Maharashtra Industrial Township Limited (MITL)
Design, Construction, Testing, Commissioning, Operation and Maintenance of Infrastructure Works at Dighi Port Industrial Area (DPIA) Phase 1 on EPC Basis – Package A
Request for Proposal cum Request for Qualification
Volume II: Technical Specifications
Part C - Wet Utilities

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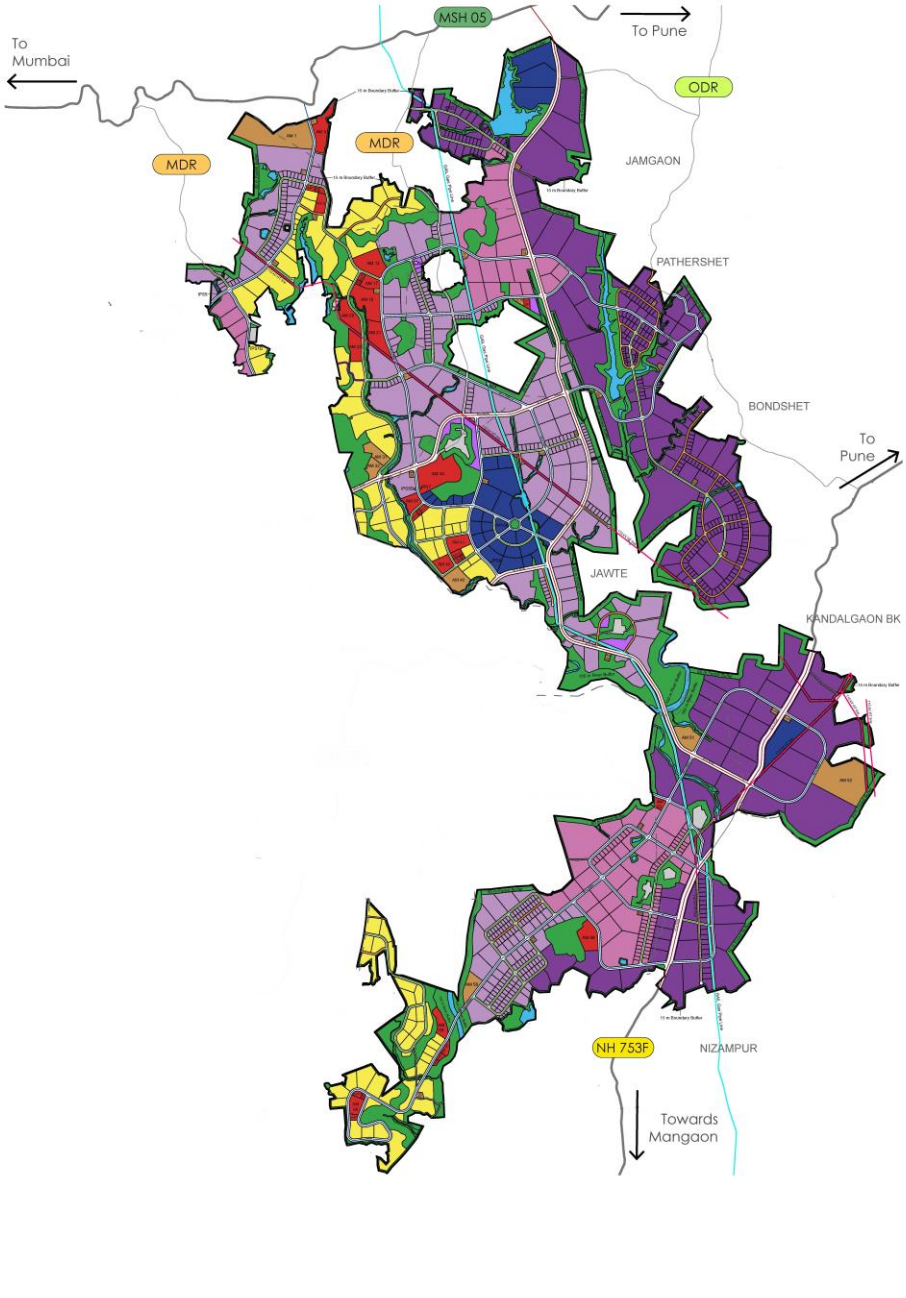

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Laws of the Republic of India are applicable to this tender.

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1 Water Transmission and Distribution Network including Firefighting System

1.1 Scope

The Potable water supply scheme for Phase I DPIA is based on surface water with the Kundalika River as the source. The overall potable water scheme includes Intake works, a Raw water system, a Water treatment plant, Storage/service reservoir(s), a distribution system and service connections.

MIDC will be responsible for tapping raw water through a jack well at the source, viz. Kundalika River and for pumping/ conveying water from the jack well up to the inlet chamber of the Water Treatment Plant for DPIA.

The subsequent works are divided into two parts.

a) Part I comprises of Water Treatment Plant, Clear Water Reservoir, and Clear Water Pump House.

b) Part II covers the Transmission line for Phase 1, Service reservoir, Transmission line for Phase 2 and Phase 3 up to the boundary of Phase 1, Distribution network and Service connections to all plots in Phase 1.

The scope under the present contract will include design, supply, installation, testing, commissioning, operation, and maintenance of both Part I and Part II works.

The storage/service reservoir shall be designed to take care of variations in water demand over 24 hours. The pumping into the storage/service reservoir should be at a constant flow rate, and withdrawal shall be as per fluctuating water demand. Minimum storage/service must be provided, considering balancing of inflows and outflows and water for firefighting as indicated in the table below. The Storage/service Reservoir shall have sufficient staging height to ensure a defined minimum terminal pressure of 17 to 21 m. The Storage/service Reservoir shall be aesthetically designed by a qualified architect along with MITL branding to the satisfaction of Employer's Engineer.

The contractor scope shall include surge analysis for the complete potable water distribution network and the contractor shall provide surge protection equipment wherever necessary as per the approved design.

The scope of work shall include but not be limited to the following:

a) Detailed design of the storage/service reservoir, distribution system and service connections

b) Architectural design and elevation of service reservoir including site layout with associated facilities, approach road, gate, security cabin etc,

c) Construction of service reservoirs for Potable Water and Recycle Water

d) Construction of compound wall along with Main Gate and Security cabin for the plot designated for Water Treatment Plant and the Service Reservoirs

e) Submission of design calculations, plans, 2D models and drawings

f) Preparation of L section and construction drawings

g) Construction of a Potable Water Network as per the approved design and plans

h) Supply and installation of Flow meters, Level sensors, Pressure sensors, and Valves as per the approved design.

i) Supply and installation of Smart water meters to consumers of all types.

j) Supply, Construction, Installation, Testing, Commissioning and O&M of the Potable Water Supply System. The contractor has to manage the water supply distribution network such that the distribution losses should not exceed 5%. The measurement shall be with reference to the flowmeter at the inlet of the Service Reservoir and the Inlet at the consumer meter.

The contractor shall design and construct the potable water supply system on a continuous running basis, along with the installation of valves, scour valves, air release valves, thrust blocks etc. as required. All valves shall be electrically actuated except scour and air release valves.

The Contractor shall furnish all required tools, plant, instruments, materials including water, electricity, labour, consumables, etc., any and everything necessary for the construction of the works, whether or not such items are specifically stated elsewhere in this document.

The system shall be designed as a closed-loop system for efficient operations and shall be designed taking the concept of a District Metering Area (DMA) with each DMA being isolated with valves and flow measured with a full-bore electromagnetic flow meter to each DMA.

In general, this work shall include designing, providing, laying, jointing and testing all pipes and specials/fittings, DI/MS (CM lined internally) pipe and specials/fittings, inlet connection, Valves, etc.

Sl	Description of Item	Minimum Requirement
1	A. Capacity of Potable Water Service Reservoir B. Clear Water Reservoir	6 ML As per the approved design
2	Potable Water Transmission Line for Phase 1, Phase 2 and Phase 3	DI K9
3	Potable Water Distribution Network	
a	HDPE Pipe sizes	110 mm to 250 mm
b	DI Pipe sizes	300 mm and above
c	Sluice Valves	Motorized actuator
d	Air Release Valves	Automatic
e	Scour Valve	Manual
4	Potable Water Management System (web-based and app-based)	Potable Water Management system to be integrated with its respective SCADA. The contractor shall be responsible for coordination related to the interfacing with the ICCC system (by others). Any control system under the contractor’s scope shall be fed with

SI	Description of Item	Minimum Requirement
		power from UPS, supplied by the contractor. A separate operation room of 50 sq.m to be provided.
5	District Metering Area (DMA)	Maximum Area of 200 acres.
6	Flow Meters (all types)	Battery-operated electromagnetic type/power operated with min 8 hours UPS backup having integration with Potable Water management system. Each flow meter shall have appropriate RTU-compatible GSM and OFC connectivity with respective SCADA (by contractor) for control and monitoring. However, Contractor has to ensure its interface with ICCC (by others) for monitoring only through their utility SCADA.
7	Service Water Connection	Minimum 32 mm
8	Service Water Meters	Battery-operated, Ultrasonic with 2 GSM SIMs/IoT enabled and compatible with the Potable Water Management System.
9	Firefighting Water Hydrants at every junction and designated locations.	Two-way brass hydrants with Battery-operated, Ultrasonic with 2 GSM SIMs and compatible with the Potable Water Management System.

1.2 Background

The Service Reservoir for Phase 1 of the DPIA (as shown in the figure below) is proposed to be located within the WTP premises. The transmission main will be laid from the clear water pump house up to the inlet valve chamber of the Service Reservoir under a separate contract. The distribution network shall start from the Service Reservoir.

Per Capita Water Supply

Water demand for Phase I- DPIA (PARCEL B) has been estimated based on the unit demand norms adopted from the CPHEEO manual on Water Supply & Treatment & National Building Code and considering the land use master plan and projected population. The unit demand for different land uses shall be referred to in Table 1-1 below.

Table 1-1: Unit Water Demand

S. No.	Category	Unit	Water Demand	Potable Water	Non-potable / Recycled Water
1.	Pharma industries	KL/ha/day	72.73	36.365	36.365

S. No.	Category	Unit	Water Demand	Potable Water	Non-potable / Recycled Water
2.	Engineering industries	KL/ha/day	25	10	15
3.	Food industries	KL/ha/day	70.3	35.15	35.15
4.	Residential	LPCD	135	90	45
5.	Commercial	LPCD	45	25	20
6.	Hotels - 2-star or 3-star	l/key/day	180	120	60
7.	Nursing home, child welfare, maternity centre (25-30 beds) and Polyclinic	l/bed/ day	340	230	110
8.	Multi-specialty Hospital & General Hospital	l/bed/ day	450	300	150
9.	Primary/ Secondary School and School for Physically Challenged	LPCD	45	25	20
10.	Community rooms, recreational clubs, religious facilities	LPCD	45	25	20
11.	Fire Station	LPCD	45	25	20
12.	Malls (Visitor)	LPCD	15	5	10
13.	Open Space/Green area	l/m²/day	3.5	-	3.5
14.	Roadside Plantation	l/m²/day	3.5	-	3.5

Figures exclude "Unaccounted for Water (UFW)" which should be limited to 15%.

1.2.1 Firefighting requirements

As per IS 9668, water for firefighting shall be provided at the scale of 1800 lpm for every 50,000 population or part thereof for towns up to 3 lacs population and an additional 1800 lpm for every 1 lac population of more than 3 lacs. The fire scenario will be accordingly modelled and evaluated, adding potable water demands. IS 9668 stipulates that the provision of 2 hrs for firefighting should be made.

The fire hydrants will be proposed on a potable water network with two-way type fire hydrants. The hydrants will be spaced as per IS 13039.

For providing the fire-fighting storage, higher of provision as recommended by CPHEEO and IS 9668 should be adopted. Fire demand shall be considered in the potable water distribution network design.

The provision of water required for firefighting shall be considered in the design of the potable water Service Reservoir. The minimum pressure of 17m to 21 m should be maintained within the potable water network on which the fire hydrants are proposed.

As per IS 908 (Specification for Fire Hydrant, Stand Post Type) The hydrant shall consist of two sluice valves with road surface boxes, a bend, a flange riser and a stand post column fitted with 63-mm male coupling(s).

The entire area (industrial, residential, and commercial) shall be developed in accordance with the National Building Code (NBC)/ International fire norms. The industries shall be required to implement fire protection systems as per the relevant hazard category.

1.2.2 Water Demand

Based on the above parameters, the tentative water demands for different land uses are as described hereunder. The breakup of total water demand is provided in the table below:

Table 1-2:Net Water demand for Phase-1 (DPIA)

Land use	Potable water demand (MLD)	Non-potable /Recycled water demand (MLD)
Pharma industries	3.86	3.86
Engineering industries	2.74	4.11
Food industries	2.82	2.82
Residential Area	6.56	3.28
Commercial / Institutional / Amenities	1.87	1.49
Roadside green	-	1.31
Open space / Green area	-	5.62
Sub Total	17.84	22.49

Figures exclude "Unaccounted for Water (UFW)" which should be limited to 15%.

1.2.3 Peak Factors

As far as the design of the distribution system is concerned, it is the hourly variation in consumption that matters. The fluctuations in consumption are accounted for, by considering the peak rate of consumption as the rate of flow in the design of the distribution system.

The following peak factors shall be adopted as recommended in the CPHEEO manual for Water Supply and Treatment.

Table 1-3: Peak Factors for Contributory Population for Water Supply

Contributory Population	Peak Factor
For a population less than 50,000	3
For a population range of 50,000 to 2, 00,000	2.5
For a population above 2, 00,000	2

The peak factor shall depend upon the contributory population on respective lines of different zones as shall be proposed during designing of distribution network.

1.3 Design Period for Various Components

Water supply projects are designed to meet the future requirements of a stipulated design period. This period, with regard to certain components of the project, depends on their useful life or the facility for carrying out extensions whenever required, so that expenditure far ahead of its utilization is avoided and capital expenditure incurred on the project does not remain idle due to underutilization of these facilities. For designing such systems, a 30-year project period is recommended. The design period normally considered for various components is as under:

a) Civil Structures: 30 years

b) Pumping Mains: 30 years

c) Mechanical and Electrical Components: 15 years

d) Distribution System: 30 years

1.4 Service Reservoir

The scope for this item includes the design, construction, testing & commissioning of the Service Reservoir. The scope also includes providing level indicators, valves, level sensors, and actuators with provision for future SCADA integration. All the electro-mechanical installations and physical infrastructure of the distribution network shall be PLC/SCADA compatible. The scope of services also includes the supply of water for hydraulic testing and carrying out hydraulic tests for the transmission main and Service Reservoir. The supply pipe from each Service Reservoir shall be fitted with an Electromagnetic flow meter for flow measurement.

1.5 Transmission Network

The transmission mains shall be designed on a continuous pressurized water supply. The work of the potable water transmission main from the clear water pump house up to the inlet valve chamber (including its construction) of the Service Reservoir will be executed by another contractor. The transmission main from the inlet valve chamber up to the terminal point into the Service Reservoir is included in the scope of this contract.

1.6 Surge Analysis

Surge analysis for the distribution system, along with the design and provision of the required surge protection devices, shall be the responsibility of the Contractor. The surge control systems shall be designed so as to ensure that:

a) The maximum residual surge shall be restricted to 10% of the maximum surge which would have developed without the surge control devices at any point in the pipeline or 10% of the design pump head, whichever is more; and

b) The vacuum pressure developed in the pipeline at any place shall be restricted to -3 m (minus 3 meters).

c) The surge protection system provides adequate protection against damage to the valves, pipe delivery systems and pumps.

1.7 River/Stream/Channel crossings

Suitable pipe bridges shall be provided at the locations where the proposed potable water supply main will cross river/ stream/nallah. The bottom level of the pipe shall be kept above the maximum water level in the water course. Final Locations of crossing shall be verified on site and design to be done by the contractor.

At a river where there is a road crossing (bridge/ viaducts) for vehicles or passengers, the span supports for the pipeline shall match with the supports of the bridge/ viaduct.

For other culvert, stream and nallah crossings, the pipe bridges shall be designed with a maximum span of 5m. The pipe supports of the pipe bridge shall be designed and constructed in accordance with approved standards. The contractor shall design and obtain approval on the final detailed arrangements from the Engineer-in-Charge before work.

In case the pipeline is passing through the bed level of the stream/nallah, the pipe shall be completely encased in the concrete of minimum M15 grade. Before placing concrete, the pipes shall be supported near each joint with a padding of compressive material on a pre-cast concrete block. Concrete shall not be placed until the pipes have been joined, inspected, and passed hydraulic testing.

The concrete shall be placed to ensure full contact with the pipe barrel throughout its length. Necessary reinforcement steel shall be provided as per the approved design and site conditions. The concrete shall be made discontinuous at flexible pipe joints by a diaphragm of fibre board or other compressible material of at least 20 mm thickness extending for the full area of the surround. The concrete encasement shall cover the pipeline on all sides by a minimum of 100 mm on each side.

1.8 Distribution Network

The distribution network shall be designed on a continuous pressurized water supply. Hazen William's formula will be used for the calculation of velocities and head losses. The water distribution network shall be mostly a closed network system so that uniform pressure is maintained at ferrule connections for each consumer. The Hazen-Williams formula is expressed as under:

$S = hf / L = 10.67 [(Q / C)^{1.85}] [1 / (d^{4.87})]$

Were,

S: Hydraulic slope

hf: head loss in meters (water) over the length of the pipe

L: length of pipe in meters

Q: volumetric flow rate, m^3/s (cubic meters per second)

C: pipe roughness coefficient

d: inside pipe diameter, m (meters)

The following considerations shall be considered while designing the network:

Minimum velocity = 0.6 m/s

Maximum velocity = 3.0 m/s

1.9 SCADA/ Automation

The contractor has to coordinate with the Master ICT System Integrator to ensure an adequate interface between the SCADA system of the pumping station, WTP, Service Reservoir and actuated valves.

The contractor is to ensure the compatibility and seamless transmission of the data from the Potable Water Management System to the Integrated Command and Control System to be installed by the Master ICT System Integrator.

The butterfly valves for all pipelines shall have electrically operated actuators with appropriate RTU-compatible GSM and OFC connectivity with respective SCADA (by contractor) for control and monitoring.

However, Contractor has to ensure its interface with ICCC (by others) through their utility SCADA for monitoring only.

The contractor shall be responsible for coordination related to the interfacing with the ICCC system (by others).

Any control system under the contractor’s scope shall be fed with power from UPS, to be supplied by the contractor.

1.10 Excavation Depth

All water supply pipes shall be laid below ground with a minimum clear cover of 1.2m above the crown of the pipes. No cover less than the above is acceptable.

The contractor also needs to check and design an anchoring arrangement to mitigate the uplift of pipes due to the water table in the project area.

1.11 Residual Pressure

The potable water supply distribution system shall be designed to achieve a minimum residual pressure of 17-21 m at the ferrule point of each service connection.

To meet the fire demand, a minimum residual pressure at the fire hydrant locations shall be considered as 17-21m.

1.12 Laying

The pipes shall be lowered into the trench by means of suitable pulley blocks, sheer legs chains ropes etc. In no case, the pipes shall be rolled and dropped into the trench. One end of each rope may be tied to a wooden or steel peg driven into the ground and the other end held by men which when slowly released will lower the pipe into the trench. After lowering, the pipes shall be arranged so that the spigot of one pipe is carefully centred into the socket of the next pipe, and pushed to the full distance that it can go. The pipeline shall be laid to the levels required. Specials shall also be laid in their proper position.

Where so directed, the pipes and specials may be laid on masonry or concrete pillars. The pipe laid on the level ground shall be laid with a socket facing the direction of the flow of water.

The pipes shall rest continuously on the bottom of the trench. The pipes shall not rest on lumps of earth or on the joints. Four-meter-long wooden templates may be used to check the level of the bed. Clearance of approximately 100 mm in depth and width equal to the length of the collar plus 30mm on both sides shall be provided at the joint which shall be refilled from sides after the joint is made.

In unstable soils, such as soft soils and dry lumpy soils it shall be checked whether the soils can support the pipelines and if required suitable special foundation shall be provided.

Some clayey soils (for example black cotton soil) are drastically affected by extremes of saturation and dryness. In changing from saturated to a dry condition, these soils are subjected to extraordinary shrinkage which is usually seen in the form of wide and deep cracks in the earth's surface and may result in damage to underground structures, including pipe materials. The clay forms a tight gripping bond with the pipe, subjecting it to excessive stresses as the clay shrinks. It is recommended that in such cases an envelope of a minimum of 100 mm of tamped sand shall be made around the pipeline to avoid any bonding.

In places where rock is encountered, a cushion of fine earth or sand shall be provided for a depth of 150 mm by excavating extra depth of the trench, if necessary, and the pipes laid over the cushion. Where the gradient of the bed slopes is more than 30 degrees it may be necessary to anchor a few pipes against sliding downwards.

1.13 Bedding

The class of bedding have been designed considering the required external loading conditions, geotechnical requirements such as subsoil and bearing capacity of soil encountered in the respective water line, type, class, and material of pipe used for the laying purposes as per the CPHEEO manual. Fine sand bedding 200mm thick shall be provided for HDPE Pipes.

Where DI pipes are to be bedded directly on the bottom of the trench, it is to be trimmed and levelled to permit even bedding of the pipeline and should be free from all extraneous matter which may damage the pipe or the pipe coating. Additional excavation is made at the joints of the pipes so that the water main is supported along its entire length. Where excavation is through rocks or boulders, the pipeline is bedded on concrete bedding or on at least 150 mm of fine-grained material, or other means are used to protect the pipe and its coating.

For MS pipes the bottom of the trench is properly trimmed to permit even bedding of the pipeline. For pipes larger than 1200 mm diameter in earth and murrum the curvature of the bottom of the trench matches the curvature of the pipe as far as possible, subtending an angle of about 120° at the centre of the pipe. Where rock or boulders are encountered, the trench is trimmed to a depth of at least 100 mm below the level at which the bottom of the barrel of the pipe is to be laid and filled to a like depth with lean cement concrete or with the non-compressible material like sand of adequate depth to give the curved seating.

1.14 Thrust blocks

Thrust blocks are required to transfer the resulting hydraulic thrust from the fitting of the pipe onto a larger load-bearing soil section.

Thrust blocks shall be installed wherever there is a change in the direction/size of the pipeline or the pressure line diagram, or when the pipeline ends at a dead end. If necessary, thrust blocks may be constructed at valves also.

Thrust blocks shall be constructed considering the pipe size, water pressure, type of fitting, gravity component when laid on slopes and the type of soil.

When a fitting is used to make a vertical bend, it shall be anchored to a concrete thrust block designed to have enough weight to resist the upward and outward thrust. Similarly at joints, deflected in a vertical plane, it shall be ensured that the weight of the pipe, the water in the pipe and the weight of the soil over the pipe provide resistance to upward movement. If it is not enough, ballast or concrete shall be placed around the pipe in sufficient weight to counteract the thrust.

When the line is under pressure there is an outward thrust at each coupling. Good soil, properly tamped is usually sufficient to hold pipe from side movement. However, if soft soil conditions are encountered, it may be necessary to provide side thrust blocks of other means of anchoring. In such cases, only the pipe on each side of the deflected coupling shall be anchored without restricting the coupling.

Pipes on slopes need to be anchored only when there is a possibility of the backfill around the pipe sloping down the hill and carrying the pipe with it. Generally, for slopes up to 30 degrees good well-drained soil carefully tamped in layers of 100 mm under and over the pipe, right up to the top of the trench will not require anchoring.

1.15 Joints

A Joint is a connection between the ends of pipes in which a gasket is used to affect a seal.

Ductile Iron pipes comprise of the following joints:

a) Socket and Spigot Push-on Joint

b) Flanged Joint

c) Flexible Joints and Interconnection and

d) Restrained Joints

Push-on flexible joints shall be provided for pipe-to-pipe connection as per IS 8329. Wherever, flange joints are required e.g., at terminal points, valves, over-ground, and underground pipe connections etc., welded-on flanges shall be used.

Double-chambered restrained joints need to be designed in accordance with ISO 10804:2018. The permissible angular deflection will be as declared by the manufacturer. The Performance Type Test of this Joint in line with ISO 10804/EN545 has to be established by the manufacturer by getting it witnessed by a NABCB (National Accreditation Board for Certification Bodies), or IAF (International Accreditation Forum) or EA (European Cooperation for Accreditation) accredited institution/certification agency.

1.16 Valves and Fittings

For the operation and maintenance of the transmission and distribution system, minimum numbers of valves are necessary. The transmission and distribution mains shall be provided with the following appurtenances and specials as per the following criteria.

1.16.1 Sluice Valve

Resilient seated sluice valves of standard make as per IS 14846 shall be proposed at different locations as per requirements to isolate a portion for maintenance.

1.16.2 Non-Return Valve

Non-return valves of standard make as per IS 5312 shall be proposed at different locations as per requirements to prevent any backflow.

1.16.3 Pressure Reducing Valve

Pressure-reducing valves with pressure-sustaining overrides have been provided to reduce the pressure difference between the locations of the same zones. It will also prevent the reduction of pressure beyond a minimum defined value.

1.16.4 Auto Release Valve

Automatic release valves with EPDM of standard make shall be proposed at suitable locations in the rising mains and distribution network to protect the line from both upsurges and down surges. The valve diameter shall be as per design requirements and guidelines.

1.16.5 Scour Valve

Scour valves of standard make have been proposed to be installed in the rising mains and distribution system at lower points in the line to drain silt and water from the line whenever required.

All the valves shall be enclosed in valve chambers with cover.

All HDPE fittings/ specials shall be of minimum PN 10 or above Pressure class, fabricated in accordance with IS: 8360 (Part I & III). PE Injection moulded fittings shall be as per IS: 8008 (Part I to IX). All fittings/ specials shall be fabricated or moulded at the factory only. No fabrication or moulding will be allowed at the site unless specifically permitted by the Engineer-in-Charge. Fittings will be welded onto the pipes or other fittings by use of Electrofusion process.

1.17 Bends

HDPE bends shall be plain square ended conforming to IS: 8360 Part I & III Specifications. Bends shall be moulded.

1.18 Tees

HDPE Tees shall be plain square ended conforming to IS: 8360 Part I & II Specifications. Tees may be equal tees or reduced take-off tees. Tees shall be moulded.

1.19 Reducers

HDPE Reducers shall be plain square ended conforming to IS: 8008 Part I & VII Specifications. The reducer must be moulded.

1.20 Flanged HDPE Pipe Ends

HDPE Stub ends shall be square-ended conforming to IS: 8008 Part I & VI Specifications. Stub ends will be welded on the pipe. The flange will be of slip-on flange type as described below.

1.21 Slip-On Flanges

Slip-on flanges shall be metallic flanges covered by epoxy coating or plastic powder coating. Slip-on-flanges shall be conforming to standard mating relevant flange of valves, pipes etc. The nominal pressure rating of flanges will be PN10.

1.22 Electro Fusion Tapping Saddle, Branch Saddle & Fittings

a) All the Electrofusion fittings should be manufactured with top-quality virgin pre-compounded PE 100 resin which should be compatible with the distribution mains.

b) The products shall comply with the requirements of EN 12201-3, EN 1555- 3 or ISO 8085-3.

c) All the fittings shall be of SDR 11 rating.

d) The fittings shall have approval from any agencies like CIPET etc.

e) All the products shall be manufactured by injection moulding using virgin compounded PE 100 polymer having a melt flow rate between 0.2- 1.4 grams/10 minutes and shall be compatible for fusing on PE 100 distribution mains manufactured according to the relevant national or international standards. The polymer used should comply with the requirements of EN 12201 -1.

f) Process voltage of all saddles must not exceed a maximum of 40 volts.

g) The heating elements should be designed for fusion at any ambient temperature between -5 to +40 degrees centigrade.

h) The heating coils contained in each individual saddle should be so designed that only one complete process cycle is necessary to fully electro fuse the fitting to the adjoining pipe or pipeline component as applicable. The heating coils shall be terminated at terminal pins of 4.0- or 4.7-millimetre diameter.

i) No heating element shall be exposed, and all coils are to be an integral part of the body of the fitting.

j) The EF tapping/ branch saddles should be fixed by a fixation device and shall be achieved by an external or integral clamping device.

k) The cutter should be designed in such a way that the cut coupon is not allowed to fall into the pipeline and is retained inside the body of the cutter.

l) A limited path style fusion indicator acting for each fusion zone as visual recognition of the completed fusion cycle should be incorporated into the body of each fitting near the terminals. The fusion indicators should not allow the escape of the molten polymer through them during or after the fusion process.

m) All the sockets in the electro-fusion fittings should include a method of tapping controlling the pipe penetration (pipe positioner /stopper).

n) All the electro-fusion products should be individually packed in transparent protective bags to allow easy identification without opening the bag and must clearly indicate their contents.

o) The brand name, size, raw material grade, SDR rating and batch identification are to be embedded as part of the injection moulding process. Each fitting should also be supplied with a Data Card or stickers with the appropriate barcode as well as manual setting information for data transfer purposes.

p) Installation and Fusion Jointing: The fusion jointing process is to be carried out as per the procedure outlined in the DVS2202 standard, if not available equivalent standards are acceptable to the employer.

q) A protocol for each fusion joint to be printed to ensure the joint process carried out is error-free. The electro-fusion machine shall have the facility to record & make print for each joint.

r) The precautions & measures mentioned by electrofusion fittings/ machine manufacturers should be taken up rigorously while making the joints in the field.

s) The jointing procedures shall be performed with the required accessories and tools as recommended by the fittings manufacturer.

t) The related pipe jointing accessories such as rotary pipe cutter, Universal clamping tools, Pipe cleaners, and Pipe peelers supplied by the same electro-fusion fitting/ machine supplier shall be used to ensure perfect jointing.

u) The usage of tapping tools such as taping keys, supplied by the same electro-fusion fitting/ machine supplier must be used to ensure perfect tapping of main lines.

v) The piping system will be tested as per the guidelines given by ISO standards. The guideline shall be furnished by the supplier of electro-fusion fittings, tools, and machines.

1.23 Back Filling and Tamping

Backfilling shall follow pipe installation as closely as possible to protect the pipe from falling boulders, eliminating the possibility of pipe lift due to flooding of the open trench and shifting the pipe out of line by caved-in soil.

The soil under the pipe and coupling shall be solidly tamped to provide firm and continuous support for the pipeline. Tamping shall be done either by tamping bars or by using water to consolidate the backfill materials. The minimum MDD of compacted soil shall not be less than 95%.

The initial backfill material used shall be free of large stones and dry lumps. In stony areas, the material for initial backfill can be shaved from the sides of the trenches. In bogs and marshes, the excavated material is usually little more than vegetable matter and this should not be used for bedding purposes. In such cases, gravel or crushed stone shall be hauled in.

The initial backfill shall be placed evenly in a layer of about 100 mm thick. This shall be properly consolidated, and this shall be continued till there is a cushion of at least 300 mm of cover over the pipe.

If it is desired to observe the joint or coupling during the testing of mains, they shall be left exposed. Sufficient backfill shall be placed on the pipe to resist the movement due to pressure while testing.

Balance of the backfill need not be so carefully selected as the initial material. However, care shall be taken to avoid backfilling with large stones which might damage the pipe when spaded into the trench.

Pipes in trenches on a slope shall have extra attention to make certain that the newly placed backfill will not become a blind drain in effect because until back fill becomes completely consolidated there is a tendency for ground or surface water to move along this looser soil resulting in a loss of support to the pipe. In such cases, the backfill shall be stamped with extra care and the tamping continued in 100 mm layers right up to the ground level.

1.24 Property Connections

Service pipes should be laid up to plot boundaries in the Project area and end-capped. The service pipe details are as defined below:

Table 1-4: Tentative Details of Property Connections

S.No.	Description	Value
1	Pipe and accessories	Service connections of required size as per water demand (Minimum 32mm), including supply and fixing of ferrules, electro fusion saddle, clamps, rubber sheets, tapping, compression fittings etc, complete.
2	Pipe Material	HDPE/MDPE
3	Number of property connections and water meters	428

1.25 Design Parameters for Distribution Network

Table 1-5: Design Parameters for Potable Water Distribution Network

Sl	Design Parameter	Value
1	Minimum residual pressure at Consumer connection (unless otherwise specified by Employer/ Employer's Engineer)	17-21m
2	Peak factor	For Residential as per CPHEEO; For industrial to be decided as per industrial process. (minimum 1.5m)
3	Losses as Unaccounted for water (UFW) to be considered for designing	2% Treatment loss, 3% Pumping and Raw Water Transmission loss and Clear water

Sl	Design Parameter	Value
		transmission & distribution loss shall be restricted to 10%
4	Bedding	Bedding for HDPE / DI pipes shall be as per relevant IS codes
5	Clear cover over pipe	The water supply pipeline shall be laid with a minimum cover of 1.2m over the pipe crown.
6	Basis of supply to consumers	Continuous pressurized
7	Maximum Unit head loss in the pipe	10m/KM
8	Hazen William Coefficient	140 (DI CM Lined); 145(HDPE)
9	Pipe Material	HDPE minimum 110mm up to 315mm HDPE (PE-100); PN 10 Size 300mm and above: DI-K9, Pumping Mains: DI-K9

1.26 Water Supply Pumping Station

The water supply pumping system shall refer to the pumping system of potable water & recycle water.

Potable water pump stations (if required) and Recycle water pump stations are included in the scope of the contract along with associated piping and connection work with the overall network or independent system. The pump houses shall be of adequate size to house the pumps of required capacity and other allied electrical and mechanical equipment, also designing and providing all PLC / SCADA / Automation requirements for required components. However, the minimum size of the pump house shall not be less than 100 sq. m with sufficient height to house the Gantry crane. The scope shall include all required appurtenances for completion of the work.

The pumps shall be of horizontal centrifugal split casing type design or End Suction type design with allowance of particles as per the quality of water being handled with a semi-open/closed impeller design based on the quality of water being handled.

a) The pumping system shall be designed as per guidelines given HI 9.8, CPHEEO Manual for general water supply pumps and NFPA guidelines for Firewater pumping systems. The contractor shall refer to all standards related to the pumping system mentioned in the General Mechanical Specification.

b) Detailed specification of the pumps and associated pipework and valves, material of construction details etc. shall be referred from General Mechanical Specification and various other relevant sections of this tender document.

c) The Pump house shall be in RCC construction of the required grade as called in the tender.

d) Pumping system configuration, capacity and head of pumps, and type of operation (continuous/VFD/intermittent) shall be selected as per the guidelines given elsewhere in this tender. The same shall be designed and due approval of such design from the Employer’s Engineer will be required.

e) Pumps shall be selected for a speed not more than 1500 rpm. If VFD based pumping systems are selected, then turn down operating condition should not be below 30 - 50% of original speed.

f) Suitable control/throttling system to be considered if continuous flow pumps are selected.

g) Suitable Lifting equipment for pump station to be provided as per guidelines given in General Mechanical Specification. Pumping stations requiring handling equipment up to 1 ton will be with manually operated travelling crane. Pumping stations requiring above 1 ton will be with electrically operated travelling crane.

h) Suitable level measuring transmitters for pump wells to be provided. Pump wells shall be designed with min 2 compartments to allow isolation of compartments for cleaning and maintenance purpose. Suitable isolation sluice gates shall be provided as required. Sluice gates shall be of CI construction with flush bottom and rising spindle arrangement.

i) Valve pit, Flowmeter Pits shall be provided with rocker pipe arrangement on upstream and downstream to take care of differential settlement. Minimum space of 600 mm from pipe flange end to adjacent wall shall be provided inside valve chamber.

j) Velocity criteria for the water supply pumping system are as follows

    a. Individual Suction Side: 1 to 1.5 m/sec

    b. Individual Delivery Side: 1.5 to 1.8 m/sec

    c. Common Delivery Header: 1.8 to 2.2 m/sec

k) The pumping system shall generally comprise the following.

    a. Isolation gate valves on individual suction and isolation gate/ butterfly valves on individual delivery lines of each pump with pressure gauges on the suction and delivery side. Individual delivery valves shall be motorised.

    b. Swing check type or single door/multi-door type non-return valves shall be provided on the delivery line of each pump.

    c. Pressure transmitter and magnetic type flow meter (with bypass arrangement and valves) on common delivery header.

    d. Suitable vibration monitoring system for all pumps and RTD and BTDs for HT motor-based pumping system

    e. Operation of pumps shall be automatic based on the levels in the suction sump. Suitable ultrasonic type level indicating transmitters and level switches shall be provided for the automatic start and stop operation of pumps. Necessary alarms/annunciations required for the safe operation of pumps shall be provided. Instruments provided shall be interlocked and compatible with SCADA

    f. Suitable sized air release valve with isolation gate valve to be provided on the highest point in the delivery pipe.

g. Stainless steel (SS 304) expansion bellows/ dismantling joints shall be provided between pump delivery valves and at header connection for ease of installation and dismantling.

h. Equal sized/same capacity of multiple pumps will be preferred to be selected for ease of maintenance and spares.

i. The clearance between pumps/piping/valves from adjacent walls shall be not less than 1000 mm.

j. It is recommended to keep a minimum distance of 1500 mm between the pump centre line and increase it as per vendor recommendations.

k. The sequence of operation of pumps shall be changed every 8 hours. (Contractor shall ensure an adequate number of pump selections accordingly)

l. +5% margin on the pump capacity shall be provided for all the pumps. The total head of the pump shall be selected considering peak flow and minimum design water level in the wet well for normal conditions of operation and checked for satisfactory operation under extreme conditions of operation. The minimum residual head is to be considered as 3m for the pump head design.

m. The pump capacity and head shall be selected such that the total pump output is in excess of the design flow to ensure free flow at all flow conditions.

n. Dead Volume shall be as per criteria given in Hydraulic Institute and pump vendor data.

o. A minimum 15% margin over the power input to the pump at the duty point will be kept while selecting the motor rating.

The design, materials, construction, manufacturing, inspection, testing and performance of all equipment shall comply with all currently applicable statutes, regulations, and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other International standards are also acceptable if these are established to be equal or superior to the listed standards.

1.27 List of Standards and Specifications

Detailed specifications for the water supply system have been presented in section 12.7. Key standards have been listed below.

a) CPHEEO Manual for Water Supply & Treatment Systems, 2023

b) SP 7 (2016): National Building Code of India, 2016

c) Urban and Regional Development Plans Formulation and Implementation Guidelines, 2014

d) SP-35: Handbook on Water Supply, Plumbing & Drainage, 1987

e) Manual on norms and standards for environment clearance of large construction projects, MoEF

f) IS 1172: Code of Basic requirements for water supply, drainage and sanitation

g) IS 8329: Centrifugally Cast (spun) Ductile Iron Pressure Pipes for Water, Gas and Sewage — Specification

h) IS 12288: Code of practice for laying of ductile iron pipes

i) IS 9523: Ductile iron fittings for pressure pipes for water, gas and sewerage

j) IS 4984: High Density Polyethylene Pipes for Water Supply

k) Sluice valves shall be of Class I type with cap conforming to IS 780, it shall be provided with false spindle.

l) The road surface box shall conform to IS 3950.

m) Duck foot bend, shall conform to IS 1538 heavy duty type.

n) The flange riser shall conform to IS 7181. The length of the pipe shall be as required.

o) Stand post column shall be of cast iron, cast in one piece conforming to Grade 20 of IS 210

p) IS 13039: External hydrant systems-Provision and maintenance-code of practice

q) Each hydrant shall be subject to hydrostatic test and shall prove perfectly watertight under a hydraulic pressure as per the IS 13039

2 Recycle Water Supply Network

High-quality treated water termed 'Recycle Water' will be produced from domestic sewage and industrial wastewater at the Sewage Treatment Plant (STP) and Common effluent treatment plant (CETP), respectively, which will be designed, supplied, installed, operated and maintained by the contractor as per the contract.

This Recycle Water will be used to meet the non-potable or non-drinking water demand from the residential, commercial, institutional, and industrial areas. Also, the water demand for horticulture/landscaping and a part of the process water demand of industrial areas will be met through this water.

The contractor will be responsible for the design, supply, installation, testing, commissioning, operation, and maintenance of a entire Recycle water transmission and distribution system, including the CETP. The scope includes a transmission main network, Recycle Water Service Reservoir (Re-SR), a distribution system and a service connection to the plots.

The implementation limit will start from the outlet valve at the pump discharge of the Recycle Clear Water Reservoir (Re-CWR) up to the service connection points outside the plots in the Project area.

Recycle Clear Water Reservoir (Re-CWR), along with the Pump House to transfer water to the Recycle Water Service Reservoir (Re-SR), will be included in the scope of other Contractors. The Recycle Water Service Reservoir (Re-SR) will be in the scope of EPC Package A

The contractor scope shall also include surge analysis for the complete Recycle water network and shall provide surge protection equipment wherever necessary. The Centre-to-centre distance of the riser connection to be considered for recycled water pipe along the green zone/area shall be as per the landscape design requirement and will be finalised during detailed design in consultation with the Employer's Engineer.

Sl	Description of Item	Minimum Requirement
1	A. Capacity of Recycle Water Service Reservoir B. Treated Effluent Reservoir	6 ML As per the approved design.
2	Recycle Water Transmission Line	DI K9
3	Recycle Water Distribution Network	As per the approved design
a	HDPE Pipe sizes	110 mm to 315 mm
b	DI Pipe sizes	DI K9 for 300 mm and above
c	Sluice Valves	Motorized actuator
d	Air Release Valves	Automatic
e	Scour Valve	Manual
4	Recycle Water Management System (web-based and app-based)	Recycle Water SCADA which can be integrated with ICCC. It should be capable of controlling and monitoring the flows through valves, real-time data collection and display of all water meters, flow meters, water level

Sl	Description of Item	Minimum Requirement
		sensors, pressure sensors capability of report generation and alerts It is to be accommodated in the same room as that for the Potable Water Management System.
5	District Metering Area (DMA)	Maximum Area of 200 acres.
6	Flow Meters (all types)	Battery-operated electromagnetic type/power operated with min 8 hours UPS backup, having integration with the Potable Water management system.
7	Service Water Connection	For 428 plot connections with a minimum 32 mm diameter. Minimum 100 Nos. of tap-off points as required for the Landscape package (by other contractors). Tap-off points for irrigation of avenue plantation in ROW as per the Contractor's scope of work and design.
8	Service Water Meters	Battery-operated, Ultrasonic with 2 GSM SIMs and compatible with the Recycle Water Management System.

2.1 Background

The STP and CETP will be co-located. The Recycle Water from both these facilities shall be pumped to a common reservoir. It is proposed to pump the treated effluent to a Recycle Water Service Reservoir (Re-SR) which is planned near to Service Reservoir (SR) for potable water. Recycle water shall be supplied from this recycle water storage facility.

The design period to be considered for various components is as under:

a) Civil Structures: 30 years

b) Pumping Mains: 30 years

c) Mechanical and Electrical Components: 15 years

d) Distribution System: 30 years

2.2 Scope

The Recycle Water Production and Distribution System shall be divided into two parts.

a) Part I comprises CETP, STP, Treated/Recycle Clear Water Reservoir, and Treated/Recycled Water Pump House.

b) Part II covers the Recycle Water Transmission line for Phase 1, Recycled Water Service reservoir, Transmission line for Phase 2 and Phase 3 up to the boundary of Phase 1 (as per approved design), Recycle Water Distribution network and Recycle Water Service connections to all plots in Phase 1.

The scope under the present contract will include design, supply, installation, testing, commissioning, operation, and maintenance of the recycled water distribution system for Part II works as indicated above.

The Recycled Water Service Reservoir shall be designed to take care of variations in water demand over 24 hours. The pumping into the Recycle Water service reservoir should be at a constant flow rate, and withdrawal shall be as per fluctuating water demand. Minimum storage/service must be provided, considering balancing of inflows and outflows. The Storage/service Reservoir shall have sufficient staging height to ensure a defined minimum terminal pressure of 17 to 21 m. The Recycle Water Service Reservoir shall be aesthetically designed by a qualified architect along with MITL branding to the satisfaction of the Employer's Engineer.

The contractor scope shall include surge analysis for the complete Recycle Water distribution network and the contractor shall provide surge protection equipment wherever necessary as per the approved design.

The scope of work shall include but not be limited to the following:

e) Detailed design of the Recycle Water service reservoir, distribution system and service connections

f) Architectural design and elevation of Recycle Water service reservoir including site layout with associated facilities, approach road, gate, security cabin etc,

g) Construction of Recycle Water service reservoirs

h) Construction of compound wall along with Main Gate and Security cabin for the plot designated for Recycle Water Service Reservoirs

i) Submission of design calculations, plans, 2D models and drawings

j) Preparation of L section and construction drawings

k) Construction of a Recycle Water Water Network as per the approved design and plans

l) Supply and installation of Flow meters, Level sensors, Pressure sensors, and Valves as per the approved design.

m) Supply and installation of Smart water meters to consumers of all types.

n) Supply, Construction, Installation, Testing, Commissioning and O&M of the Recycle Water Supply System. The contractor has to manage the Recycle Water supply distribution network such that the distribution losses should not exceed 5%. The measurement shall be with reference to the flowmeter at the inlet of the Recyled Water Service Reservoir and the Inlet at the consumer meter.

The contractor shall design and construct the Recycle Water supply system on a continuous running basis, along with the installation of valves, scour valves, air release valves, thrust blocks etc. as required. All valves shall be electrically actuated except scour and air release valves.

The Contractor shall furnish all required tools, plant, instruments, materials including water, electricity, labour, consumables, etc., any and everything necessary for the construction of the works, whether or not such items are specifically stated elsewhere in this document.

The system shall be designed as a closed loop system for efficient operations and shall be designed taking the concept of a District Metering Area (DMA) with each DMA being isolated with valves and flow measured with a full-bore electromagnetic flow meter to each DMA.

In general, this work shall include designing, providing, laying, jointing and testing all pipes and specials/fittings, DI/MS (CM lined internally) pipe and specials/fittings, inlet connection, Valves, etc.

Sl	Description of Item	Minimum Requirement
1	A. Capacity of Recycle Water Service Reservoir B. Recycle Water Clear Water Reservoir	4 ML As per the approved design
2	Recycle Water Transmission Line for Phase 1, Phase 2 and Phase 3	DI K9
3	Recycle Water Distribution Network	
a	HDPE Pipe sizes	110 mm to 250 mm
b	DI Pipe sizes	300 mm and above
c	Sluice Valves	Motorized actuator
d	Air Release Valves	Automatic
e	Scour Valve	Manual
4	Recycle Water Management System (web-based and app-based)	Recycle Water Management system to be integrated with its respective SCADA. The contractor shall be responsible for coordination related to the interfacing with the ICCC system (by others). Any control system under the contractor's scope shall be fed with power from UPS, supplied by the contractor. A separate operation room of 50 sq.m to be provided.
5	District Metering Area (DMA)	Maximum Area of 200 acres.
6	Flow Meters (all types)	Battery-operated electromagnetic type/power operated with min 8 hours UPS backup having integration with Recycle Water management system. Each flow meter shall have appropriate RTU-compatible GSM and OFC connectivity with respective SCADA (by contractor) for control and monitoring. However, Contractor has to ensure its interface with ICCC (by others) for monitoring only through their utility SCADA.

Sl	Description of Item	Minimum Requirement
7	Service Water Connection	Minimum 32 mm
8	Service Water Meters	Battery-operated, Ultrasonic with 2 GSM SIMs/IoT enabled and compatible with the Recycle Water Management System.
9	Landscaping Water Tapping Points	Tapping points with valves shall be provided connection to the irrigation system for avenue plantation and landscaping as per the recycle water distribution system duly approved by the Employer's engineer.

2.3 Recycled Water Service Reservoir

The scope for this item includes the design, construction, installation, testing & commissioning of a Recycle Water Service Reservoir (Re-SR).

The scope also includes providing level indicators, valves, level sensors, and actuators with provision for future SCADA integration. All the electro-mechanical installations and physical infrastructure of the distribution network shall be PLC/SCADA compatible. The scope of services also includes the supply of water for hydraulic testing and carrying out hydraulic tests for the transmission main, distribution network and Re-SR. The supply pipe from each Re-SR shall be fitted with an Electromagnetic flow meter for flow measurement.

2.4 Crossing of Transmission Lines and Distribution Network over Small River and Nallah

Suitable pipe bridges will be provided at the locations where the proposed transmission main will cross rivers/ streams. The bottom level of the pipe will be kept above the maximum water level in the water course. Final Locations of the crossing shall be verified on-site and design to be done by the contractor.

At a river where there is a road crossing (bridge/viaduct) for vehicles or passengers, the span supports for the pipeline shall match with the supports of the bridge/ viaduct. For other culvert, small river and nallah crossings, the pipe bridges shall be designed with a maximum span of 5m. The pipe supports of the pipe bridge shall be designed and constructed in accordance with approved standards. The final detailed arrangements shall be designed by the Contractor and approved by the Engineer prior to work.

Complete concrete encasement shall be provided to the pipe in cases of road crossings and nalla crossings Concrete used for this shall be of the M15 type. Before placing concrete, the pipes shall be supported near each joint with a padding of compressive material on a pre-cast concrete block. Concrete shall not be placed until the pipes have been joined, inspected, and passed hydraulic testing.

The concrete shall be placed to ensure full contact with the pipe barrel throughout its length. Necessary reinforcement steel shall be provided as per the approved design and site conditions. The concrete shall be made discontinuous at flexible pipe joints by a diaphragm of fibre board or other compressible material of at least 20 mm thickness extending for the full area of the surround. The concrete encasement shall cover the pipeline on all sides by a minimum of 100 mm on each side.

A specific geotechnical investigation shall be performed by the contractor for each proposed crossing to evaluate potential 100-year flood scour depths of the waterway at the ultimate development of the drainage basin. The final detailed arrangements shall be designed by the Contractor and approved by the Engineer prior to work.

2.5 Distribution Network

The distribution network shall be designed for a continuous pressurised water supply. Hazen-William's formula will be used for the calculation of velocities and head losses. The water distribution network shall be mostly a closed network system so that uniform pressure is maintained at the ferrule connection for each consumer. The Hazen-Williams formula is expressed as under:

$S = hf / L = 10.67 [(Q / C)^{1.85}] [1 / (d^{4.87})]$

Were,

S	:	Hydraulic slope
hf	:	head loss in meters (water) over the length of pipe
L	:	length of pipe in meters
Q	:	volumetric flow rate, m^3/s (cubic meters per second)
C	:	pipe roughness coefficient
d	:	inside pipe diameter, m (meters)

Following considerations shall be taken into account while designing the network:

Minimum velocity	=	0.6 m/s
Maximum velocity	=	3.0 m/s

2.6 SCADA/ Automation

The contractor needs to coordinate with the Master ICT System Integrator (separate contract) for interfacing between the SCADA system of the pumping station, Re-SR and actuated valves.

The contractor is to ensure the compatibility and seamless transmission of the data from the Recycle Water Management System to the Integrated Command and Control System to be installed by the Master ICT System Integrator.

The butterfly valves for all pipelines shall have electrically operated actuators with appropriate RTU-compatible GSM and OFC connectivity with respective SCADA (by contractor) for control and monitoring.

However, Contractor has to ensure its interface with ICCC (by others) through their utility SCADA for monitoring only.

The contractor shall be responsible for coordination related to the interfacing with the ICCC system (by others).

Any control system under the contractor's scope shall be fed with power from UPS, to be supplied by the contractor.

2.7 Excavation Depth

All water supply pipes shall be laid below ground with a minimum clear cover of 1.2m above the crown of the pipes. No cover less than the above is acceptable.

The contractor also needs to check and design anchoring arrangements to mitigate the uplift of pipes due to the water table in the project area.

2.8 Residual Pressure

The recycle water supply distribution system shall be designed to achieve a minimum residual pressure of 17 m to 21m at each service connection.

2.9 Laying

The pipes shall be lowered into the trench by means of suitable pulley blocks, sheer legs chains ropes etc. In no case, the pipes shall be rolled and dropped into the trench. One end of each rope may be tied to a wooden or steel peg driven into the ground and the other end held by men which when slowly released will lower the pipe into the trench. After lowering, the pipes shall be arranged so that the spigot of one pipe is carefully centred into the socket of the next pipe, and pushed to the full distance that it can go. The pipeline shall be laid to the levels required. Specials shall also be laid in their proper position.

Where so directed, the pipes and specials may be laid on masonry or concrete pillars. The pipe laid on the level ground shall be laid with a socket facing the direction of the flow of water.

The pipes shall rest continuously on the bottom of the trench. The pipes shall not rest on lumps of earth or on the joints. Four-meter-long wooden templates may be used to check the level of the bed. Clearance of approximately 100 mm in depth and width equal to the length of the collar plus 30mm on both sides shall be provided at the joint, which shall be refilled from the sides after the joint is made.

In unstable soils, such as soft soils and dry lumpy soils, it shall be checked whether the soils can support the pipelines, and if required, suitable special foundation shall be provided.

Some clayey soils (for example, black cotton soil) are drastically affected by extremes of saturation and dryness. In changing from saturated to a dry condition, these soils are subjected to extraordinary shrinkage, which is usually seen in the form of wide and deep cracks in the earth's surface and may result in damage to underground structures, including pipe materials. The clay forms a tight gripping bond with the pipe, subjecting it to excessive stresses as the clay shrinks. It is recommended that in such cases an envelope of a minimum of 100 mm of tamped sand shall be made around the pipeline to avoid any bonding.

In places where rock is encountered, a cushion of fine earth or sand shall be provided for a depth of 150 mm by excavating extra depth of the trench, if necessary, and the pipes laid over the cushion. Where the gradient of the bed slopes is more than 30 degrees it may be necessary to anchor a few pipes against sliding downwards.

2.10 Bedding

The class of bedding shall be designed considering the required external loading conditions, geotechnical requirements such as subsoil and bearing capacity of soil encountered in the respective water line, type, class and material of pipe used for the laying purposes as per the CPHEEO manual. Fine sand bedding 200mm thick shall be provided for HDPE Pipes.

Where DI pipes are to be bedded directly on the bottom of the trench, it is to be trimmed and levelled to permit even bedding of the pipeline and should be free from all extraneous matter which may damage the pipe or the pipe coating. Additional excavation shall be made at the joints of the pipes so that the water main is supported along its entire length. Where excavation is through rocks or boulders, the pipeline shall be bedded on concrete bedding or on at least 150 mm of fine-grained material, or other means are used to protect the pipe and its coating.

For MS pipes the bottom of the trench shall be properly trimmed to permit even bedding for the pipeline. For pipes larger than 1200 mm in diameter in earth and murrum, the curvature of the bottom of the trench shall match with the curvature of the pipe as far as possible, subtending an angle of about 120° at the centre of the pipe. Where rock or boulders are encountered, the trench shall be trimmed to a depth of at least 100 mm below the level at which the bottom of the barrel of the pipe is to be laid and filled to a like depth with lean cement concrete or with the non-compressible material like sand of adequate depth to give the curved seating.

2.11 Thrust Blocks

Thrust blocks are required to transfer the resulting hydraulic thrust from the fitting of the pipe onto a larger load-bearing soil section.

Thrust blocks shall be installed wherever there is a change in the direction/size of the pipeline or the pressure line diagram, or when the pipeline ends at a dead end. If necessary, thrust blocks shall be constructed at valves also.

Thrust blocks shall be constructed considering the pipe size, water pressure, type of fitting, gravity component when laid on slopes and the type of soil.

When a fitting is used to make a vertical bend, it shall be anchored to a concrete thrust block designed to have enough weight to resist the upward and outward thrust. Similarly at joints, deflected in the vertical plane, it shall be ensured that the weight of the pipe, the water in the pipe and the weight of the soil over the pipe provide resistance to upward movement. If it is not enough, ballast or concrete shall be placed around the pipe in sufficient weight to counteract the thrust.

When the line is under pressure, there is an outward thrust at each coupling. Good soil, properly tamped is usually sufficient to hold pipe from side movement. However, if soft soil conditions are encountered, it may be necessary to provide side thrust blocks or other means of anchoring. In such cases, only the pipe on each side of the deflected coupling shall be anchored without restricting the coupling.

Pipes on slopes need to be anchored only when there is a possibility of the backfill around the pipe sloping down the hill and carrying the pipe with it. Generally, for slopes up to 30 degrees, well-drained soil carefully tamped in layers of 100 mm under and over the pipe, right up to the top of the trench will not require anchoring.

2.12 Joints

A Joint is a connection between the ends of pipes in which a gasket is used to affect a seal.

Ductile Iron pipes comprise of the following joints:

a) Socket and Spigot Push-on Joint

b) Flanged Joint

c) Flexible Joints and Interconnection and

d) Restrained Joints

Push-on flexible joints shall be provided for pipe-to-pipe connection as per IS 8329. Wherever, flange joints are required e.g., at terminal points, valves, over-ground and underground pipe connections etc., welded-on flanges shall be used.

Double-chambered restrained joints need to be designed in accordance with ISO 10804:2018. The permissible angular deflection will be as declared by the manufacturer. The Performance Type Test of this Joint in line with ISO 10804/EN545 has to be established by the manufacturer by getting it witnessed by a NABCB (National Accreditation Board for Certification Bodies), or IAF (International Accreditation Forum) or EA (European Cooperation for Accreditation) accredited institution/certification agency.

2.13 Valves and Fittings

For the operation and maintenance of the transmission and distribution system minimum numbers of valves are necessary. The transmission and distribution mains shall be provided with the following appurtenances and specials as per the following criteria.

2.13.1 Sluice Valve

Resilient seated sluice valve of standard makes as per IS 14846 shall be proposed at different locations as per requirements to isolate a portion for maintenance.

2.13.2 Non-Return Valve

Non-return valves of standard make as per IS 5312 shall be proposed at different locations as per requirements to prevent any backflow.

2.13.3 Pressure Reducing Valve

Pressure-reducing valves with pressure-sustaining override shall be provided to reduce the pressure difference between the locations of the same zones.

2.13.4 Air Release Valve

Automatic air release valves with EPDM of standard make shall be proposed at suitable locations in the rising mains and distribution network to protect the line from both upsurge and down surges. The valve diameter shall be as per design requirements and guidelines.

2.13.5 Scour Valve

Scour valves of standard make shall be installed in the rising mains and distribution system at lower points in the line to drain silt and water from the line whenever required.

All the valves shall be enclosed in valve chambers with cover.

2.14 Back Filling and Tamping

Backfilling shall follow pipe installation as closely as possible to protect the pipe from falling boulders, eliminating the possibility of pipe lift due to flooding of the open trench and shifting the pipe out of line by caved-in soil.

The soil under the pipe and coupling shall be solidly tamped to provide firm and continuous support for the pipeline. Tamping shall be done either by tamping bars or by using water to consolidate the backfill materials. Minimum MDD of compacted soil shall not be less than 95%.

The initial backfill material used shall be free of large stones and dry lumps. In stony areas, the material for initial backfill can be shaved from the sides of the trenches. In bogs and marshes, the excavated material is usually little more than vegetable matter and this should not be used for bedding purposes. In such cases, gravel or crushed stone shall be hauled in.

The initial backfill shall be placed evenly in a layer of about 100 mm thick. This shall be properly consolidated, and this shall be continued till there is a cushion of at least 300 mm of cover over the pipe.

If it is desired to observe the joint or coupling during the testing of mains, they shall be left exposed. Sufficient backfill shall be placed on the pipe to resist the movement due to pressure while testing.

Balance of the backfill need not be so carefully selected as the initial material. However, care shall be taken to avoid backfilling with large stones which might damage the pipe when spaded into the trench.

Pipes in trenches on a slope shall have extra attention to make certain that the newly placed backfill will not become a blind drain in effect because until back fill becomes completely consolidated there is a tendency for ground or surface water to move along this looser soil resulting in a loss of support to the pipe. In such cases, the backfill shall be stamped with extra care and the tamping continued in 100 mm layers right up to the ground level.

2.15 Property Connections

Service pipes should be laid up to plot boundaries in the Project area and end-capped. The service pipe details are as defined below:

Table 2-1: Details of Property Connections

S.No.	Description	Value
1	Pipe and accessories	Service connections of required size as per water demand (Minimum 32mm), including supply and fixing of electrofusion saddle, clamps, rubber sheets, tapping, compression fittings etc, complete.
2	Pipe Material	HDPE
3	Number of property connections and water meters	428

2.16 Design Parameters for Distribution Network

Table 2-2: Design Parameters for Distribution Network

S.No.	Design Parameter	Value
a)	Minimum residual pressure at service connection (unless otherwise specified by Employer/ Employer's Engineer)	17 m to 21m
b)	Peak factor	For Residential as per CPHEEO; For industrial to be decided as per industrial process. (minimum 1.5)
c)	Losses as Unaccounted for water (UFW) to be considered for designing	10% losses (in transmission and distribution combined)
d)	Bedding	Bedding for HDPE / DI shall be as per relevant IS codes
e)	Clear cover over pipe	The water supply pipeline shall be laid with a minimum cover of 1.5m over the pipe crown
f)	Basis of supply to consumers	Continuous pressurized
g)	Maximum unit head loss in the pipe	10 m/Km
h)	Hazen William Coefficient	140 (DI CM Lined); 145(HDPE)
i)	Pipe Material	HDPE minimum 110mm upto 315mm HDPE (PE-100); PN 10 DI-K9: Size 300mm and above and Pumping Mains

2.17 List of Standards and Specifications

Detailed specifications for the water supply system shall conform to the standards listed below.

CPHEEO Manual for Water Supply & Treatment System, 2023

SP 7 (2016): National Building Code of India, 2016

Urban and Regional Development Plans Formulation and Implementation Guidelines, 2014

SP-35: Handbook on Water Supply, Plumbing & Drainage, 1987

Manual on norms and standards for environment clearance of large construction projects, MoEF

IS 1172: Code of Basic requirements for water supply, drainage and sanitation

IS 8329: Centrifugally Cast (spun) Ductile Iron Pressure Pipes for Water, Gas and Sewage — Specification

IS 12288: Code of practice for laying of ductile iron

IS 9523: Ductile iron fittings for pressure pipes for water, gas and sewerage

IS 4984: High-Density Polyethylene Pipes for Water Supply

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3 Stormwater Drainage

3.1 Scope

The Scope of Work shall include:

a) Detailed Design and plans for the stormwater drainage system

b) Submission of design calculations, plans, 2D models and drawings

c) Preparation of L section and construction drawings

d) Construction of stormwater Network as per approved design and plans

e) Testing, Commission and O&M of the System

The contractor shall design and construct the stormwater drainage system and shall furnish all required facilities, plant, instruments, and materials, including water, electricity, labour, consumables, etc., any and everything necessary for the construction of the works, whether or not such items are specifically stated elsewhere in this bid. The Standards and Specifications for the Design and Construction of Stormwater Drainage Systems are given in this section.

The contractor shall make their arrangements for water and power required for the work, and nothing extra will be paid for the same.

This will be subject to the conditions that the water used by the contractor (s) shall be fit for construction purposes to the satisfaction of the Employer's Engineer. No underground water usage for construction is permitted.

Arrangement of Power for construction purposes is the contractor's responsibility.

In general, this work shall include the construction of Precast Rectangular box drains, catch basins and inter-connection infrastructure, including but not limited to pipes, gratings etc.

The precast rectangular box drains shall be mandatorily factory-made, fair-finished in accordance with Clause 8 of Volume 2, Part E – Civil and Structural Specifications.

Cast-in-situ construction shall be permitted only for the non-regular sections, junctions, etc, with a length not exceeding 15% of the total length of the box drains.

The major objective of stormwater drainage system design is to protect the area from flooding and efficient operation of systems during the design storm events. The drainage system is designed to collect stormwater run-off from roadway surface and right-of-way, along with runoff from plots and convey it along and through the stormwater network and discharge into a receiving body without causing adverse site impacts.

Stormwater collection systems shall be designed to provide adequate surface drainage. Surface drainage is a function of transverse and longitudinal pavement roughness, inlet spacing and inlet capacity.

The stormwater drainage system shall be designed with an integrated approach considering the relevant external catchment. Further, it shall be designed considering all the relevant parameters, including future development works. The contractor is to refer to the indicative Tender drawings for the tentative disposal point of the stormwater drain. The Outfall Location shall be verified on-site, and the design to be done by the contractor. Outlet points shall be terminated in a natural water body having adequate assimilating capacity as approved by the Engineer-in-charge.

The discharge design facilities for stormwater collection and conveyance systems include consideration of stormwater quantity and quality. The general considerations in the design of stormwater drains shall be:

i. Drains shall be designed for appropriate design frequency/return period depending on the importance of the development and economic considerations.

ii. Drains shall be planned to take into consideration the ground levels, slope of the ground, valley and ridges and also the land uses planned for urban development.

iii. Drains shall be planned to get an adequate longitudinal slope, considering the nature of the soil and subsoil water level. Drainage of large areas can be better achieved by subdividing them into small grids to avoid a long main drain. The aim should be to get a high velocity for the dominant flow.

iv. Efficiency in the maintenance of the drainage system is an important consideration in selecting the size, shape and location. The specification of the drain shall also aim at preventing the possibility of ingress of other extraneous materials, debris, vegetation, etc. Where grating is provided on drains, they shall be so located as to attract the attention of maintenance staff, be easy to approach, inspect and clean it.

Sl	Description of Item	Minimum Requirement
1	Return period for the design of Storm Water Drains	5 years
2	Drain Type	Precast Box Drain of size as per approved design
3	Catchment Area	Runoff water from ROW developed plots and adjoining areas of parcel B development.
3	Property connections	Minimum 428 subject to the contractor’s design.
4	Manholes and Covers	Maximum 15 m and at junctions/bends as per approved design. The manhole cover and frame shall be Precast SFRC heavy-duty factory-made with embossed MITL logo. conforming to the IS 12592.
5	Rainwater harvesting structures	As per the approved design.

3.2 Catchments

The stormwater drainage system should be planned by dividing the DPIA (Parcel B) project area into various micro drainage catchments based on the topography.

The design discharge shall be calculated as per the Rational Method and the Roughness coefficient of the surface. Catchments shall be delineated based on topography and the location of outfalls. The EPC contractor shall carry out detailed investigations to explore the feasibility of utilising the existing water bodies as the final outfall of stormwater for the Phase I DPIA (Parcel B) project area.

The EPC contractor shall delineate the entire project area and consider all relevant parameters for designing a stormwater drainage network.

3.3 Hydraulic & Hydrological analysis for estimation of the Highest Flood Level

The contractor has to delineate the associated catchment of the stream/river to analyse the data based on hydrological analysis, considering the different rainfall scenarios. The study shall be carried out based on the Govt. published papers, CWC, IS codes, IRC or Govt. Manuals.

The contractor shall arrive at the Highest Flood Level (HFL) for the area and validate the results with the details of the existing nearby culvert/bridge and the elevations from the survey data set. The above result will define the Road formation levels, cross-drainage structures and outfalls of the drainage network.

3.4 Storm Frequency/ Return Period

The components of the proposed stormwater drainage system shall be designed for the following design standards based on national and international best practices:

- Once in a 5-year event flows for stormwater drains/channels.
- Once in a 25-year event flows for culverts
- Once in a 50-year event flows for minor bridges

3.5 Rainfall Intensity

For the estimation of flood discharge, the Central Water Commission (CWC), jointly with the India Meteorological Department (IMD), RDSO, Ministry of Railways and Ministry of Surface Transport, has compiled very useful data. The entire country has been divided into 26 hydrometeorological homogeneous subzones. The project area falls under West Coast Region subzone 5(a) and (b), as per the flood estimation report.

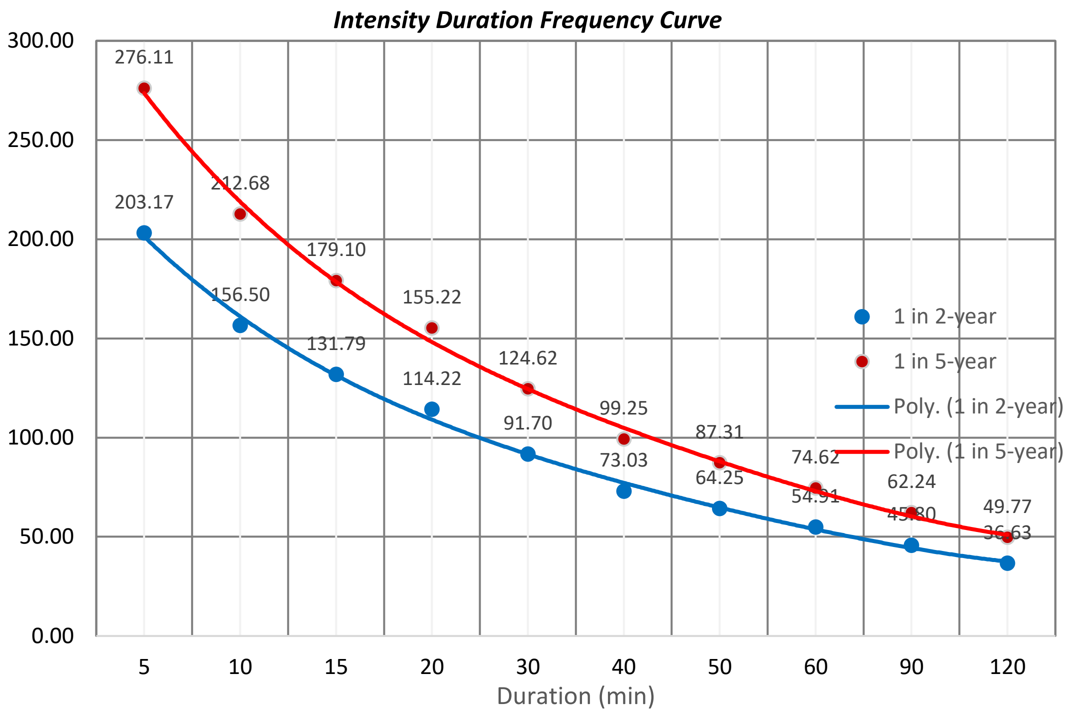

Figure 3-1: IDF Curves

However, it is noted that this is only for reference/tender purposes. The contractor has to develop the IDF curve before starting of design of the stormwater network and get approval on the same from the Employer Engineer. To prepare the IDF curve the contractor is required to collect/purchase authenticated AWS/ARG datasets on 1 hour duration rainfall for the last 30 years minimum, to prepare the IDF curves as cited above.

3.6 Other Design Parameters

The minimum and maximum design velocity shall be as per the guidelines of the CPHEEO manual on the Stormwater Drainage System.

3.6.1 Minimum Longitudinal Gradient

A minimum longitudinal gradient of 0.3 per cent shall be provided for satisfactory drainage as per Ref: IRC: SP: 50-2013. Steeper gradient as per site requirement shall be calculated and submitted for Employer Engineer approval.

3.6.2 Inlet Spacing

The spacing of inlets depends on the condition of the road surface size and type of inlet/Catch basin* and rainfall. They shall be provided at closer intervals near junctions and valley curves; however, maximum spacing shall not be more than 30 m. (Ref: IRC: SP:50-2013).

** Catch basin denoted as a node to reflect the drain detail like Ground level, invert level and size of drain. Purpose of inlet is to catch road surface runoff and outlet into drain.*

3.6.3 Freeboard

The freeboard is the vertical distance from the water surface of designed flow condition to the top of the channel. The importance of this factor depends on the consequence of overflow of the channel bank. Freeboard should be sufficient to prevent waves, superelevation changes, or fluctuations in water surface from overflowing the sides. The recommended value of minimum freeboard for different widths of drains is given in the table below:

Table 3-1: Minimum Free Board

S.No.	Drain Size	Free Board
1.	Up to 300 mm bed width	10 cm
2.	Beyond 300 mm & up to 900 mm bed width	15 cm
3.	Beyond 900 mm & up to 1500 mm bed width	30 cm
For larger drains, the freeboard shall be higher than 90cm depending upon the discharge		

3.7 Design Methodology

3.7.1 Rational Method

Storm runoff is that portion of the precipitation which drains over the ground surface. Estimation of such runoff is dependent on the intensity and duration of rainfall, characteristics of the tributary area and the time required for such flow to reach the drain. In the usual case of urban drainage systems, the Rational method is widely used for estimating the peak runoff rates. It is used to estimate the peak instantaneous discharge from the watershed, and it is assumed that the peak runoff rate is proportional to the peak intensity of rainfall multiplied by the contributing area. The constant of proportionality is called a 'runoff coefficient', always lesser than unity. The formula is:

$Q = CIA/360$

Where:

Q = flow, m^3/s

C = weighted runoff coefficient

I = rainfall intensity in mm/hr

A = drainage area in hectares

The assumptions and limitations inherent in the Rational Formula are:

Runoff coefficient - The runoff coefficient incorporates a large number of variables into a single index that ranges between 0 and 1. In addition, the parameter can take on a wide range of values even for the same land use characteristics.

Rational method is simplistic in its accounting of runoff and loss processes, so must be limited to small, relatively homogenous, and simple watersheds.

It only provides a single value on the discharge hydrograph, the peak discharge. If the objective is to determine the size for an inlet or a pipe, then this single point on the discharge hydrograph is adequate.

Peak flow occurs when the entire watershed is contributing to the flow.

Rainfall intensity is the same over the entire drainage area.

The frequency of the computed peak flow is the same as that of the rainfall intensity.

The coefficient of runoff is the same for all storms of all recurrence probabilities.

3.7.2 Synthetic Unit Hydrograph Method

This method is based on unit hydrograph principle and used when catchment area is greater than 25 sq km. Central Water Commission (CWC) has published Flood Estimation Report for different zone for India. The project alignment falls in the West Coast Region subzone 5(a) and (b).

Synthetic Unit graph parameters are computed using the following equations

tp	0.258*[L Lc / (S)^0.5]^(0.49)
qp	1.017/[tp]^(-0.520)
W50	2.396*[qp]^(-1.08)
W75	1.427*[qp]^(-1.08)
W R50	0.75*[qp]^(-1.25)
WR75	0.557*[qp]^(-1.12)
TB	7.193*[(tp)^(-0.53)]7.621*[(tp)^(0.623)]
QP	qp * A
Tm	tp + tr/2

Where,

T = Time from the center of Unit rainfall duration to the peak of Unit Hydrograph

qp = Peak discharge of hydrograph per unit area

W50 = Width of U. G. measured at 50% maximum discharge ordinate

W75 = Width of U. G. measured at 75% maximum discharge ordinate

W R50 = Width of the rising side of U. G. measured at 50% of maximum discharge ordinate

WR75 = Width of the rising side of U. G. measured at 75% of maximum discharge ordinate

TB = Base width of Unit Hydrograph

QP = Peak discharge of Unit Hydrograph

Tm = Time from the start of rise to the peak of unit hydrograph in hours

tr = Unit rainfall duration adopted in a specific study in hours

3.7.3 Time of concentration

The storm duration chosen for design is equal to the time of concentration. Maximum discharge in drainage system occurs when the entire catchment is contributing to the flow. The time of concentration, (tc) is the time required for a given drop of water from the most remote part of watershed to reach the point of interest. Detail analysis of Tc for each catchment need to done by the EPC contractor to arrive at a particular time(Hrs) to calculate travel time of flow for each catchment.

The concentration time depends on

a) the distance from the critical point to the structure; and

b) the average velocity of flow.

IRC:SP:13-2004 suggested following relationship for time of concentration.

$t_c c = [0.87 \times (L^3/H)]^{0.385}$

Where, $t_c c$ = the concentration time in hours

L = the distance from critical point to the structure in km

H = the fall in level from the critical point to the structure in meter

3.7.4 Critical Intensity

The critical intensity for a catchment is that maximum intensity which can occur in a time interval equal to the concentration time tc of the catchment during the severest storm (in the region) of a given frequency Ic, Since each catchment has its own tc, it will have its own Ic

Ic = Io (2 / (tc+1))

(Ref: IRC -SP 13:2004)

3.7.5 Runoff Coefficient

The runoff coefficient, C, in Equation is a function of the ground cover and a host of other hydrologic abstractions. Where watershed is not homogeneous but is characterized by dispersed areas that can be characterized by different runoff coefficients, a weighted runoff coefficient should be determined. It relates the estimated peak discharge to a theoretical maximum of 100 percent runoff. Typical values for C are given in table below. If the basin contains varying amounts of different land cover or other abstractions, a composite coefficient can be calculated through area weighing using Equation below:

Weighted C = $\Sigma(Cx*Ax)/A_{total}$

Where:

x = Subscript designating values for incremental areas with consistent land cover

The runoff coefficient for the project area development based on the proposed land use pattern are shown in below table.

Table 3-2: Runoff Coefficients for Rational Formula (refer IRC SP 50 Table-6.1)

Land use	Runoff Coefficient	Definition
Industrial	0.75	Industrial
Residential	0.35	Residential areas
Commercial, Mixed Use, PSP (Public and Semi-Public)	0.8	Densely built areas
Parks & Open Spaces (including green buffers, ecological parks)	0.20	Green area (Sandy)
Transportation (Roads, Transport & Logistics)	0.9	Pavement (Bitumen or Concrete)

3.7.6 Hydraulics

Drainage network to be designed as per relevant guidelines of CPHEEO manual, IRC codes, IS Codes as described in above sections.

The size of the drains shall be determined using Manning's formula.

The Manning's equation is given below:

$$Q = \left(AR^{2/3}\, S^{1/2}\right)/n$$

Where,

Q = Discharge capacity of the drain in m3/s

n = Manning's roughness coefficient

A = Flow area in m2

R = A/P = Hydraulic radius in m

P = Wetted perimeter in m

S = Channel slope

3.8 Covered Lined Drain for Storm Water System

A separate dedicated collection and conveyance network is proposed for the collection and safe disposal of stormwater. The system shall comprise storm water interception & diversion facilities and a network of rectangular RCC drains. The drains shall be completely covered at the top.

Collection & conveyance network shall be planned considering natural topography and planned grade levels. The network shall be designed on the assumption that although silting might occur at times of low flow, however, it should be flushed out during peak flows.

3.9 Drain Size, Depth and Type

RCC rectangular drain with Precast RCC cover/Box Drain is proposed at the edge of the carriageway on both sides of the road. The sizes of stormwater drains shall be designed as per relevant IS codes and finalised in consultation with the Employer's Engineer during the Detailed Engineering Stage.

The stormwater runoff shall be intercepted through catch basins which eventually convey it to drain through a connecting pipe. Catch basins shall be equipped with CI gratings and their spacing shall as per relevant IRC code for efficient drainage. However, the contractor can propose alternate materials & type of grated inlets to stormwater with the approval of the Employer Engineer.

3.10 List of Standards and Specifications

The design and construction of storm water drainage network and the outfalls shall conform to design requirements and construction specifications set out in the following Indian Standards.

a) IS - 456 Code of practice for Plain & Reinforced concrete.

b) IRC SP-50-2013 - Guidelines on Urban Drainage

c) IS - 458 Pre-cast Concrete Pipes (with and without reinforcement);

d) IRC SP-42-2014- Guidelines on Road Drainage

e) C.P.W.D. specifications (Govt. of India) with all latest amendments issued from time to time.

f) CPHEEO Manual for Storm Water Drainage Systems -2019 - MoUD, GoI

g) SP 35:1987 - Hand book of Water Supply and Drainage, Bureau of Indian Standards.

h) Manual on artificial recharge of ground water by Central groundwater Board Ministry of Water-Resources Government of India.

i) Rain water harvesting and conservation Manual by consultancy services organization CPWD, New Delhi, India;

j) IS14333:1994 High Density Polyethylene Pipes for Sewerage-Specification

k) IS 4515:2002 Stone Pitched Lining

l) IS 3873:1993 Laying of Cement Concrete /Stone Slab Lining on Canal

m) IS 7740: 1985 Code Of Practice For Construction And Maintenance Of Road Gullies

n) IS 5961: 1970, Specification of Cast Iron Grating for Drainage Purpose.

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4 Industrial Wastewater and Domestic Sewage Collection System

The domestic sewerage network will collect the domestic sewage from the residential, commercial, institutional and amenities plots and convey it to the Sewage Treatment Plant (STP) located within the project area. The industrial sewer network will collect the effluent/wastewater from the industrial plots and convey it to the Common Effluent Treatment Plant (CETP) located within the project area.

The domestic sewerage and industrial effluent network shall be designed in such a fashion as to minimise any intermediate pumping requirement, but in unavoidable circumstances, intermediate sewage/effluent pumping stations (ISPS/IEPS) may be provided at places, if required.

The domestic sewerage network and industrial sewer network will be two independent networks and shall be designed as gravity systems. The network shall be designed to cater for the peak flows, with peak factors, as applicable.

The networks shall be planned considering natural topography and the proposed grade levels. The treated effluent generated from the STP and CETP will be recycled and reused completely within the project area, complying with the environmental clearance (EC) conditions.

The contractor's scope of work shall include designing, providing, supplying, lowering/ laying and jointing of pipes, including excavation, backfilling, bedding, etc, for the collection & conveyance of the domestic sewage and industrial wastewater/effluent, up to the STP and CETP, including the STP and CETP.

The scope of services includes the supply of water for hydraulic testing and carrying out hydraulic tests for networks and manholes.

The scope for manholes includes design and construction of manholes, drop manholes and scrapper manholes as per the type design in RCC M-25, necessary coping in RCC, fixing GRP encapsulated Galvanized Steel Steps or Rungs, providing Precast SFRC heavy-duty factory-made with embossed MITL logo Manhole frames and covers over manholes etc. complete, including all civil works like excavation, backfilling, PCC, RCC works etc.

4.1 Scope

The Scope of Work shall include:

a) Detailed Design, and plans for the independent systems for domestic sewerage & industrial wastewater/effluent collection & conveyance network

b) Detailed design of intermediate sewage pumping stations (as applicable)

c) Submission of design calculations, plans, 2D models and drawings

d) Preparation of L section of domestic sewerage & industrial effluent/wastewater collection network and construction drawings for all components of the proposed domestic sewerage & industrial effluent system

e) Construction of independent domestic sewerage & industrial effluent collection & conveyance network as per the approved design and plans

f) Construction, supply, and installation of intermediate sewage & industrial effluent pumping stations, rising mains complete with all accessories, valves etc.

g) Supply and installation of meters for online monitoring of the quantity of effluent from individual industrial plots.

h) Installation, Erection, Testing, Commissioning and O&M of the complete domestic sewerage & industrial effluent system. The contractor shall be solely responsible for ensuring that the effluent collection system is free from any egress of water outside the system. The maintenance of all the devices, equipment, instruments, software systems etc including the cost of spares, batteries, subscription charges for SIM cards and annual maintenance, if any shall be borne by the contractor during the entire tenure of the contract for Operation and Maintenance.

4.2 Design Details for Industrial Wastewater and Domestic Sewage Collection System

The following parameters shall be followed for the design of the Industrial Wastewater Collection System and the Domestic Sewage Collection system :

Table 4-1: Design parameters of domestic sewerage & industrial effluent system

S.No.	Description	Value
1	Pipe Diameter	As per design but ID not less than 200 mm dia
2	Sewer Pipe Material along the Road	HDPE of PE100 PN6 up to 225mm and DWC SN8 pipe for sizes above 200mm
3	Encasing Pipe Material for Road Crossing	RCC NP4
4	Plot Connections	428 Nos. with a Diameter of the pipe 160mm
5	Flow meters	342 Nos. Battery-operated, electromagnetic with 2 GSM SIMs/IoT enabled and compatible with the Sewerage Management System.
6	Intermediate Sewage Pumping Station	As per the contractor's design
7	Sewerage Management System (web-based and app-based)	Sewerage Management system to be integrated with its respective SCADA. Each flow meter shall have appropriate RTU-compatible GSM and OFC connectivity with respective SCADA (by contractor) for control and monitoring. However, Contractor has to ensure its interface with ICCC (by others) for monitoring only through their utility SCADA. The contractor shall be responsible for coordination related to the interfacing with the ICCC system (by others). Any control system under the contractor's scope shall be fed with power from UPS, supplied by the contractor.

S.No.	Description	Value
		To be accommodated in the same room as that for the Potable Water Management System. It should be capable of real-time data collection and display of all effluent flow meters, sewage flow meters (as future provision), flowmeters of intermediate pumping stations. It shall have the capability of report generation and alerts

Table 4-2: Design parameters of Manholes

Sl	Description	Value
1	Type	Precast (as per approved design)
2	Material of Construction	Minimum RCC M25 with bituminous paint on the outer surfaces of Manholes and epoxy paint on the inner surface.
3	Distance	Not more than @ 30 m c/c and at Junctions, Bend, change of alignment and additional manhole for plot connection, as required.
4	Manhole Covers	Precast SFRC heavy-duty factory-made with embossed MITL logo.
5	Depth of Manholes	Minimum depth – 1.2 m Maximum depth – 6 m
6	Manhole Flushing System	To be considered using recycle water as per the approved design.

4.3 Background

The domestic sewerage network will collect the sewage from the residential, commercial, institutional and amenities plots and convey it to the sewage treatment plant (STP) located within the project area. The industrial effluent network will collect the wastewater from the industrial plots and convey it to the common effluent treatment plant (CETP) located within the project area.

The implementation limit of these two systems will be from the service connection point outside the plot boundaries to the inlet points of the intermediate sewage pumping station if any and/or directly to STP premises by gravity system to the best possible extent. The design and construction of the property chamber for connection are in the scope of the contractor.

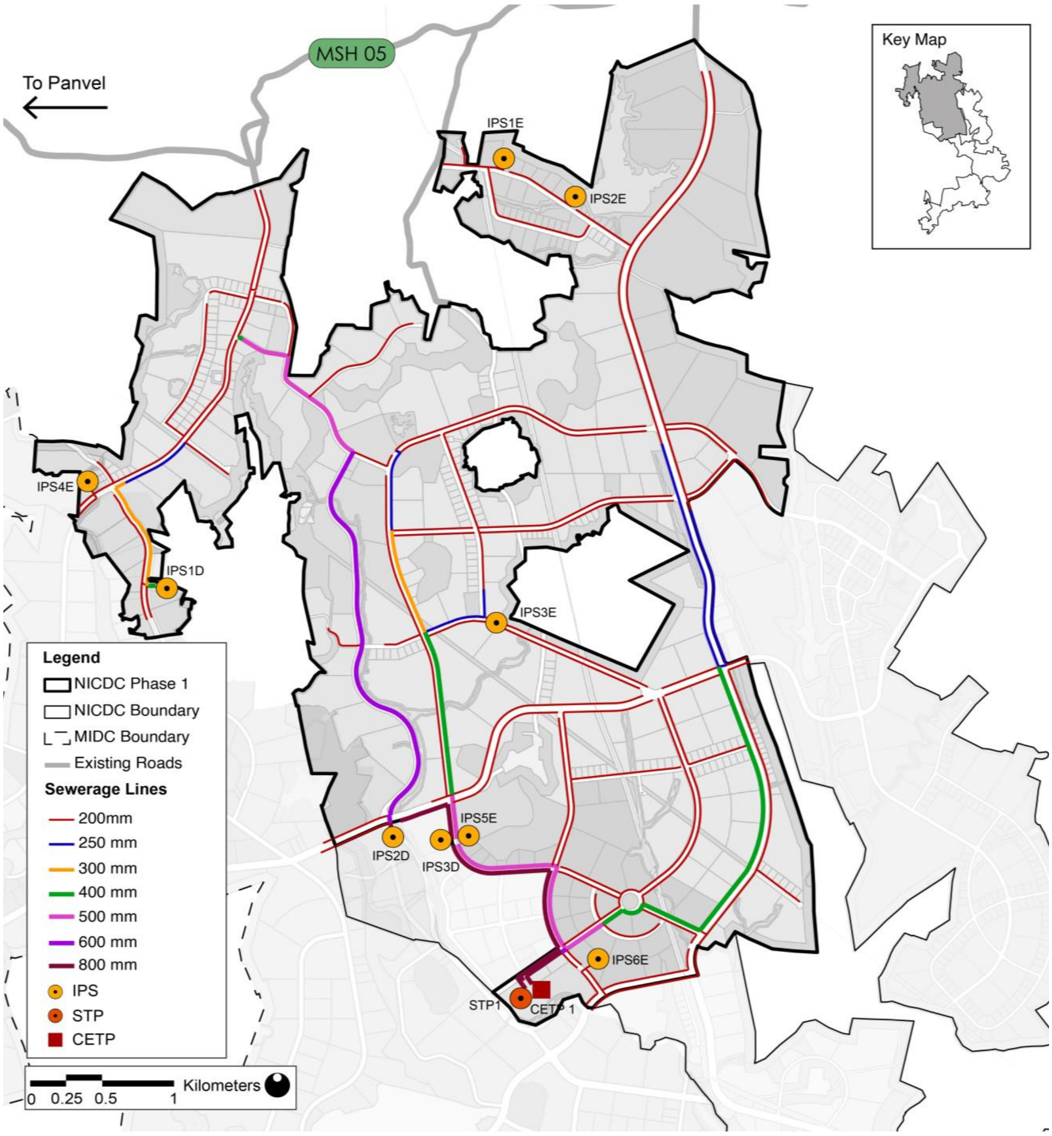

Figure 4-1: Domestic Sewerage and Industrial Effluent Collection & Conveyance Network

4.4 Estimated Generation of Industrial Wastewater and Domestic Sewage

Table 4-3: Domestic Sewage / Industrial Effluent Generation

Land use	Without infiltration (MLD)	With infiltration (MLD)
Pharma industries	5.02	5.52
Engineering industries	4.45	4.90
Food Industries	3.66	4.03
Residential Area	7.87	8.66
Commercial / Institutional / Amenities	2.69	2.96
Sub Total	23.69	26.06

Table 4-4: Domestic Sewage / Industrial Effluent generation conversion factor

Land use	(%)
Residential	80
Industrial	65

Land use	(%)
Commercial / Institutional / Amenities	80
Horticulture	0

4.5 Rate of Infiltration

Infiltration into the domestic sewerage & industrial effluent system occurs through defective sewers, manholes, etc. The rate of infiltration into sewers also depends upon the groundwater table and the permeability of the surrounding soil. Though strict quality control and good workmanship would ensure minimum infiltration, however as the system condition deteriorates with age, the possibility of infiltration increases.

For the hydraulic design of sewers, an allowance for infiltration shall not be more than 10% of the total domestic sewage / industrial effluent flow per day.

4.6 Design Period

Industrial Wastewater and Domestic Sewage collection, conveyance, treatment & disposal projects are designed to meet the future requirements of a stipulated design period. This period, with regard to certain components of the project, depends on their useful life or the facility for carrying out extensions whenever required, so that expenditure far ahead of its utilisation is avoided and capital expenditure incurred on the project does not remain idle due to underutilization of these facilities. For the purpose of designing such systems, a 30-year project period is recommended. The design period normally considered for various components is as under:

Pipeline and it's appurtenances : 30 years

Pumping Mains : 30 years

Mechanical and Electrical Components : 15 years

4.7 Peak Factor

As far as the design of the Industrial Wastewater and Domestic Sewage network is concerned, it is the hourly variation in consumption of water that matters. The fluctuations in consumption are accounted for, by considering the peak rate of consumption as rate of flow in the design of network. The flow in sewers varies considerably from hour to hour and also seasonally, but for the purposes of hydraulic design it is the estimated peak flow that is adopted. The peak factor or the ratio of maximum to average flows, depends upon contributory population & industrial processing. In general, the following values shall be adopted as suggested in the CPHEEO manual and as tabulated below:

Table 4-5: Peak Factors for Contributory Population for Per Capita Sewage Flow

Contributory Population	Peak Factor
For population less than 20,000	3.00
For population range of 20,000 to 50,000	2.50
For population range of 50,000 to 750,000	2.25
For population above 750,000	2.00

Since the variability of flow in industrial sewers is not as high as domestic sewer and depends on the batch production, the contractor after discussing with the Employer/PMNC shall consider the same in designing the system. However, for the design of effluent network, a minimum peak factor of 1.5 shall be considered

4.8 Sewage Pumping Stations

The Industrial Wastewater and Domestic Sewage system shall be planned and designed in such a fashion that no intermediate pumping is required. However, the same is to be ascertained during the detailed design of the respective system by the contractor. The scope and specifications given in this section are applicable to intermediate pumping stations for both domestic sewerage and industrial effluent systems.

For sewer depths higher than 6m, the increase in depth of cut leads to an increase in the cost of excavation. Lower depth of sewers will increase the number of ISPS. Considering the soil strata, high groundwater table (1.5m from ground during monsoon) and depth of sewer & industrial effluent network, efforts to be taken to minimize the depth of pumping stations up to 6m. The design of SPS/ISPS shall be based on contributing flow, area availability, maximum depth of sewer, high ground water table, etc. Open excavation shall be used for construction of pumping stations with side slope of 1V: 1.5H up to 3.0m depth and with side slope of 1V: 2H for deeper excavation, along with 1m wide berms at every 4.0m.

Method of open excavation as defined above can be adopted up to a depth of 6 to 7.5 m below ground in open/unrestricted areas. Whereas, for deeper excavation or excavation in restricted areas, sheet piling can be adopted since excavation area will be more due to side slope and berms.

Intermediate Sewage Pumping stations are included in the scope of contract and laying of sewer pipeline up to Inlet of Intermediate Pumping station and from outlet of common delivery pipe (rising main) to the nearest Manhole and further network will be under the present scope of services. The pump houses shall be of adequate size to house the pumps of required capacity and other allied electrical and mechanical equipment, also designing and providing all PLC/SCADA/Automation requirements for required components.

In case intermediate pumping is required, the intermediate sewage pumping station shall be designed with given below specifications:

Pipe Material for Rising Main shall be DI pipe K 9 as per (IS 8329) with sulphate resistant cement internal CM lining.

The wet well shall be designed as per sub clause 4.6.6. of CPHEEO manual on Sewerage & Sewage Treatment Systems. However, minimum diameter of the wet well shall be 1.5 m.

The Pumps shall be of submersible type with open impeller. Detailed specification of the pumps shall be referred from general mechanical specifications provided in the tender document.

For average dry weather flow upto 3 MLD, at least one mechanical screen shall be provided and for average dry weather flow of 3 MLD or more, at least two mechanical screens with 100% standby shall be provided. In case, it is not possible to accommodate the screens within the wet well, a separate screen chamber before the wet well shall be provided.

The Pump house shall be in RCC construction of required grade as called in the tender.

The pumping station shall de designed with odour control system.

Pumping system configuration, capacity of pumps, type of operation (continuous/VFD/intermittent) shall be selected such that

a) No of start / stops of pumps at any inlet flow condition (whether lean/avg/peak) for constant flow pumps should not be more than 6 times /hr.

b) 100% or more standby at all conditions of pumping flow

c) If VFD is selected, then turn down operating condition should not be below 30 – 50% of original speed.

d) Suitable control/throttling system to be considered if continuous flow pumps are selected.

e) Suitable Lifting equipment for pumps and screens to be provided.

Suitable level measuring transmitters for pump well/ screen chamber to be provided.

Sewage / Industrial effluent Pumping system details shall be referred from the relevant section and General Mechanical Specification of this specification.

4.9 Property Connections

Service pipes for the property connections should be laid up to plot boundaries in the project area & end capped. The service pipe details are as defined below:

Table 4-6: Tentative Details of Property Connections

S.No.	Description	Value
1	Pipe Diameter	Not less than 160 mm OD.
2	Pipe Material	HDPE
3	Total number of domestic sewerage property connections	86
4	Total number of industrial property connections	342

4.10 Coefficient of Roughness

The coefficient of roughness is based on the type of pipe material proposed for the sewage collection & conveyance. As per guidelines of the CPHEEO manual on Sewerage & Sewage Treatment Systems, the coefficient of roughness “n” for HDPE pipe shall be considered as 0.010.

4.11 Design Capacity of Sewers

Sewers shall be designed to carry estimated peak flows generated in the design year and would be designed 80% full at ultimate peak flow. This is to ensure proper ventilation and prevent septicity of sewage. No sewer pipe shall run at any time more than 80% full.

4.12 Minimum and Maximum Velocity in Sewer

Considering typical values of particle size and specific gravity, minimum partial flow velocities are considered at present peak flows and at design peak flows. The maximum velocity shall be considered in order to prevent scouring.

A velocity of 0.6 m/s would be required to transport sand particles of 0.09 mm size with a specific gravity of 2.65. Thus, the sewers are designed on the assumption that although silting might occur at minimum flow, it would be flushed out during peak flows. Erosion of sewers is caused by sand and other gritty material in the sewer and also by excessive velocity. Velocity in a sewer is recommended not to exceed 3 m/s.

Table 4-7: Maximum and Minimum Velocity in Sewer

S.No.	Criteria	Velocity (m/s)
1	Minimum velocity at initial peak flow	0.6
2	Minimum velocity at ultimate peak flow	0.8
3	Maximum velocity	3.0

4.13 Slope in Industrial Wastewater and Domestic Sewage Collection System

The minimum slopes that shall be considered for the design of the network are as in the table below:

Table 4-8: Minimum Slopes

S.No.	Sewer Size (Mm)	Minimum Slope (1 In)
1	200	250
2	250	360
3	300	450
4	375	670
5	450	830
6	>=525	1000

4.14 Bedding

For HDPE pipes bedding shall be designed taking into account the required external loading conditions, geotechnical requirements such as subsoil and bearing capacity of soil encountered in the respective sewer line, type, class and material of pipe used for the laying purposes as per CPHEEO manual on Sewerage & Sewage Treatment Systems and IS 783.

Fine sand bedding 200mm thick shall be provided for HDPE Pipes.

The contractor also needs to check and design the anchoring arrangement to mitigate the uplift of pipes due to the high-water table in the project area.

4.15 Manhole Size, Depth, and Type

The channels in Manholes at junctions and bends shall be smooth with gradual transitions to avoid turbulence and deposition of solids. Manholes are usually constructed directly over the line of the sewer. They are circular, rectangular or square in shape. Manholes should be of such size that will allow necessary cleaning and inspection. As per IS-4111: 1986 "Circular type Manholes are much stronger than rectangular and arch type Manholes and thus these are favoured over rectangular as well as arch type Manholes". Therefore, circular Manholes shall be proposed on all sewer lines for all depths starting from 0.9m. The diameter of the Manhole varies with the change in depth of the Manhole. GRP-encapsulated GI Rungs shall be provided for entry into Manholes.

The scope for this item includes providing and constructing precast RCC circular manholes, Drop manholes and flushing manholes in accordance with the CPHEEO manual on Sewerage & Sewage Treatment Systems and IS 4111 part 1 and 2. The contractor has to minimize the number of drop manholes; however, if required drop manholes shall be provided in line with the recommendation of the CPHEEO manual on Sewerage & Sewage Treatment Systems. Flushing manholes shall be connected with a recycle network system with all necessary arrangements. The contractor's scope also includes the provision of flushing water in case of the non-availability on recycle water during the initial years.

Table 4-9: Manhole Sizing

Range of Depths, m	Maximum Dia Up to	Manhole Size
above 0.90 m and up to 1.65 m	500 mm	900 mm dia.
above 1.65 m and up to 2.30 m	600 mm	1200 mm dia.
above 2.30 m and up to 9.0 m	900 mm	1500 mm dia.
above 9.0 m and up to 14.0 m	1200 mm	1800 mm dia.

4.16 Spacing of Manholes

As per IS – 4111: 1986, For inspection, cleaning and testing of sewers, manholes should be built at every change of alignment, gradient or diameter, at the head of all sewers and branches and at every junction. This shall be kept in mind while designing the system.

The sewer shall be in a straight line between two manholes.

The maximum distance between service manholes should not be more than 30 m.

Manhole spacing is limited to 30m for sewers having service connections.

4.17 Cover Frame

As per IS-4111: 1986, the size of manhole covers should be such that there should be clear opening of not less than 560 mm diameter for manholes exceeding 0.9 m depth.

The manhole cover and frame shall be Precast SFRC heavy-duty factory-made with an embossed MITL logo conforming to the IS 12592.

Table 4-10: Manhole Cover Details

Manhole Type	Load withstanding capacity	Suitable Locations
M.D (Medium Duty)	10.00 MT	Footpaths and Cycle Track
E.H.D (Extra Heavy Duty)	35.00 MT	Carriage way for all roads.

4.18 Crossing of Sewer lines over Small River and Nallah

Suitable pipe bridges will be provided at the locations where the proposed transmission main/distribution main will cross river/ streams. The bottom level of the pipe will be kept above the maximum water level in the water course. Final Locations of crossing shall be verified on site and design to be done by EPC contractor.

At river where there is road crossing (bridge/ viaducts) for vehicles or passengers, the span, supports for the pipeline shall match with the supports of the bridge/ viaduct. For other culvert, small river and nallah crossings, the pipe bridges shall be designed with maximum span of 5m. The pipe supports of the pipe bridge shall be designed and constructed in accordance with approved standards. The final detailed arrangements shall be designed by the Contractor and approved by the Engineer prior to work.

Complete concrete encasement shall be provided to the pipe in cases of road crossings and nalla crossings Concrete used for this shall be of the M25 type. Before placing concrete, the pipes shall be supported near each joint with a padding of compressive material on a pre-cast concrete block. Concrete shall not be placed until the pipes have been joined, inspected and passed hydraulic testing.

The concrete shall be placed to ensure full contact with the pipe barrel throughout its length. Necessary reinforcement steel shall be provided as per the approved design and site conditions. The concrete shall be made discontinuous at flexible pipe joints by a diaphragm of fibre board or other compressible material of at least 20 mm thickness extending for the full area of the surround. The concrete encasement shall cover the pipeline on all sides by a minimum of 100 mm on each side.

A specific geotechnical investigation shall be performed by the contractor for each proposed crossing to evaluate potential 100-year flood scour depths of the waterway at the ultimate development of the drainage basin. The final detailed arrangements shall be designed by the Contractor and approved by the Engineer prior to work.

However, Gravity sewers, if possible, shall be converted to pumped sewer lines by a low lift dedicated pumping station before the crossing discharging into the gravity section after crossing the watercourse; this will help in keeping the pumped sewer visible to the eye or close to the ground at all times. The EPC contractor has to design & decide as per site conditions for all crossing at water bodies.

4.19 SCADA/ Automation

The contractor needs to coordinate with the Master ICT System Integrator (separate contract) for interfacing between the SCADA system of STP and intermediate sewage pump stations (ISPS).

4.20 List of Applicable Codes and Standards

Detailed specifications for the water supply system have been presented in section 12.8. Key standards have been listed below.

CPHEEO Manual for Sewerage and Sewage Treatment, 2013

SP 7 (2005): National Building Code of India, 2005

Urban and Regional Development Plans Formulation and Implementation Guidelines, 2014

SP-35: Handbook on Water Supply, Plumbing & Drainage, 1987