement



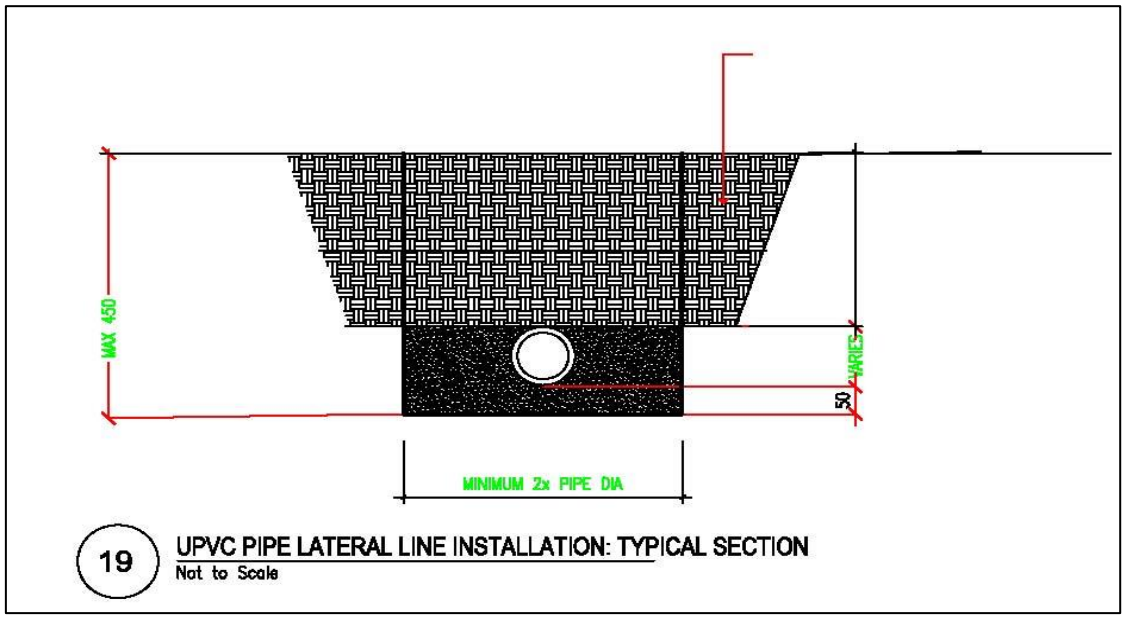
17 uPVC Pipe Main and Sub Main Line Installation: Typical Section



18 Pipe Sleeve Detail



19 uPVC Pipe Lateral Line Installation: Typical Section



END OF PART