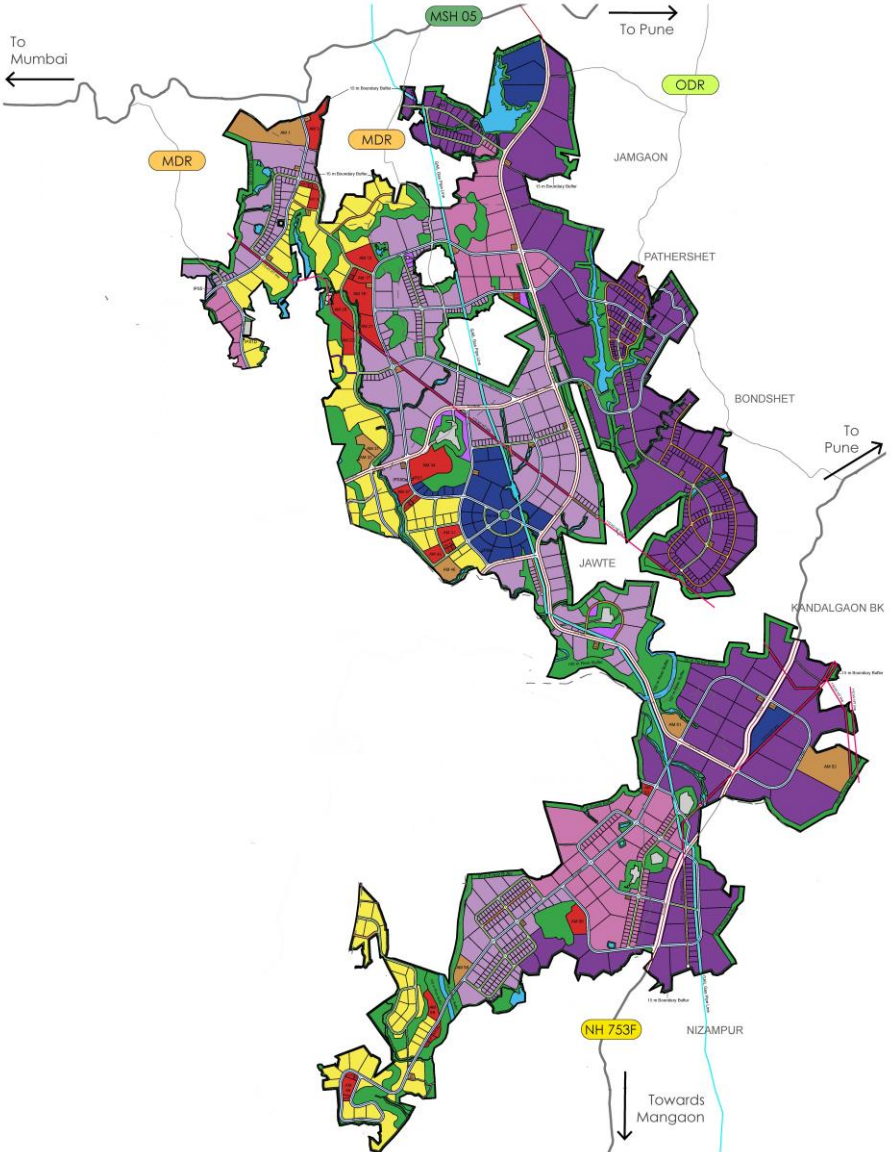
Maharashtra Industrial Township Limited (MITL)

Design, Construction, Testing, Commissioning, Operation and Maintenance of Infrastructure Works at Dighi Port Industrial Area (DPIA) Phase 1 on EPC Basis

Volume II: Technical Specifications

Part J - Water Treatment Plant

July 2025



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Part A: Treatment Plant

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Acronyms and Abbreviations

DPIA	**Dighi Port Industrial Area**
MITL	Maharashtra Industrial Township Limited
NICDC	National Industrial Corridor Development Corporation
DMIC	Delhi-Mumbai Industrial Corridor
MIDC	Maharashtra Industrial Development Corporation
WTP	Water Treatment Plant
MLD	Million Litres per day
CPHEEO	Central Public Health and Environmental Engineering Organisation
MoUD	Ministry of Urban Development (MoUD)
MEICA	Mechanical, Electrical and Instrumentation Control and Automation
GA	General Arrangement
O&M	Operation and Maintenance
DLP	Defect Liability Period
CAPEX	Capital Expenditure
OPEX	Operational Expenditure
NPV	Net Present Value
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
FDS	Functional Design Specification
RFI	Request for Inspection
GFC	Good For Construction
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
TSS	Total Suspended Solids
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
DO	Dissolved Oxygen
DG	Diesel Generator
UGSR	Under Ground Storage Reservoir
FRP	Fibre-Reinforced Plastic
N&E	North and East
EOT	Electric Overhead Travelling

PLC	Programmable Logic Controller
SCADA	Supervisory Control and Data Acquisition
UPS	Uninterruptible Power Supply
GPRS	General Packet Radio Service
MCC	Motor Control Centre
QA/QC	Quality Assurance / Quality Control
QAP	Quality Assurance Plan
HV	High Voltage
LV	Low Voltage
AMF	Automatic Mains Failure
SPT	Standard Penetration Test
CCTV	Closed Circuit Television
CMMS	Computerized Maintenance Management System

1 Water Treatment Plant

1.1 General Description of Works

The scope of work for the Water Treatment Plant (WTP) under this contract comprises of site data collection and studies, site development, design, engineering, manufacture, supply, transportation to site, storage, construction, installation/erection, testing, commissioning, performance guarantee test run and putting into successful operation of the complete 21 MLD WTP facility on EPC basis with 4 year O&M basis including all Civil, Structural and Architectural, Mechanical, Piping, Electrical, Instrumentation, Control and Automation and all infrastructural work covering buildings, lighting, drains, roads, landscaping, plantation, all preparatory and temporary works to meet the entire scope of works for the plant capacity indicated in the process design requirements.

Each of the treatment plants shall comprise, but not be limited to, the following components:

a) Process/treatment units and components as described in Volume II: Technical Specifications: Part J: WTP of this tender document

b) Mechanical, Electrical, Instrumentation, Control and Automation (MEICA) systems complete, including supply, installation, testing and commissioning services

c) Buildings and Civil works, including pipeline systems/channels, internal roads, curbs, pavements, drainage systems, etc.

d) All functional buildings, structures, equipment and other accessories and ancillaries related to process units

e) Testing, trial runs and commissioning services for all systems, including performance guarantee

f) Operation and Maintenance of the plant, including the supply of chemicals and consumables

The Contractor shall be fully responsible for designing and construction of the WTP to ensure that the whole of the Works, including each individual component, is designed, and constructed in a manner so that the system as a whole operates as a fully integrated system with PLC and SCADA which is capable of achieving the required output efficiently and economically, and to include all plant, equipment and accessories required for the safe and satisfactory operation of the facilities. To achieve this, the Contractor shall ensure that each individual component performs in a manner which is complementary to that of all other components. Any accessories which are not specifically mentioned in the specifications, but which are usual or necessary for completion of the Works and successful performance of the System and facilities shall be provided by the successful Bidder within the tendered cost.

The Water Treatment Plant shall have a well-planned layout, aesthetically pleasing elevations for buildings and landscaping by a qualified architect, considering the location near one of the entry gates to the site.

The plant layout shall include necessary space provision to accommodate a receiving chamber for future phases and arrangements for establishing connections and maintaining continuity of raw water flow to the future units.

The Contractor shall ensure that his designs are "maintenance-friendly" and that all items of plant and equipment are designed and installed in a manner which will facilitate routine and periodic maintenance operations.

The Bidder shall include in its scope all the equipment, works and services necessary for complete, safe and reliable operation and maintenance of the facility in accordance with the terms of the Contract, even if certain works are not expressly stated in any part of the Tender Documents.

The Bidder's scope shall also include the interior works, including but not limited to false ceiling, flooring, lighting, ventilation, HVAC, and office furniture in each part of the building suited for the intended activity and purpose.

1.2 Standards and Codes

Except where otherwise specified, all Plants, Equipment, Materials, Workmanship, preparation of drawings, 3D models shall comply with the requirements of CPHEEO, relevant Indian Standards (hereinafter referred to as IS) issued by the Bureau of Indian Standards (BIS) or such other Code of practices or Manuals issued by the Relevant State/ Central Government agencies of India for that purpose.

In the absence of any Indian Standard or Specification, International Standards and Specification such as those issued by International Organization for Standardization (ISO), British Standards (BS or BS EN), European Standards (EN), American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), Japanese Industrial Standards (JIS), International Electro-Technical Commission (IEC) or any other International Standards, Specification or manual to be followed or shall be proposed by the Contractor for approval by Employer's Engineer.

All Standards and Specifications, whether national or international, applied and used shall be with the latest edition (revision, amendments or correction slips) as available up to the date of submission of the Bid.

In the event of conflict between any of these Specifications and the Codes referred to, such specifications shall be defined, prepared by the contractor and submitted to the Engineer for approval. The decision of the Engineer in such a case shall be final and binding on the Contractor.

All drawings submitted by the Contractor shall use the English language and SI units.

All drawings shall be clearly and fully cross-referenced to the Specification and the tender drawings as relevant. Where drawings are revised, the revision letter or number shall be incorporated in the title block, and the revision shall be indicated on the drawing with the revision letter or number shown in an adjacent triangle.

1.3 Detailed Scope of Work

The detailed scope of works for Water Treatment Plant (WTP), but not limited to, the following:

1) Site topographic survey and geotechnical investigations, soil testing as deemed necessary by the contractor

2) Setting out the works

3) Site development including land clearing, planning utility routing, access roads, excavating, dewatering, grading, etc, in coordination with the infrastructure for water distribution systems.

4) Study and analysis of the raw water for the water treatment process design.

5) Basic Engineering Package including Process and Hydraulic design with calculations, Equipment List and Datasheets

6) Preparation of Process flow diagram, Process and Instrumentation Diagram, Hydraulic flow diagram, Site Layout, GA drawings, Piping Layout and Equipment Layouts. Submission of detailed engineering submittals as per the tender requirements.

7) Design and detailed engineering of all process units, buildings, structures and equipment.

8) Preparation of an integrated 3D BIM model.

9) Design and Construction of all civil units/structures and building works.

10) Design, Erection and Commissioning of bypass lines

11) Design, engineering, procurement, manufacturing, shop fabrication, assembly, testing and inspection at supplier's works, packing, insurance, dispatch, shipping, delivery at Indian port/unloading at Indian port/delivery from Indian port to site in case of imported equipment and delivery/unloading at site for indigenous equipment, unloading and storing at site, successful completion of site acceptance test (SATs) of all Mechanical, Electrical, Instrumentation Control and Automation (MEICA) equipment.

12) Erection of all MEICA items, including testing, commissioning, performance testing of process units, trial run for one month, handing over of the full package, warranty, and defect liability period

13) One-month performance guarantee test to successfully demonstrate the guaranteed parameters for treated water and others (consumption of power, chemicals, etc) after successful commissioning and stabilisation of the Water Treatment Plant.

14) Contractor will be responsible for the complete facility for four (4) years of the operation and maintenance from the date of issue of the Completion Certificate and the successful completion of PGTR. The Operation and Maintenance period will commence upon the issue of the completion certificate only in the case of deferred PGTR due to the non-availability of the raw water for treatment for reasons not attributable to the contractor.

15) Pumping systems for conveyance/transmission of the treated water from the treated water tank to the service reservoir.

16) Safe disposal of treatment plant residuals, like but not limited to dewatered sludge.

17) Automation & Control - PLC-based automation system with application software shall be provided. The treatment plant shall be capable of running in automatic mode with a redundant PLC/SCADA system. Complete automatic PLC/SCADA-based operation including clarification, filtration, sludge dewatering, operation of blowers, disinfection process, chemical dosing, VFDs, limit switches and instrumentation in the plant. The automation system for the water treatment plant shall be designed to include a minimum

of 20% spare capacity for each I/O module. Spare terminals shall be provided for at least 20% of the I/O points to ensure easy integration of additional field devices. All wiring and cabling infrastructure shall be designed to support the additional 20% I/O capacity, ensuring that spare I/O points are fully functional and ready for immediate use.

18) Ultrasonic level transmitter on all sumps/tanks. Flow meter in all lines, but not limited to filter feed lines, filter backwash discharge line, treated water transfer pumps.

19) HMI Panel shall comprise of up-to-date standard PC with monitor, printer, mouse, RS-view, RS-links (gateway version), entire process and operator software with dynamic flow charts, pictures, screens, alarms, historical trends, reports, etc.

20) Digital energy meter along with CTs and protective switchgears on each MCC, which shall be connected on MODBUS communication with PLC to have all parameters like Voltage, current, Power Factor, active and reactive power.

21) Site Master Planning in accordance with the Development Control Regulations, by-laws, provisions for future treatment plant units.

22) Architectural design and drawings for buildings, including Administration and Control Building, Filter House, Blower House, Chemical Building, Maintenance Building, MCC, Guard Room.

23) Landscape design and drawings.

24) Construction of Internal Roads, including connecting road to site from existing road to have a separate and independent entry to plant/site.

25) Boundary wall of approved height with top barbed fencing as per approved design for the required perimeter of the site, with entry gates and security cabin.

26) Illumination/Lighting of the entire WTP, laboratory with equipment and uninterrupted supply of reagents, chemicals and testing facilities.

27) Storm water drainage within battery limits and extension up to nearest drain/point of disposal, drinking water & sanitation water system for operating & maintenance personnel, yard lighting, fencing, etc.

28) Drinking water, toilet, urinal and changing room facilities for the security staff and labourers.

29) Lay-down areas, warehouses, workshops with necessary equipment, tools and tackles for site construction, pre-fabrication purposes and for operation and maintenance.

30) Architectural model of WTP as per the approved process design depicting the process units, layout, landscaping post completion stage of WTP along with the provision for the future WTP phases. The architectural model should be made in a suitable scale and accommodated on a tabletop of size 2m x 2m. The 3D model shall be made using acrylic or any other approved durable material within 3 months from the appointed date. The 3D model shall be placed at the place designated by the Employer/ Employer’s Engineer.

31) The Contractor shall ensure that all designs and equipment for which he is responsible are safe. Nothing in this requirement shall remove the Contractor's obligation from drawing the attention of the Employer's Representative to any feature of the Works, which is not consistent with safety, or to prevent him from making proposals for incorporating equipment or designs which would increase the safety of the site and plant.

32) The installation layout and system design shall not allow any item of plant to be so positioned that danger to operating personnel could arise during normal operation and maintenance. Attention shall be paid to the position of pipes, air vents, electrical cables, and rotating machinery.

33) All rotating shafts, couplings, gears, flywheels, belt drives or other moving parts shall be fully guarded. Guards shall be designed to provide ready access to bearings, grease points, thermometer sockets/instrument probes and other checkpoints and to allow safe routine observation and servicing to be executed without the need to dismantle any part of their structure.

34) All the statutory consents, including but not limited to Consent to Establish (CTE), Consent to Operate (CTO) and statutory compliances during construction and O&M period to ensure uninterrupted and continuous operation of the plant.

35) Any other items of work which have not been specifically mentioned in specifications but are necessary for the plant as per engineering practice and safety norms and operation and guaranteed performance of the entire plant shall be deemed to be included within scope of work of these specifications and shall be provided by the Contractor without any extra cost to the Employer.

1.4 Works Life Expectancy

The Contractor shall design the Works for a life expectancy as follows:

Name of unit	Design Life
Concrete structures	50 years.
Mechanical plant	15 years.
Electrical plant	15 years.
Control panels	15 years.
External instrumentation systems	10 years
Computer systems	10 years.
Piping	30 years
Chemical Tanks (GRP/FRP)	30 years

1.5 General Arrangement of Treatment Plant

The Contractor shall ensure that the whole of the works as installed are safe for use by the operation and maintenance staff, and by any other persons having access thereto.

The treatment plant shall be designed with a compact layout having vertical stacking of compatible units and equipment, ensuring minimal land footprint while maintaining full operational functionality, safety, and ease of maintenance. The design shall incorporate a modular approach, enabling phased implementation, ease of expansion for future phases.

Permanent guardrails, electrical safety devices, thermal insulation, noise-suppression devices, written notices, safety colours, and the like shall be provided during the erection and operation of the plant. The equipment layouts shall provide easy and safe access to all operating devices, free from hazardous obstructions.

A continuous, unobstructed walkway shall connect all the process units, allowing seamless movement between various units. Intermediate entry and exit points shall be provided on the walkway. Walkway bridge shall be provided between successive elevated units, and between

other elevated units that require connectivity for the ease of operation. This Walkway shall be at least 1.2m wide, paved or tiled and shall have a hand railing, as required.

Nothing in this Specification shall remove the Contractor's obligation to draw the attention of the Employer's Representative to any feature of the Works, which is not consistent with safety, or prevent him from making proposals for incorporating equipment or designs which would increase the safety of plant equipment.

A set of special tools and tackles which are necessary or convenient for erection, commissioning, maintenance and overhauling of the equipment shall be supplied.

The tools shall be shipped in separate containers clearly marked with the name of the equipment for which they are intended.

The following general rules, but not limited to below shall be followed in arranging and designing the Plant units:

1) Sufficient room (of not less than 3.0 m wide) shall be allowed between items of Plant and adjacent Plant or fixed structures to permit safe and convenient access for operation and maintenance, for the provision of appropriate structure foundations. In case of the areas that require movement of heavy equipment for installation and replacement, sufficient access shall be provided to move heavy vehicles.

2) An area adjacent to all mechanical plant shall be provided as a maintenance lay down area; fixed runways, lifting eyes or other means shall be provided to permit the removal of Plant Equipment that may logically be required to be removed during its normal operational life for maintenance or any other purpose.

3) The Pumps should be designed for positive suction. Pumps shall generally comply with the requirements of codes and standards as cited in the tender documents. Pumps shall be so selected as to have a maximum capacity of not less than 125% of the rated capacity. Pump sets shall be suitable for the required duty conditions and shall be designed and constructed for 24-hour continuous duty at full load. The pumps shall be designed for continuous operation at any point of the head capacity curve between 25% and 125% of the pump's rated flow without undue vibration or overheating.

4) Areas where leakage is likely to occur, whether in normal use or during maintenance, shall be provided with underground drain line or covered RCC drainage channels, which shall direct spillage either to a suitable drain or to a sump from where it can be pumped to drain.

5) Plant where necessary shall be provided with a removable acoustic enclosure to limit the noise produced during normal operation to the limits detailed in the General Requirements.

6) The plant shall be arranged, and the building shall be designed to permit the removal/relocation of Plant items. The Plant layout shall be such that no flooding/inundation is allowed even during heavy monsoon, and the units should always be accessible.

7) All the units shall have drain valves. The drain valves of a diameter less than 250mm shall be manually operated and higher than 250mm shall be electrically operated. For the valves located below ground level extended spindle shall be provided for ease of operation.

8) Equipment Bases: Steel base plate with proper corrosion restraint paint/protection shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Employer's Representative. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections. Bases shall be appropriately painted for protection against corrosion.

9) All motors shall have a run indication.

10) Aeration blowers shall be located inside the blower room with necessary acoustic hoods complying with statutory and safety norms.

11) The main control room housing PLC/SCADA shall be in such a manner that the entire WTP is preferably visible to the operator through glazed windows.

12) Knife Gate valves shall be provided for sludge application.

13) Doors, Windows, and Ventilators shall be of aluminium glazed type.

14) EOT crane shall be provided for Centrifuge Building, Blower room, etc., as required of adequate capacity (minimum 2 times the weight of the heaviest equipment).

15) Adequate measures shall be taken to prevent dry running of the pump. Every sump and tank shall be provided with an ultrasonic level transmitter. The level of tanks and sumps shall be displayed on the control room panel.

16) Contractor should design the plant in such a manner that the vehicular approach road from entry and exit points is available up to the Centrifuge Building, Blower Room, Lamella Clarifiers, Filter House, Chemical House and MCC.

17) Flushing connections shall be provided for all sludge handling units and sludge lines.

18) Access to platforms shall be by stairs/ ladders. Access shall be by stairway if the unit requires frequent attention from operating personnel.

19) Common delivery header and suction header of pumps (and blowers) shall be provided with a blind flange on one end.

20) Sludge handling system with bracket making to be provided and storage area also be properly designed with flooring & roof.

21) The whole area should have a well-designed landscape, tree plantations, tiled pathways, adequate safety hand railings at all units, area lighting for the whole plant area and a well-designed storm water drainage system.

22) Chemical House including storage area, Testing Laboratory with all required equipment, testing chemicals/agents required for regular testing and testing kits, etc.

23) Chemical pipework shall be secured to racks or trays to be fixed to duct walls or walls of tanks and buildings as necessary. The method of securing the pipes to the racks shall be by clips or something similar, facilitating ease of removal in such a way that individual runs can be changed without dismantling adjacent pipes.

24) All chemical pipes shall be colour-banded and suitably labelled to enable individual lines to be identified throughout their run. Particular attention shall be paid to the layout of the chemical pipework, which shall be functional and neat in appearance. Generally, where pipework is installed in ducts, it shall be supported not less than 150 mm clear of the floor.

25) When selecting materials for pipework, the Contractor shall consider the deteriorating effect of some of the synthetic materials due to the action of ultraviolet light. Where such materials are employed, they shall be shielded from direct sunlight. All the exposed MS piping should be Zinc Epoxy coated as base, then painted 2 coats with approved colour to suit to the type of carriage liquids

1.6 Sludge Generation and Dewatered Sludge Requirement

A sludge treatment system shall be designed to treat the entire quantity of the sludge generated from the treatment with influent parameters and flows as indicated in the particular design requirements for the plant.

The dewatered sludge after treatment should have a minimum consistency of 20% Dry Solids, with at least 95% per cent of the dewatered sludge samples meeting the requirement.

The treatment facility shall be designed to treat sludge for disposal to a landfill/ hazardous waste management facility as per MPCB norms, at a suitable location as approved by the Engineer-in-Charge.

The contractor shall be solely responsible for the treatment, secured transportation and safe disposal conforming to the latest MPCB/CPCB Hazardous Waste Management Rules.

1.7 Pipe Material and Type of Valve

The design requirements for Pipe material and Valve type common for WTP are provided in **Table 1-1.**

Table 1-1: Pipe Material and Valve Type Specification

S No	Application	Pipe Material	Valve Type
1.	Raw Water	DI	Gate valve
2.	Treated Water	DI	Butterfly valve
3.	Sludge	DI	Gate valve
4.	Thickened and Dewatered Sludge	DI	Knife edged gate valve
5.	Air pipe	SS 316	Butterfly valve
6.	Chemical	• Polymer: SS 316/FRP • Alum: uPVC/ CPVC/ HDPE/ GRP • NaOCl: uPVC/ CPVC/ HDPE/ GRP (As per chemical compatibility and options to be selected as per suitability based on type of installation, whether exposed to sunlight or inside shed or overhead or underground)	Ball valve / Diaphragm valve

1.8 Surveys, Topographical Survey and Soil Investigation Agency

A detailed geotechnical investigation shall be performed at the Site before starting works by the successful Bidder. However, the Bidder is required to verify the sub-soil strata, including the CBR value, by conducting the site investigation prior to developing the civil/structural design.

The geotechnical parameters necessary for the detailed foundation designs would depend on the findings of site-specific ground investigation.

The Contractor is required to confirm the topographical surveys and soil investigations before starting works.

The contractor should be ready with the qualified agencies he intends to use for the purpose and ensure that the work starts within a fortnight of the LOI. He shall conduct investigations as are normally necessary to ensure full and satisfactory designs and safety.

1.9 Workability and Maintenance

Facilities and equipment shall be arranged and spaced sufficiently to enable satisfactory operation and maintenance of the Plant. Access around all equipment shall be provided, in accordance with Good Utility Practices, to allow effective inspection, maintenance and removal of equipment.

Aisle ways adjacent to equipment and lay-down areas shall be sufficient to facilitate all aspects of major maintenance and Plant overhaul. General arrangement drawings shall be provided, clearly identifying the outline of all major Plant equipment, their weights and associated floor loading capacity and lay down location.

Space should be provided at the front and rear of the skid to allow the use of mobile equipment and access to pressure vessels for membrane replacement or leakages repairs.

Permanent lifting devices should be provided for maintenance of heavy equipment; they should be sized to lift the heaviest equipment in the said process unit.

The lay down areas for all major facilities shall have adequate space for direct heavy transport, as well as trailer access and direct mobile crane access. Platforms shall be provided around equipment as required for maintenance work, testing, inspection, and safe operation. Platforms where provided, shall be sized to facilitate safe ergonomic operation of manual valves and equipment between waist and shoulder level of an average height man. Those parts of the facility where maintenance activities will be performed shall be provided with permanent arrangements for slinging or handling during maintenance and overhaul.

All automatic valves and major equipment should be at ground level or accessible by permanent platforms. The marking and test specification of safe working load values on lifting equipment shall be in SI units.

All platforms to be visited on a daily basis shall be provided with stairways, except where a permanent access ladder is the only feasible means of access. All interior and exterior platforms gratings and/or checker plate shall be of GRP. Handrails shall be SS- 304 Schedule 10 made of 32NB pipes/tubes with top and intermediate rows of pipes running parallel to each other and the height of railing not less than 1100mm.The distance between 2 vertical posts shall not be more than 1.5 meters. The post shall also be of 32 NB.

Platforms shall be constructed using a suitable grade of GRP grating, to the relevant ISO, British Standards or ASME Standards and shall cater for the relevant loadings for maintenance. Generally, no frequently accessed platform shall be less than 1m wide and all platforms shall be extended up to the equipment, valves, and instrumentation that they serve. All edges of floors, platforms and walkways shall be provided with curbs or kicking strips.

Sufficient space should be provided to ensure easy inspections and maintenance of all the equipment.

1.10 Plant Reliability Criteria

A part of the Works shall be deemed to have failed its test if:

- A single item of Plant/ equipment fails more than twice during the test.
- More than four individual Plant items/ equipment fail.

An item of Plant/equipment shall be deemed to have failed if manual intervention is required to restore the Plant/equipment to its fully operational state: i.e. the failure of a duty drive shall be considered as one failure, if the standby drive fails to start, that shall be considered as a second failure.

If the tests show that the specified water quality has not been reached, the Contractor shall submit his proposals for meeting the guarantees to the Engineer's Representative and shall carry out at his own expense whatever measures may be necessary to achieve the specified water quality.

Such measures may include improvements, alterations or additions to the plant, and the contractor shall bear the whole cost of such electrical, mechanical, civil works or other changes. Tests will be repeated until the Engineer's representative is satisfied that the guarantees have been met.

1.11 Noise Limits

There should not be any noise nuisance generated from the WTP. Therefore, the noise limit at 1m away from the blowers or any other equipment should not exceed 80 dB (A).

1.12 Detailed Engineering Designs and Drawings

The Contractor shall submit the 3D BIM Model in accordance with Schedule L, Design and Drawing in accordance with Clause 11.2 and Schedule D, for approval by the Employer's Engineer, including but not limited to the list below.

Contractor shall submit the documents for Basic Engineering, followed by Detailed Engineering. The contractor shall submit detailed engineering designs and drawings after the approval of the basic engineering. designs and drawings, and shall inter alia comprise:

1) Civil

a. Foundation Recommendation including Bearing Capacity, Piling requirement, Pile Load Capacity, any soil improvement requirement, if applicable.

b. Approximate Quantum of Civil and Structural works (Major Quantities)

c. Civil general arrangement drawings of all structures

d. Architecture designs and concepts for treatment units, buildings, landscaping, etc.

e. Plan and elevation of all buildings.

f. Structural design calculations for all structures and buildings

g. Reinforcement drawings and Bar bending schedule

h. Standard drawings for Steel/FRP/Aluminium works, e.g. Handrail, Ladder

i. Transformer fencing

j. Design of internal roads as per applicable development control regulations

k. Plant stormwater Drainage system

l. Water supply, Sewerage and Plumbing drawings for buildings

m. A drawing showing buried pipelines and other utilities along with N&E coordinates and offsets from permanent structures

n. Cable routes and Cable trenches

o. General arrangements and main sections of all plant areas

p. A description of the building services provisions proposed for the Works

2) Process and Hydraulics

a. Detailed Hydraulic Calculations

b. Detailed Hydraulic Flow Diagram

c. Plan and L-section profile of the main pumping

d. Detailed Process Design Calculations

e. Detailed Process flow diagram, inclusive of mass balance

f. Comprehensive P&ID including the details of pipeline sizes and materials, valve size and type, Equipment detail, instrumentation and identification of controlling PLC

3) Mechanical

a. Mechanical general arrangement drawings of all structures.

b. Detailed Mechanical Equipment Schedule along with equipment datasheets

c. Equipment Specifications with supporting vendor brochures.

d. Detailed Piping schedule which includes the details of size, type, material, coating, lining, gauges/thickness and pressure rating.

e. Detailed Valve schedule which includes the details of size, type, material, pressure rating, operator/actuator type, Open/Close/Modulating type, etc.

f. Detailed Penstock schedule which includes the details of size, type, differential head, seating or non-seating, operator/actuator type, Open/Close/Modulating type, etc.

g. Outline Dimensional drawings and cross-sectional drawings for the following items for WTP but not limited to:

    i. Cascade Aerator

    ii. Stilling Chamber, Parshall flume, Distribution Chamber

iii. Flash Mixer, Flocculator

iv. Clarifier Mechanism

v. Dual Media Rapid Gravity Filter

vi. Disinfection System

vii. Centrifuge

viii. Sludge Conveyor System and Hopper

ix. Chemical Dosing System

x. Dosing Tanks

xi. Dosing Tank Agitators

xii. Manual and Motorized Penstocks

xiii. Manual and Motorized Gate Valve

xiv. Manual and Motorized Butterfly Valve

xv. Non-Return Valve

xvi. Knife Edged Gate Valve

xvii. Dismantling Joints

xviii. EOT Crane, Electrical Chain/Wire Hoist, Gantry Crane with electrical chain hoist and Manual Hoist

xix. Fixed Lifting Davit crane

xx. Pipeline sizes and materials

xxi. Performance curves, Efficiency curves and Graphs for all pumps and blowers

xxii. Catalogues for all electromechanical equipment

4) Electrical

a. Drawings

i. Electrical General Arrangement Drawings:

ii. Composite Single Line Diagram for the electrical system:

iii. Schematic drawings for each HV / LV switchboard.

iv. Internal and external general arrangement for each switchboard.

v. Bill of quantities of each switchboard

vi. Transformer schematic and general arrangement drawings

vii. Cable block diagrams

viii. Cable connection diagrams (or schedules)

ix. Cable routing/installation drawings

x. Foundation and fixing details drawings

xi. Transformer enclosure drawings

xii. Earthing system general arrangement drawing.

xiii. Lighting drawings.

b. Schedules

i. Cable Schedules

ii. Load and Power consumption schedule

iii. Junction Box schedule

iv. Protection relay setting schedule

c. Calculations

i. Transformer sizing

ii. DG sizing

iii. Fault level

iv. Cable sizing

v. Coordinated protection study

vi. Earthing calculations

vii. Battery sizing

viii. Lighting calculations.

Note:

- Schematic drawings shall include a comprehensive schedule of the components used in each switchboard, MCC and control panel, including details of the type, manufacturer and rating of each component.
- The external arrangement of each switchboard, MCC and control panel shall show the arrangement of all components, including details of panel section, switch and instrument labels.

5) Control and Instrumentation

a) Drain

i) Power supply distribution, single line and schematic diagrams for each control panel

ii) Internal and external general arrangement for each control panel (dimensional)

iii) Control panel wiring diagram, relay logic diagram, along with terminal block details

iv) System configuration and layout diagram along with bill of material, program listings, block logic diagram and control logic write-up for PLC

v) UPS and battery sizing calculations

vi) Control and instrumentation loop drawings

vii) Catalogues for all instruments

viii) Control and Instrumentation system configurations diagrams

ix) Instrument installation detail drawing

x) Cable block diagrams

xi) Cable routing/installation drawings

xii) Foundation and fixing details and trenches drawings

xiii) Mimic general arrangement (full colour copies shall be provided)

xiv) Loop Diagrams and Interconnection Diagrams.

b) Schedules

i) Cable schedule

ii) Cable interconnection schedule

iii) Control and instrumentation load schedule for each control panel

iv) I /O schedule

v) Junction box schedule

vi) Instrument schedule with tag nos

vii) Instrumentation, process control set point schedule

viii) Instrument data sheets

c) Documentation

i) Functional design specification (FDS)

ii) Factory acceptance test document (FAT)

iii) Site Acceptance Test document (SAT)

Note: Electrical control schematics, loop diagrams and schedules shall be of scale as directed by the Employer's Engineer.

1.13 Engineering Specifications

The Contractor shall follow the technical specifications provided in the relevant sections of Volume 3 and Volume 4 for the design, engineering and procurement of Mechanical, Electrical, Instrumentation, Control and Automation (MEICA) equipment/systems.

2 WTP Process Design Requirements

2.1 Design flow for WTP

The WTP should be designed for the average daily flow of 21,000 m^3/day.

2.2 Raw Water Quality

The plant shall be designed to treat the raw water quality with the characteristics summarised in **Table** 2-1**.** For the parameters other than those listed in the table below, Successful bidders shall analyse the raw water Characteristics for obtaining approval from the employer engineer during the detailed design stage.

Table 2-1: Raw water characteristics

S.No.	Parameters of Raw Water	Values	Unit
1	pH	6.5 – 8.5	
2	Turbidity	500	NTU
3	Alkalinity	150	mg/l as $CaCO_3$
4	Total Hardness	225	mg/l as $CaCO_3$
5	Total Suspended Solids	650	mg/l
6	Total dissolved solids	≤500	mg/l
7	Iron as Fe++	<1	mg/l
8	Chlorides	200	mg/l
9	Sulphate	200	mg/l

2.3 Treated Water Quality

The final treated water after filtration and disinfection shall comply with the following criteria:

Parameter	Value
pH	7 – 7.5
Turbidity	not exceeding 1.0 NTU
Suspended solids	not exceeding 1.0 mg/l
Colour	not exceeding 5 Hazen units
Taste and odour	unobjectionable
Iron as Fe	not exceeding 0.1 mg/l
Manganese as Mn	not exceeding 0.1 mg/l
Total aluminium	not exceeding 0.03 mg/l as Al.
Total Coliform (MPN/100 ml)	Nil
E coli (MPN/100 ml)	Nil
Faecal Coliform (MPN/100 ml)	Nil
Residual Free Chlorine	not exceeding 0.2 mg/l

In addition to the above, the Contractor shall ensure compliance with IS 10500 (2012) for heavy metals & other parameters.

2.4 Performance guarantee

The potable water quality shall adhere to IS 10500 (2012). All works for the processing and treatment of raw water shall be designed for a capacity of 21 MLD. The performance test shall

be conducted at the maximum flow of 21 MLD. These tests shall be undertaken to assess compliance with the water quality requirements as indicated in the tender and will be performed under both the dry season and the monsoon season conditions. During the performance guarantee run test, a minimum of 10% of analyses shall be carried out by a third-party laboratory approved by CPCB/MPCB and the Employer/Engineer-in-charge.

The WTP shall be designed for continuous operation and shall have a turndown ratio without manual intervention of at least two to one. It shall be possible with manual intervention to reduce the flow through the plant to 50% of full capacity without affecting the quality of the treated effluent/wastewater.

2.5 Clarifier water quality for the dry season

For the dry season or non-monsoon season conditions, when raw water turbidity is not expected to exceed 40 NTU, clarified water quality shall be compatible with the following standards:

Turbidity	< 5 NTU
TSS	< 5 mg/l
Total Aluminium	< 0.03 mg/l as Al

2.6 Clarifier water quality for the monsoon conditions

For the monsoon conditions with turbid water, the clarified water quality shall be compatible with the following standards:

Turbidity	Any single value not exceeding 7 NTU maximum, with an average value over 24 hours not exceeding 5 NTU
TSS	< 5 mg/l
Total Aluminium	< 0.5 mg/l as Al at any time over 24 hours

2.7 WTP Treatment Scheme and Scope

Contractor's scope of work for the project shall include, but not be limited to, the treatment scheme indicated in Volume 2, Part J – WTP and Volume 3, Tender Drawings, which is the minimum requirement.

The Contractor shall provide an elaborate and technically sound process justification for the selection and sequencing of each unit operation, supported by detailed calculations, process flow diagrams, and evidence of proven performance, such as operational data from reference installations, pilot studies, or validated performance literature. The efficacy of contaminant removal at each stage shall be demonstrated and traceable through mass balance or removal efficiency analysis.

In addition, the Contractor shall obtain and furnish vendor-supported performance guarantees and process warranties for all critical equipment and treatment modules, including chemical dosing systems, clarifiers, filter units, and UV systems. All such documentation shall be subject to technical scrutiny and approval by the Owner or their authorised representative before procurement and implementation.

The raw water from the source shall be pumped (by others) and delivered through a rising main at the battery limit of the plant.

The contractor shall provide a connection with the rising main and ensure the minimum required head of water is available at the inlet of the Cascade Aerator as per the approved hydraulic flow diagram. The water shall be directed to subsequent treatment units by gravity.

Cascade aeration shall ensure oxidation of soluble iron to ferric form, which will get settled in the clarifiers and liberate dissolved gases, if any. It will also help in raising the dissolved oxygen content. The cascade aerator shall be of a circular tray type of concrete construction with the inlet pipe located in the centre. Water shall be introduced into the top tray through the central feed pipe and allowed to flow down the successive trays.

The Parshall flume is used to measure the incoming raw water. An ultrasonic level transmitter shall be installed at the jump to measure the water level, and hence, the flow is measured.

Then the raw water shall be mixed with Alum and/or Poly Aluminium Chloride (PAC) in the flash mixer, followed by a flocculator. The flocculated water shall flow to the sedimentation basin, i.e. lamella clarifier. The suspended solids will settle down in the form of sludge, and clarified water overflow will take place over adjustable weirs. A dedicated flash mixer and flocculator shall be provided for each individual lamella clarifier.

The clarified water from the clarifier will flow to the dual media rapid gravity sand filter through the clarified water channel. The filter is a declining rate type; the filter runs normally be not less than 24 hours with a loss of head not exceeding 1.5m.

Disinfection shall be through a UV light based system followed by chlorine dosing to obtain a residual value of Chlorine.

A covered Clear Water Reservoir, along with a pumping station, shall be considered for storage of the treated water.

2.8 WTP Staffing Requirements

The bidder shall provide all the necessary minimum operating staff and maintenance personnel so as to ensure the smooth operation & maintenance of the plant.

The O&M staff shall include a minimum number of dedicated personnel for the operation and maintenance of the WTP as indicated below:

Position	Min. Number	Desired Qualification
Plant cum HSE Manager	1 (general shift)	Bachelor's degree in Civil/Environmental/Chemical Engineering with a minimum of 10 years of work experience of a similar nature.
Chemist/Lab Technician	1 (general shift)	Bachelor's degree in Chemistry with a minimum 7 years work experience of a similar nature.
Process Engineer	1 (general shift)	Diploma in Environmental/Chemical Engineering with a minimum 7 years work experience of a similar nature.
Mechanical Engineer	1 (general shift)	Diploma in Mechanical Engineering with a minimum 7 years work experience of a similar nature.
E&I Engineer	1 (general shift)	Diploma in Electrical Engineering with a minimum 7 years work experience of a similar nature.

Position	Min. Number	Desired Qualification
Mechanical Fitter[#]	1 (general shift)	ITI in Mechanical with a minimum 5 years work experience of a similar nature.
Electrician	1 (general shift)	ITI in Electrical with a minimum 5 years work experience of a similar nature.
SCADA Operator	1/shift + 1 reliever[$]	ITI in Electrical/Instrumentation with a minimum 5 years work experience of a similar nature.
Plant Operator	3/shift + 1 reliever[$]	ITI in Mechanical with a minimum 5 years work experience of a similar nature.
Skilled Labour	3/shift + 1 reliever[$]	12th pass with a minimum of 3 years work experience of a similar nature.
[#] The operator shall be provided per process unit or for a group of process units based on the level of automation implemented in the plant and as approved by the Engineer-in-charge. In any case, the plant shall have the following dedicated operators 1 No. for Filter House, 1 No. for CWR pumps, 1 No. for preliminary treatment units, including Clarification.		
[$] Contractor to ensure the availability of a suitable reliever for the designated position and maintain continuity in operations 24x7 and 365 days a year.		
The O&M staff shall also include a Computer operator, an office boy, Security Staff, a Gardener, Housekeeping staff, etc.		

The Contractor shall obtain the Engineer-in-charge's approval on the detailed proposed staffing schedule before the start of the O&M period for each of the sections of the Works. The schedule shall cover all categories of staff from the works superintendent to cleaners, including adequate numbers of maintenance staff.

The staffing schedule for the O&M contract period shall be prepared to operate the Plant on a 24-hour per day basis with three equal shifts of 8 hours.

3 WTP Particular Design Requirements

The water treatment technology to be used is proposed to consist of the basic unit processes, viz., coagulation, flocculation, clarification, and filtration, followed by disinfection. A schematic representation of the proposed water treatment process/technology to be adopted is given below

Sludge line from Clarifier:

3.1 Cascade Aerator

The Cascade Aerator shall be of concrete construction with a circular concentric tray design, with the inlet pipe located in the centre. Water shall be introduced at a required head into the top tray through the central feed pipe and shall be allowed to flow down to the successive trays by gravity.

Exposure time will be suitably designed so that the desired DO level will be maintained by providing an adequate number of steps in the cascade aerator. Each tray shall be provided with a sufficient fall to ensure the required aeration efficiency per tray is achieved. Each receiving tray shall be provided with a pool to allow entrained air to mix with water. A collecting launder shall be provided to receive the aerated water falling from the lowest tray.

The design details for the cascade aerator are provided in table below:

Table 3-1: Design details of Cascade aerator

Description	Values	Unit
Qty.	1	no.
Design Flow	21	MLD
MOC	RCC M35	
Surface Loading Rate	0.035 – 0.045	$m^2/m^3/hr$
No. of steps	minimum 5	no.
Height of riser	250 - 300	mm

3.2 Stilling Chamber

The design details for the cascade aerator are provided in the table below:

Table 3-2: Design details of Stilling Chamber

Description	Values	Unit
Qty.	1	no.
Retention Time	30	sec
MOC	RCC M35	
Free Board	0.5	m

3.3 Inlet Channel with Parshall flume

The Parshall flume shall be installed with a fibreglass-reinforced plastic. The flume shall be accurate in dimensions and shall include in one integrally moulded piece the approach, the throat, and the downstream section. The inside of the flume shall be smooth and free of any irregularities. The outside surface of the flume shall include necessary flanges and/or other anchoring devices for firm, permanent anchorage to the concrete.

The flume liner shall be fabricated using general-purpose resin with glass reinforcement. Resin shall be general-purpose, corrosion-resistant polyester unless otherwise specified, containing no bulk extenders or fillers for viscosity control. Ultraviolet light inhibitors shall be added to the laminate. Wall thickness shall not be less than 3/16” for 3” through 9” flumes and not less than ¼” for flumes 12” and larger.

Ultrasonic flow meters shall be of digital processing technology using a microprocessor and memory card, acoustic signal processing, appropriate time resolution for higher accuracy and with measurement data displayed both in strip chart and data log formats.

The design and application of ultrasonic flow meters shall take into account the Parshall flume or channel construction, the material, size, shape, environment, process fluid or material, the presence of foam, granules, size, etc.

Ultrasonic flow measuring system shall consist of a flow sensor, flow transmitter cum computing unit, prefabricated cable connecting the sensor and transmitter, and any other item required for completing the flow measurement system.

The level measurement shall be taken using an ultrasonic system based on the time-of-flight principle. Horizontally and vertically adjustable stainless-steel construction ultrasonic flow measuring sensor bracket shall be installed.

The transducer shall be a non-contact type suitable for continuous measurement of level. The transducer shall have a blocking distance no more than 10% of the measurement range and a 3dB beam angle no wider than 10°. The system shall measurement level to an accuracy of ±0.5% of the measurement span. The flow measurement shall be accurate to ±1.0%.

3.4 Flash Mixer

The raw water from the cascade aerator shall enter the Flash Mixing units. The coagulant chemicals will be added to the raw water from the chemical house. An electrically driven impeller-type mixer will be provided in the tank for thorough dispersion of chemicals. After the flash mixing tank the flow will go to the lamella clarifiers. The rapid intense mixing of the coagulant chemicals with the feed water is provided in the form of flash mixing, with a necessary mixing time. This helps in the formation of micro-flocs and results in the proper

utilisation of the coagulant viz., preventing localisation of concentration and premature formation of hydroxides, which may lead to less effective utilisation of the coagulant.

The design details are provided in table below:

Table 3-3: Design parameters of Flash Mixer

Description	Values	Unit
Qty.	2	no.
Design Flow	7	MLD
MOC	RCC M35	
HRT	Minimum 1	min
Flash mixer	minimum 150	RPM
MOC of the mixer	SS316. The mixer motor shall have VFD to control the rpm as required.	
Inlet and outlet arrangement	Sluice/ Open channel gates	
Coagulant Dosing System		
Alum (max)	40	mg/l
Chemical Dosage Tank Storage Capacity	8	Hrs
Solution Strength	10%	
Storage capacity in the Chemical Building shall be for 60 days of uninterrupted usage at design flow.		
Lime Dosing System		
Lime Dosage	20	mg/l
Solution Strength	5%	
Storage capacity in the Chemical Building shall be for 60 days of uninterrupted usage at design flow.		

3.5 Flocculator and Lamella Clarifier

. Table 3-4: Design parameters of Flocculator & Lamella clarifier

Description	Values	Unit
Flocculator		
No. of Units	4	no.
Average flow per unit	5.25	MLD
HRT for Flocculator Zone	Minimum 30	min
Flocculator type	Rectangular	
Type of Agitator	Slow speed Paddle type flocculator	
MOC of Agitator	SS 316	
Lamella Details		
No. of Streams	4	Nos
Lamella Type	Rectangular with inclined plates	
Dimensions of Tube Settler / Plate Settler Pack	As per the Contractor's design	
MOC of plates	FRP/uPVC	
Plate Thickness	As per the contractor's design, ensuring distortion-free plates (without any bending/warping) and an external stiffener.	
Angle of Inclination Tubes	60	Degrees

Description	Values	Unit
Lamella Tank details		
Number of tanks	4	
Tank Shape	Rectangular (with a flat bottom) or Square	
Length to Width Ratio	3:1 to 5:1 for Rectangular Tank	
Bottom slope	1% for the Rectangular Tank/ 1 in 12 for the square tank having a circular mechanism	
Sludge Scraping	Chain and Flight Mechanism for Rectangular Tank/ Circular Mechanism for Square Tank	
MOC of Scraping Mechanism	Chain & Flight Scrapers - Polyacetal chain, glass fibre/ polyester flights, stainless steel 316L fabrication Circular Mechanism – SS316 fabrication with Neoprene squeegee	
Sludge Collection	Max 2 no. with a side slope of a minimum of 45 degrees for Rectangular Tank	
Weir Loading	< 300	m3/m/day
Solid Loading Rate (SLR)	6 - 8	m3/m2/hr
Flocculant Dosing System		
Poly Dosage	1-2	mg/l
Chemical Dosage Tank Storage Capacity	8	Hrs
Solution Strength	1%	

3.6 Dual Media Rapid Gravity Sand Filters

The clarified water from the Lamella clarifier shall flow through the clarified water channel to the Dual Media Rapid Gravity Sand Filters by gravity. The filter shall be a declining rate type; the filter runs should normally be not less than 24 hours with a loss of head not exceeding 1.5m.

The clarified water shall be distributed to the filters through covered peripheral reinforced concrete channels viz. the filter inlet channels. These channels shall be properly sized to ensure that clarified water is evenly distributed to all the filters. Overflow weirs are to be provided in the outer walls of these channels to discharge any overflow into the filter wash water channels.

Each filter bed shall be provided with meters for head loss, rate of flow of filters, flow controller, sluice valves, penstock of adequate size and dimension of approved quality. Each filter bed shall have separate control table for accommodating operating knobs and switches of these meters and valves.

Foundation under the drainage system laid in trenches in a typical rectangular grid pattern shall be provided underneath the filter units to drain off any water leaking through the bottom raft.

Every filter shall have walkways all around the wall. RCC platform with 32 NB SS-304 Sch. 3 pipe hand railing of 1200 mm height at 1500 mm C/C shall be provided at the top of filters for access and operation.

A filter gallery of a minimum 6m clear width shall be provided along the entire length of the filters. All the pipelines, valves, etc., in the gallery shall be properly supported on reinforced concrete pedestals. The drain water collected in a sump shall be pumped to the wash water collecting channel as required.

The filter control blocks shall be a reinforced concrete-framed structure located at one end of the filter streams. It shall have all the equipment, viz., air scour blowers, pumps.

Table 3-5: Design Details of Dual Media Rapid Gravity Sand Filter

Description	Values	Unit
Minimum No. of Filter Units	Minimum 6 (4W + 2S)	Nos
Configuration of Filter Unit	Twin bed	
Average daily flow	21	MLD
Filtration rate for n condition	maximum 7.5	$m^3/m^2/hr$
Filtration rate for (n-2) condition	maximum 10	$m^3/m^2/hr$
Type of media	Anthracite + Sand + any other media as per the contractor's design	
Anthracite	Sp. gravity of 1.4, effective size 0.7-1.7 mm and a minimum depth of 500 mm	mm
Sand Bed	Sp. gravity of 2.6, effective size 0.3 to 0.7mm and a minimum depth of 700 mm. Uniformity coefficient not less than 1.5.	mm
Other Media as per the Contractor's design	Minimum specific gravity of 3.5 and effective sand as per the contractor's design.	
Gravel and Pebbles	as per the contractor's design	
Water Column	Minimum 2000	mm
Freeboard	Minimum 500	mm
Inlet and outlet arrangement	Sluice/ Open channel gates	
Type of backwash	Air scouring (at least 2 minutes), combined air and wash water (at least 3 minutes), rinsing (at least 5 minutes) with a crossflow arrangement.	
Backwash velocity	24 - 36	$m^3/m^2.hr$
Backwash pump quantity	2 (1W+1S)	
MOC	CI, SS316, SS410 (Casing, Impeller, Shaft)	
Min. Air backwash velocity	45 - 60	m/hr
Air blower quantity	2 no. (1W+1S)	
Type of blower	Rotary tri-lobe blowers with acoustic hoods and suitable EoT	
Filter backwash Tank capacity	minimum for 2 backwash cycles	
MOC	RCC (min M35 grade)	
Filter underdrain system	False bottom with PP nozzles	
Wash water consumption	It should not exceed 2% of the quantity of water filtered between two consecutive washings.	

A reasonably constant level shall be maintained in the main clarified water inlet channel to the filters.

The common clarified water inlet chamber and channel and the individual filter inlet shall be sized so that the head loss along them is very small in view of the need to maintain a similar head differential to all filters and to ensure that there will be sufficient free fall between the water levels downstream of the clarifier launder and the water level at the inlet channels to the filters.

Each filter shall be washed on a time cycle related to the operating philosophy. An increase in the backwash cycle would require a shortening of the filter cycle and vice versa.

To carry out the dirt effectively to the central or side gullet, horizontal flow of water shall be introduced at the top of the medium (cross flow) during backwashing. This shall be done using clarified water.

Each filter shall be provided with a loss of head measuring system comprising of differential pressure transmitter, a panel-mounted digital differential pressure indicator, and any other item required to complete the system.

Each filter shall also be fitted with float float-type level switch to close the filter outlet before the media surface becomes uncovered, either on normal drain down preparatory to filter washing or cessation of inflow of clarified water.

An ultrasonic level measuring system comprising of level sensor, a level transmitter and panel-mounted digital level indicators shall be provided for the inlet channel to the filters.

The level transmitter shall be an indicating type with LCD display. It shall generate an isolated 4-20 mA DC signal. This signal shall be connected to the filter plant annunciation cum control panel. Signal multipliers shall be provided for multiplying this signal. One output of the signal multiplier shall be connected to a digital level indicator mounted on the front facia plant annunciation cum control panel to indicate level in inlet channel to the filters.

Filter pebbles or gravel shall be rounded, or water-worn stones, which when placed in layers in a filter above or around the under drains, effectively distribute wash water. The proposed depths and grading of each layer of gravel shall be as per the contractor’s design.

Filter sand is hard-grained quartz or silica sand having no constituent in any way friable or liable to mechanical breakdown when subject to pressure. The sand shall contain no carbonaceous matter, clay or silt and the loss on acid washing and ignition shall in each case be less than 2% by weight. The sand shall be supplied substantially free of fines and coarse material and at least 95% by weight shall be between the grading limits as approved by the Engineer-in-charge.

The effective size is defined as the size of the aperture through which 10% of the sand (by weight) passes.

The uniformity coefficient is defined as the ratio of the size of the aperture through which 60% of the sand passes to the effective size.

Fines are defined as the particles which pass through a size of aperture 0.9 times the effective size, and not more than 1% shall pass through the nearest sieve size.

All sand shall be washed, heat dried, graded, and packed in plastic or polyethene bags as approved by the Engineer’s representative for delivery to or storage at the site.

3.7 UV Disinfection

The main goal of disinfection shall be to kill or inactivate harmful microorganisms such as bacteria, viruses, and protozoa that may be present in the water even after other treatment steps. The proposed UV system shall be completely automated and controlled through PLC/SCADA. UV facility shall also include to measure the effectiveness of UV disinfection. Filtered water from the dual media rapid gravity filter will flow to the UV system by gravity for disinfection of the treated water, followed by Sodium Hypochlorite dosing to maintain Free Residual Chlorine (FRC) in the water distribution network.

Table 3-6: Design details of UV Disinfection tank

Description	Values	Unit
Nos. of Units	1	
Average flow	21	MLD
Qty	As per design with a standby provision	min
MOC	RCC, min. M35	
Inlet and outlet arrangement	Sluice/ Open channel gates	
Freeboard	0.5	m
The Dosing Rate	Minimum 40	mJ/cm2
Wavelength for UV light	253.7 nm (minimum)	
Ultraviolet Transmittance	75	%

3.8 Chlorination System

Sodium Hypochlorite dosing system (including dosing pumps and tanks) shall be provided for dosing adequate Chlorine to achieve an average FRC value at the farthest property connection.

Description	Values	Unit
Free Residual Chlorine (FRC)	Average 0.5	ppm
Chlorine Dosing System	Linked with FRC measurement	
Dosing Pumps	3 (2w+1S)	Nos.
Type	Positive displacement	
Dosing tank	2 No.	
Mixing arrangement	As per the contractor's design	
MOC	HDPE	
Measurement of FRC	FRC sensor and transmitter	

Contractor shall make adequate arrangements as per the manufacturer's recommendation to store Sodium Hypochlorite with an appropriate concentration, adequate for about 60 days of uninterrupted usage at design flow.

3.9 Filter House and Annexe Building

The filter house shall accommodate the dual media rapid sand filters, filter appurtenances, filter operating consoles, pipe gallery, wash water tank, the air blowers and the wash water pump sets etc. The filters and appurtenances shall be roofed and enclosed within the building. The height of the roof shall be a minimum of 3.6 m above the upper-level walkway at the top of the filter box. The filter annexe building housing air blowers, backwash tank filling pumps,

etc., shall be adjacent to the filter house structure, with interconnecting staircases or walkways to be provided to facilitate operator movement.

Filter beds and filter house shall be constructed of RCC of minimum M35 grade concrete, and the superstructure shall be a framed structure with panelling done by brickwork. The filter house, along with the annexe building, shall be aesthetically designed by a qualified architect to the satisfaction of the Engineer-in-charge.

Adequate doors, ventilators and windows shall be provided in the filter house to admit sufficient natural light. Adequate illumination as per approved design shall be ensured for round-the-clock operation. The internal design of the filter house shall not permit landing/ resting/nesting spaces for pigeons or other birds, and shall adopt adequate measures to prevent access for the birds in the filter house.

When filter beds are arranged in a single row, the pipe gallery is on one side of the beds. When the beds are arranged in two rows, the pipe gallery is located in between. Pure/Filtered water conduit or Channel shall be located in the pipe gallery or by the side of the pipe gallery. The top slab of the pure water channel is used as a lower-level walkway.

A walkway shall be provided around and in between filter beds with stainless steel handrails. The floor of the filter operating platform, walls and walkways in between the filters shall be provided with vitrified/ceramic tiles of approved quality and shade. All concrete surfaces shall be plastered. The inner walls of the filter house shall be painted as per approved specifications.

Pipe gallery should be well designed to provide adequate space, ventilation, adequate lighting/illumination, drainage and easy accessibility to all pipe-work and other fittings.

An upper-level walkway shall be provided at the top level of the filter box, and the filter operating consoles shall be accommodated on it. The width of the walkway is normally the same as that of the pipe gallery. The pipe gallery and pure water channel shall be housed in a building with headroom over the upper-level walkway of 3.5 m to 4.0 m.

White glazed tiles of approved make shall be provided in the filter chamber, also up to 30 cm below the top of the filter media and also on the inside of wash water gutters and gullet. There shall be a 40 mm wide and 25 mm high bead on the edge of the walkway to prevent debris and dust from falling into the beds during the cleaning of the floor.

3.10 Clear Water Reservoir and Pumping Station

The Raw water after all treatment, i.e. sedimentation, filtration and disinfection, shall be directed to the Clear Water Reservoir. The Clear Water Reservoir with a pumping station shall be provided to pump water to the Service Reservoir. Adequate arrangements to prevent contamination of the RO-treated water shall be made.

Table 3-7: Clear Water Reservoir

Description	Values	Unit
No. of Units	1 (With 2 compartments)	
Average flow	21	MLD
HRT at Average flow	Minimum 4	hr
MOC of the tank	RCC M35	

Description	Values	Unit
Tank cover	Slab in RCC M35	
Treated water transfer pumps	06 (3W+3S)	no.
Capacity of the pump	minimum 300	m^3/hr
Pump head	as per the system requirement	

The Clear Water Reservoir shall be provided with a pumping station suitable to pump water to the Service Reservoir (SR).

Table 3-8: Clear Water Pumping Station

Description	Values	Unit
Water transfer pumps	04 (2W+2S)	No.
Type of pumps	Submersible	
Pump lifting arrangement	Guide rails and lifting chains both in SS 316 and EOT Crane	
Capacity of the pump	as per the Contractor's design	m^3/hr
Pump head	as per the Contractor's design	
MOC of Pumps	Casing: SS 316; Impeller: SS 316, Shaft: SS 410	
Pump operation	VFD based	
Lifting Arrangement for maintenance	EOT Crane with suitable capacity	

An adequate area should be available in the pumping station for the maintenance of the pumps and the installation of electrical panels. The pumping station should be provided with an EOT crane with suitable capacity. The capacity of lifting equipment must be at least twice the weight of the heaviest item to be lifted. An electromagnetic flowmeter should be installed at the common discharge header of the clear water pumps.

3.11 Filter Backwash Wastewater Treatment

The backwash wastewater from filters shall be collected into a balancing tank. The balancing tank shall be constructed in two compartments. Overflow from first compartment shall be collected into second compartment and then pumped back to the inlet of the clarifier. The backwash wastewater shall not exceed 2% of the water filtered.

Table 3-9: Design details of Filter back wash wastewater treatment unit

Description	Values	Unit
Nos. of Units	1 with 2 compartments	
Average flow	21	MLD
MOC	RCC, min. M35	
Hydraulic Retention Time	minimum 2-hour	hours
Type of pump	submersible pumps	
Pump lifting arrangement	Guide rails and lifting chains SS 316.	
MOC	CI, SS316, SS410 (Casing, Impeller, Shaft)	
Qty	Minimum 3 Nos.(2W+1S)	
Capacity	As per the process design	

3.12 Sludge Handling System

3.12.1 Sludge Holding Tank

The clarifier underflow from the clarifiers and sludge from backwash recirculation sump shall be pumped to Sludge Holding Tank.

Description	Values	Unit
Nos. of Units	1	Nos.
MOC	RCC, min. M35	
Tank HRT	2	hrs
Sludge Thickener Feed Pump		
MOC	CI, SS316, SS410 (Casing, Impeller, Shaft)	
Qty	02 (1W+1S)	Nos.
Capacity	As per process design	

3.12.2 Sludge Thickener

Sludge thickeners of suitable capacity will be provided for thickening of sludge received from the sludge sump. The supernatant from the thickener will be routed to the backwash recirculation sump, and the thickened sludge from thickener will be collected in thickened sludge sump

Table 3-10: Design Criteria of Sludge Thickener

Description	Values	Unit
Nos. of Thickener Units	2	
Average flow	Flow Rate of Sludge to be Checked	MLD
MOC	RCC, min. M35	
Maximum solids loading rate	90	Kg/m^2.day
Outlet Sludge Consistency	4-5%	
Side Water Depth	3-5	m
Free Board	0.5	m
MOC of Launder	RCC	
MOC of Thickener mechanism	SS 316	
MOC of bridge	Shot blasted & CSEP	
MOC of weir and fasteners	SS 316	
Epoxy coating Minimum DFT	250	µm
MOC of the telescopic valve	SS 316	

3.12.3 Thickened Sludge Sump

One Thickened Sludge sump with two compartments of RCC construction will be provided to collect thickened sludge from the thickener. The sump will be equipped with an agitator so that the surface of the liquid is constantly agitated. From the thickened sludge sump, the thickened sludge will be taken to the centrifuge through centrifuge feed pumps for further dewatering.

Description	Values	Unit
Nos. of Units	1	Nos
MOC	RCC, min. M35	
Tank HRT	4	hrs
Dewatering Feed Pump		

MOC	CI, SS316, SS410 (Casing, Impeller, Shaft)	
Qty	02 (1W+1S)	Nos
Capacity	As per the process design	

3.12.4 Sludge Dewatering Building

Sludge dewatering units shall be provided for dewatering the sludge housed in the dedicated Sludge Dewatering Building, which shall be an RCC-framed structure with an RCC roof.

Sludge dewatering units shall be installed on the first floor or a raised platform such that the dewatered sludge can be discharged directly into the tractor trolley parked underneath, through a chute and opening in the floor. Adequate space at the same floor level shall be provided for the installation of the below-mentioned dewatering units, electrical panels, control panels and the maintenance bay. An electrically operated hoist shall be provided for the lifting and moving of the centrifuge parts and moving them to the maintenance bay.

The dewatered sludge loading area should have an industrial flooring suitable for the movement of a tractor trolley and glazed tiles on the walls and ceiling for washing and cleaning of the splashed sludge. The floor shall have an adequate slope for draining the wash water and connection to the nearest sewer.

Dewatered sludge cake from the centrifuge will be stored in the sludge storage/ tractor trolley shed. The sludge storage shed should be sized for a minimum 15-day storage capacity at the design flow.

The Centrate from the centrifuge shall be collected in the balancing tank and pumped back to the stilling chamber.

Table 3-11: Design details of Centrifuge

Description	Values	Unit
No. of Units	3 (2W+1S)	No.
Type of Unit	Solid Bowl Centrifuge	
Operating hours	16 hrs/day	
MOC of centrifuge Bowl, Scroll and other wetted parts	SS 316	
Type of conveyor	Screw conveyor	
MOC of screw conveyor	SS 316	
MOC of discharge chute	SS 316	
Capacity	By Bidder	
Inlet sludge solid concentration	4- 5%	
Solid concentration in dewatered cake	Minimum 20 %	
Polymer dosing tank	01	No.
MOC	FRP/PE	
Polymer dosing pumps	2 (1W+1S)	No.
Polymer Dosing Pump Capacity	As per the process design	
Sludge Storage Shed for Dewatered Sludge	15 days storage capacity	days
To aid in the flocculation of sludge, the DWPE system for the centrifuge will be designed for a dosage rate of 2.0 to 3.0 kg/ton of solids at 0.1% solution strength.		

3.12.5 Dewatered sludge disposal (off-site)

The Contractor shall be responsible for identifying suitable disposal location/land/site and route(s) for all sludge arising from the Works and disposing of the sludge and for paying all tipping & transportation charges and other associated costs, including that for land/site. The Contractor shall dispose of any waste materials off-site in accordance with MPCB directives, existing laws and regulations. All permissions and consents shall be obtained by the contractor from the respective authorities.

3.13 Chemical House

The chemical house will be designed as an RCC-framed structure with brick walls, rooms having adequate corridor approach, with proper ventilation, natural lighting, and drainage. The chemical house and centrifuge building shall be aesthetically designed by a qualified architect to the satisfaction of the Engineer-in-charge.

There should be access to the first floor and roof by means of stairs.

One no. electrically operated monorail hoist with a capacity of 1 Ton is to be provided on the first floor for lifting the chemicals.

Adequate area shall be provided for the following:

Floor	Facility
Ground Floor:	Operator office area + toilet block
	Alum Storage Area
	Lime Storage Area
	Poly Storage Area
	Unloading area
First Floor:	Alum dosing tanks and pumps
	Lime dosing tanks and pumps
	Poly dosing tanks & pumps
	Lifting mechanism for transporting chemicals to the first floor
	Walkways and stairs with handrails for accessing the dosing tank

3.14 Chemical dosing systems

For all the chemical dosing systems in the plant, the material of construction used shall be compatible with the dosing chemical. All chemical lines shall be colour-banded and suitably labelled to enable individual lines to be identified throughout their run. An appropriate dyke wall shall be constructed for each dosing system. All the dosing systems shall have a calibration column, strainer, pressure damper, safe overflow arrangement, drain arrangement, and vent. Chemical dosing systems shall be installed inside the building with appropriate ventilation. All the chemical dosing systems in the project shall have 100% capacity x 2 nos. of dosing pumps. Storage capacity for each chemical used in the treatment process shall be for 60 days of consumption.

3.15 WTP Admin cum Control Building

The WTP Admin cum Control Building shall be a single/double-storeyed structure with a minimum total built-up area of 300 sq. m and a floor height of 4.5 m. The Admin Block shall

comprise offices for employees, a Laboratory, a Plant Manager Room, a Meeting Room, a Record Room, a Control Room, a SCADA, a Rack Room, and a Pantry with dining and toilets for the staff and visitors. The interior works for the building shall include false ceiling, flooring, lighting, ventilation, HVAC, and office furniture in each part of the building suited for the intended activity and purpose.

The control room shall be of adequate size to accommodate the monitors, operator consoles for the operation of 22 MLD WTP and to accommodate visitors (minimum 25 nos. in standing position) to the facility.

The proposed building shall meet the following minimum carpet requirements

Sl	Name of the Building Units	Minimum Area Requirement
1	Laboratory	60 sq. m
2	Plant Manager Office	20 sq. m
3	Office for Staff	40 sq. m
4	Meeting Room (15-seater)	60 sq. m
5	Record Room	12 sq. m
6	Control Room	60 sq. m
7	SCADA Room	As per the contractor’s design
8	Rack Room (if applicable)	As per the contractor’s design
9	Pantry with Dining Room	30 sq. m
10	Male Toilet block on each floor	8 sq. m
11	Female Toilet block on each floor	8 sq. m

At least 1 day of water storage for use by staff and visitors, calculated as per NBCC guidelines for water requirements, has to be provided on top of the building in the form of an RCC or PE tank.

The building shall be RCC RCC-framed structure with brick wall panels. The brick walls, plastering, painting, plinth protection, etc., shall be as per the civil specifications. The building shall be aesthetically designed by a qualified architect to the satisfaction of the Engineer-in-charge.

3.16 Laboratory Room

The laboratory shall be adequately sized to accommodate all the testing equipment, sample storage, chemical/reagent storage (for 60 days' use), tables and chairs for at least 2 chemists and other laboratory staff.

The laboratory shall be provided with an RCC platform projecting 750 mm from the wall at about 1000 mm height from the floor level along the walls on the three sides of the internal walls of the laboratory. At least two laboratory sinks of size 375 mm x 450 mm (ID) in stainless steel of reputed make of good quality installed in the RCC platform. The white glazed tiles shall be provided on the RCC platform and on the walls above the platform for a height of at least 60 cm above the platform. Shelves shall be provided on the wall above the platform for the storage of chemicals, reagent bottles required for daily usage. The space underneath the platform shall be provided with shutters with door fittings and may be used for long-term storage of chemicals/reagents. In any case, adequate storage space with secured shelves for a 60-day storage of laboratory chemicals and reagents shall be provided within the laboratory.

The floor of the laboratory shall be provided with antiskid vitrified/ceramic with an arrangement to wash and drain the floor. The first-floor slab and the roof slab shall be in concrete, suitably designed for loading as per the relevant IS code of practice.

3.17 Sampling and Analysis

Sampling and analysis shall be performed to measure the physical, chemical, and biological parameters as per design requirements, at the appropriate locations and frequencies. In case of multiple units (Such as clarifiers, filters), the indicated sampling and analyses shall be performed for each individual module.

All the sampling and analyses shall be performed as per procedures in APHA (American Public Health Association), Standard Methods for Examination of Water and Wastewater, latest edition. An original copy of the APHA standard methods shall be procured and permanently stored at the laboratory.

3.18 Analytical Laboratory

A well-equipped Laboratory with all the necessary equipment shall be provided by the contractor, and an adequate stock of reagents and chemicals shall be maintained at all times for 60 days of use.

The analytical lab shall be equipped for routine analyses to be conducted on a day-to-day basis. The Contractor should also provide for the supply of laboratory equipment, instruments, glassware, chemicals, and miscellaneous items.

The following is the list of minimum laboratory equipment to be provided by the contractor and should always be available for dedicated use for the testing requirements related to the WTP:

S.No.	Description	Qty
1	Benchtop pH meter with buffer solutions	1
2	Benchtop Conductivity meter	1
3	Dry Thermostat Reactor	1
4	Analytical Balance	1
5	Thermometer	1
6	Desiccators	1
7	Digestion Block	1
8	Vacuum Pump	1
9	Water bath	1
10	UV Visible Spectrophotometer	1
11	Colorimeter	1
12	Distilling Apparatus with Graham Condenser	1
13	Flocculator (6 jar accommodation)	1
14	Refrigerator	1
15	TSS portable meter - Turbidity and solids analyzer	1
16	TDS portable meter	1
17	Glass wares	1 lot
18	Lab Accessories	1 lot
19	Laboratory Chemicals	1 lot
20	Teflon magnetic stirrer	1 lot

S.No.	Description	Qty
21	Handheld DO meter	1
22	Set-up for Coliform count, E-coli count	1 lot

Apart from the above-mentioned equipment, the laboratory shall have all the necessary equipment and chemicals/reagents for the following chemical and bacteriological routine analyses:

Temperature	Chlorides	Suspended solids
pH	Alkalinity	Residual Chlorine
Conductivity/ Total Dissolved Solids	Hardness	E. coli counts
Turbidity	Sulphate	Colour

The methods, as per the APHA – Standard Methods for Examination of Water and Wastewater shall be described in the laboratory manual. The book and the soft copy of APHA – Standard Methods for Examination of Water and Wastewater – latest edition shall be bought and shall always be available in the lab.