



# KARACHI WATER & SEWERAGE BOARD

## OFFICE OF THE PROJECT DIRECTOR (S-III) PROJECT

Block – D, 1<sup>ST</sup> Floor, 9th Mile Karsaz, Shakra-e-Faisal, Karachi

Telephone No. 021-99240873, Fax No. 021-99240828

No. PD/S-III/KW&SB/2018/1519

Dated: December 21, 2018

**The Managing Director,**  
Sindh Public Procurement Regularity Authority,  
Karachi.

### GREATER KARACHI SEWERAGE PLAN

Subject: **PRE-QUALIFICATION NIT NO.PD/S-III/KW&SB/2018/1356 DATED 27-09-2018 (SR. NO.37818)**

1. The KW&SB had invited application for bidding of Contract Package "Design – Build (DB) and Operation of New Sewage Treatment Plant at Korangi – Karachi" from Pre-Qualified / Short Listed Contractor's Firm in accordance to Rule 46(4) of SPPRA Rules (Amendment 2017) and are hoisted on Authority's website at Sr. No.37818.
2. In compliance to Rule 46(4)(a), attach please find the Technical Proposal both soft and hard copy, discussed with all applicants (Minutes of Meeting attached as Annexure) together with reference to the Employer's requirement.
3. To proceed further as per Rule 46(4)(a)(vi), the Procurement Committee asked bidders to revise their technical proposal (if any) following the discussions at meeting, and come up with revised technical proposal and supplementary financial proposal (if any) in accordance to Rule 46(b)(i).
4. An early action is requested, being Court Matter, to be accorded top priority.

  
21.12.2018  
**Noor Ahmed Samoo**  
Project Director  
(S-III Project)

Copy to:

1. Registrar Judicial Water Commission of Supreme Court of Pakistan, Karachi
2. Secretary Training Management & Research Wing SGA&CD Member Task Force
3. Managing Director, KW&SB

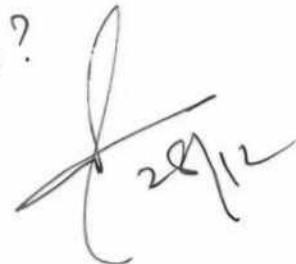
SPPRA INWARD DIARY

NO : 3079

DATED : 24/12/2018

*ma faraz sb*

*What action is required from SPPRA?*

  
28/12



**KARACHI WATER & SEWERAGE BOARD**  
**OFFICE OF THE DY. PROJECT MANAGER (S-III)**  
**SECRETARY PROCUREMENT COMMITTEE**

Block – D, 1<sup>st</sup> Floor, 9th Mile Karsaz, Shahra-e-Faisal, Karachi

No. DY.P.M/S-III/KW&SB/2018/ 308

Dated: December 20, 2018

**MINUTES OF MEETING**

**Subject:** Meeting of Procurement Committee for Evaluation of Technical Proposal submitted by Pre-Qualified / Short listed Contractor Firm for Contract Package Design – Build (DB) and Operation Sewage Treatment Plant at Korangi - Karachi Held on 20<sup>th</sup> December, 2018

1. Attach please find Minutes of Meeting on the above subject held on Thursday 20<sup>th</sup> December, 2018 at 11.0 A.M. in the Committee Room, Block – D, M.D Secretariat, KW&SB chaired by Syed Hassan Ejaz Kazmi, Project Director (100 MGD. Dhabeji Project) as Convener of meeting.
2. As per Clause 46(4)(a) of SPPRA Rules 2010 (Amended 2017) the technical proposal discussed in the presence of all members of Committee constituted as per Clause No.7 of SPPRA Rule 2010 (Amended 2017) and representatives of participating firms, including Team of The Engineer (M/s. TCI).
3. The list of participants is attached at Annexure - 1.

  
20.12.2018  
**Deputy Project Manager /**  
**Secretary Evaluation Committee**  
**S-III Project, KW&SB**

**Distribution:**

- ▶ All Members

**Copy to:**

- ▶ Project Director, S-III Project, KW&SB

## MINUTES OF MEETING HELD ON 20-12-2018

### SUBJECT: DESIGN-BUILD & OPERATION OF NEW SEWAGE TREATMENT PLANT AT KORANGI-KARACHI

In pursuance to clause 22 of Instruction to bidders Vol-I of bidding documents, a joint meeting of bidder's representatives along with the team of consultants and the members of Procurement Committee was convened on December 20, 2018 at 11:00 A.M at KW&SB secretariat to discuss the bidders' conceptual design etc. with respect to the Employer's requirements.

Following participants attended the meeting:

#### Employer

- |                          |                                  |
|--------------------------|----------------------------------|
| 1. Mr. Noor Ahmed Samoo  | Project Director, S-III Project  |
| 2. Mr. Hassan Ejaz Kazmi | Convener, Procurement Committee  |
| 3. Mr. Amir Waqar        | Secretary, Procurement Committee |
| 4. Mr. Imtiazuddin       | Member, Procurement Committee    |
| 5. Mr. Gangji            | Member, Procurement Committee    |
| 6. Mr. Shafqat           | Member, Procurement Committee    |
| 7. Mr. Riaz Khan Ghauri  | Member, Procurement Committee    |

#### Consultant

- |                                |                                    |
|--------------------------------|------------------------------------|
| 1. Dr. Muhammad Bashir Lakhani | The Engineer, Techno Consult Intl. |
| 2. Mr. Arshad Farooqui         | Chief Resident Engineer, TCI       |
| 3. Mr. Farooq Ahmed            | Senior Resident Engineer, TCI      |
| 4. Mr. Muhammad Rashid         | Contract Engineer, TCI             |

#### Bidders

- |                       |                                 |
|-----------------------|---------------------------------|
| 1. Mr. Yousuf Mahmood | Project Manager, DESCON         |
| 2. Mr. Jawaid Cheema  | Environmental Engineer, DESCON  |
| 3. Mr. Talha Razzaq   | Engineer BD, DESCON             |
| 4. Mr. Sunjao         | MD, South Asia, Sinohydro       |
| 5. Mr. Faizullah      | Director BD, Sinohydro          |
| 6. Mr. Zhong Aiyang   | Manager, Sinohydro              |
| 7. Mr. Zhu Bo         | Business Development, Sinohydro |
| 8. Mr. Xie Lan Qing   | GM Karachi, Sinohydro           |
| 9. Mr. Lin Zhong      | Chief Engineer, Sinohydro       |
| 10. Mr. Sun Xianwan   | Business Manager, Sinohydro     |

Meeting started with the recitation of Holy Quran.

Project Director (S-III), welcome the participants of the meeting and handed over the proceedings of the meeting to the Convener of Procurement Committee.

Convener explained purpose of the meeting on behalf of the procurement committee to the participants, that this meeting has been arranged to discuss the submissions made by the bidders in response to clarifications sought by the Procurement Committee in respect of the Technical Bids submitted by the bidders.

Convener Procurement Committee, asked the representatives of DESCON – POTEN (JV) to explain their submissions.

Representative of DESCON-POTEN (JV), circulated the point wise reply of the required clarifications and confirmed that, there would be no deviation from the Employer's Requirements in their Technical Proposal, except the Waste Water Pumps to be provided with Cordon Shaft and all contractual requirements have been met in accordance with design guidelines provided in the bidding documents.

Sinohydro-NCME-RMG (JV) also circulated their item wise reply against the clarifications required by the Procurement Committee. Sinohydro-NCME-RMG (JV) has informed that their Technical Bid is in compliance with the Employer's Requirements as given in bidding documents except the Grit Chamber of Cyclone desanader type is to be changed to rectangular type and they were asked to incorporate intermediate pumping in their technical proposal to meet the design guidelines provided in bidding documents. Representatives of Sinohydro-NCME-RMG (JV) agreed to revise their technical proposal, accordingly.

The meeting was concluded with the remarks that no major deviation found in both the technical proposals and are in line with the Employer's requirement. However subsequent to above discussions and as agreed in the meeting both the bidders were asked to come up with their revised technical bid and supplementary price bid (if any) to confirm the Employer's further clarification in its requirement and in accordance with SPPRA rules for Stage two under two stage two envelope mode of procurement.

Meeting ended with vote of thanks to and from chair.

Encl: Attendance Sheet



## KARACHI WATER & SEWERAGE BOARD

### GREATER KARACHI SEWERAGE PLAN- S-III

#### *Design – Build (DB) and Operation of New Sewage Treatment Plant at Korangi – Karachi*

#### EMPLOYER'S REQUIREMENTS

#### PART 1: DESIGN REQUIREMENTS

#### PART 2: OPERATION MANAGEMENT REQUIREMENTS

  
Dy. Project Manager  
S.M. Project  
KW & SB



**Techno-Consult International (Pvt.) Ltd.**

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**WATER & ENERGY DIVISION**

Part 1  
**Design Requirements**

  
Dy. Project Manager  
S.III Project  
KW & SB

# Employer's Requirements

## Part 1 Design Requirements

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**Dy. Project Manager**  
**S.III Project**  
**KW & SB**

***In these Design Requirements, terms "Works" and "STP" (meaning Sewage Treatment Plant TP-IV, Karachi) are synonymous.***

1. **GENERAL**

- a) The STP Site, with an area of about 121.00 hectares, is located in Korangi Creek, Karachi. The dimensions and the natural surface levels (NSL) contours, of the STP Site, are shown in Annexure 1 and 2 of these Design Requirements, respectively. These plans are however tentative only and the Contractor shall be required to carry out his own site surveys and prepare the site plan thereof for carrying out designs under this Contract.
- b) Untreated wastewater, from the last manhole of the sewerage system, with location and invert level, as shown in Annexure 1 and 2 of these Design Requirements, shall be carried to the First Wastewater Screening Chamber of STP, through a gravity pipeline (of appropriate gradient and of diameter to accommodate the flows of the last reach of the trunk sewer). Following is the tentative design data for the last reach of the trunk sewer, to be confirmed by the Contractor prior to proceeding for the designs under this Contract:

Last Reach of Trunk Sewer	
RCC Conduit Cell	3.0 X 3.0 (M)
Slope	0.0475 (%)
Invert Level (IL) of Last Manhole	73.840 (m)

- c) The design capacity of STP shall be as follows:

Design Daily Influent Wastewater Flow (Maximum Day)	818,300 (m <sup>3</sup> /d)
Design Peak-Hour Wastewater Flow	46,030 (m <sup>3</sup> /h)
Design Daily Influent Pollution Loads (Maximum Day)	
Biochemical Oxygen Demand (BOD)	163,570 (kg/d)
Total Suspended Solids (TSS)	122,680 (kg/d)

- d) The STP shall be designed to treat the influent wastewaters, for bringing their biochemical oxygen demand (BOD) and total suspended solids (TSS), within the following concentration limits, prior to their discharge to the sea:

Biochemical Oxygen Demand (BOD)	50 (mg/l)
Total Suspended Solids (TSS)	50 (mg/l)

## Employer's Requirements: Particular Specifications for Works

- e) The Contractor shall ensure by his own means and guarantee that the composition of the influent wastewater, in terms of its constituents and their variations, of whatsoever nature, shall not prevent the STP or him from achieving the desired performance results, in every respect, in accordance with the Contract.
- f) The STP shall be designed such that the space utilization is compact and optimal, without any undue wastage of the available land and the unused (surplus) land, if any, remains contiguous and on one side of the Site.
- g) The STP shall be designed with energy requirements as minimum as possible.
- h) Except where otherwise laid down in these "Design Requirements", the process designs of component facilities shall be based upon the design guidelines and methods, laid down in the following reference:

Metcalf & Eddy, Inc. (2003) *Wastewater Engineering: Treatment and Reuse*, McGraw-Hill, New York

### 2. WASTEWATER TREATMENT SYSTEM

- a) Sequential system comprising two-stage wastewater screening, primary settling and trickling filters shall be adopted, for the removal of BOD and TSS, from the influent wastewater.
- b) The sludge would be generated from the primary and secondary settling tanks. The sludge shall be dewatered, in order to reduce its volume and to render it suitable for transportation for disposal or land application, as the case may be. For this purpose, sludge drying beds shall be adopted. The sludge shall be thickened and digested prior to its dewatering in the drying beds.

### 3. COMPONENT FACILITIES

#### 3.1 General

The component facilities, to be provided for STP, shall include, but may not be limited, to the following:

- a) Process-related Facilities, as follows:
  - First Wastewater Screening Chamber
  - Wastewater Pumping Station
  - Second Wastewater Screening & Grit Chambers Structure(s)
  - Flow Division Structures
  - Primary Settling Tanks
  - Intermediate Wastewater Pumping Facilities

## Employer's Requirements: Particular Specifications for Works

- Trickling Filters
- Secondary Settling Tanks
- Primary, Secondary, Thickened & Digested Sludge Pumping Facilities
- Sludge Thickeners
- Sludge Digesters
- Sludge Drying Beds
- Treated Effluent Pipeline and Marine Disposal Outlet
- Process Piping Works
- On-site Process Monitoring Works

b) Buildings, as follows:

- Plant Building

c) Miscellaneous Works, as follows:

- Land Grading and Site Development Works
- Entrance Gates
- Boundary Walls
- Roads, Pavements and Vehicle Parking Areas
- Walkways
- Stormwater Drainage Works for the Site
- External Water Supply Works in the Site
- External Sewerage Works in the Site
- External Illumination Works
- External and Plant (Equipment) Electrification Works
- Standby Electricity Generation Facilities

### 3.2 Overall Arrangement

- a) Intermediate wastewater pumping, after primary settling, shall be required to control the heights of certain upstream sanitary structures.
- b) Except, for the First Wastewater Screening Chamber and Wastewater Pumping Station, numbers and physical arrangement of the remaining process-related facilities shall be determined by the Contractor, subject to the provisions of the Contract, such that any unit of process-related facilities can be brought out of operation, by diverting flows to other parallel units.

## 4. PROCESS-RELATED FACILITIES

### 4.1 First Wastewater Screening Chamber

- a) The objective of First Wastewater Screening Chamber, to be constructed in RCC, shall be to remove large objects from the influent wastewater, in order to protect the downstream equipment and machinery.

Employer's Requirements: Particular Specifications for Works

- b) The Screening Chamber shall receive influent wastewater through gravity sewer, for screening. The wastewater, after screening, shall be allowed to the two Wet Wells of the Wastewater Pumping Station.
- c) The influent gravity sewer shall discharge into a Common Influent Chamber, (of Minimum Clear Length – in Flow Direction: 3000 mm) provided at the start of the Screening Chamber, which shall be connected to parallel downstream Screening Channels through manually-operated stainless steel (SS) sluice gates, in order to bring any one of the Screening Channels out of operation, for cleaning or maintenance purposes.
- d) Clear width and numbers (duty) of the isolatable parallel Screening Channels shall be based upon the Peak-Hour Flow, with an approach velocity to screen in the range of 0.6 – 1.0 mps.

In addition to duty Screening Channels, one standby Screening Channel, of same size as of duty Channel, shall be provided, in parallel.

- e) Vertical bar screens (clear bar spacing: 75 mm), of monolithic stainless steel (SS) construction, sliding in side SS guide channels and equipped with mechanical (motorized) & manual (standby) hoisting arrangement, for manual cleaning, shall be installed. Each Screening Channel shall be provided with two screens, placed in series, so that one screen is always in place while the other is hoisted for cleaning.
- f) At the top of the Screening Chamber, RCC platforms, of adequate space, shall be provided for manual cleaning of the screens, operation of the sluice gates and other purposes.
- g) Top of the Screening Chamber shall be open enough to provide adequate ventilation to inside the chamber.
- h) Each Screening Channel, at its downstream end, shall be connected to a Common Effluent Chamber (of Minimum Clear Length – in Flow Direction: 3000 mm), provided at the end of the Screening Chamber, through manually-operated sluice gates (SS).
- i) Two effluent pipes shall be provided, from the Common Effluent Chamber to the two Wet Wells. The inlet to these effluent pipes shall be provided with manually-operated sluice gates (SS), in order to enable bringing any one of the Wet Wells out of operation, for maintenance purposes.
- j) Stainless steel (SS) vertical monkey ladder shall be provided from the top to the base, for the purpose of entry, at the following points:
  - Common Influent Chamber
  - Common Effluent Chamber

## Employer's Requirements: Particular Specifications for Works

- Each Screening Channel, upstream of screens
  - Each Screening Channel, downstream of screens
- k) As and where required, galvanized iron (GI) pipe railings shall be provided for complete occupational safety of the operation staff.
- l) Plinth protection, in concrete paving (Minimum 900 mm wide) shall be provided, at the finished grade level, all around the Screening Chamber.

### 4.2 Wastewater Pumping Station

#### 4.2.1 General

- a) The purpose of the Wastewater Pumping Station is to receive screened wastewater from the First Wastewater Screening Chamber and pump it to the Second Wastewater Screening & Grit Chambers Structure(s).
- b) The Wastewater Pumping Station shall comprise the following:
- Two parallel Wet Wells, each of capacity equal to half the required total capacity, with the provision that each of the Wells can be isolated for cleaning and maintenance purposes
  - One Dry Well
- c) All the raw wastewater pumps shall be vertical-shaft, solids-handling, centrifugal type, suitable for dry installation, to be placed, on raised foundation pads, at the base slab of the Dry Well, with their motors (low-voltage type) to be above-ground and connected to the pumps through vertical shafts.
- d) Preferably the two Wet Wells and the Dry Well shall be accommodated in one integral structure.

#### 4.2.2 Wet Wells

##### General

- a) The Wet Wells shall receive screened wastewater from the First Wastewater Screening Chamber, through gravity-flow pipelines.
- b) The Wet Wells shall be uncovered underground structure, to be constructed in RCC.
- c) The gravity-flow pipelines from the Common Effluent Chamber, of First Wastewater Screening Chamber, shall discharge directly into the respective Wet Wells.

## Employer's Requirements: Particular Specifications for Works

- d) A Suction Pipes Trough, with depressed base slab, shall be provided, downstream of each Wet Well, to accommodate the suction inlets, of the Wastewater Pumps, placed in Dry Well.

The suction pipelines of half of the Wastewater Pumps shall extend to each of the Wet Wells. Each suction inlet shall comprise a downward 90° bend and a bell-mouth at the end.

- e) Stainless steel (SS) vertical monkey ladders shall be provided, one in each Wet Well, from the top to the base, for the purpose of entry.
- f) As and where required, galvanized iron (GI) pipe railings shall be provided for complete occupational safety of the operation staff.
- g) Plinth protection, in concrete paving (Minimum 900 mm wide) shall be provided, at the finished grade level, all around the Wet Wells.

### Design Basis

- a) Effective volumetric capacity of the Wet Wells shall be that lying between the Maximum Allowable Wastewater Level in the Wet Well, at which level all the wastewater pumps (excluding standby) are to be operating, and the Minimum Allowable Wastewater Level in the Wet Well, at which level all the pumps are to be shut off.

The Maximum Allowable Wastewater Level in the Wet Wells shall be that at which no surcharging shall take place in the Screening Chamber and upstream sewerage network.

The effective capacities of Wet Wells (including Suction Pipes Troughs) shall be such as that pump motor starts per hour shall not exceed the maximum permissible values for the selected pump-motor sets.

- b) Scale Hydraulic Modeling shall be got carried out to determine the geometry and dimensions of the Wet Wells and Suction Pipes Troughs, in order to provide suitable hydraulic conditions and avoid silting problems.

### 4.2.3 **Dry Well**

#### General

- a) The purpose of Dry Well is to house the raw wastewater pumps and their ancillaries. The Dry Well shall comprise underground substructure (all RCC) and above-ground superstructure (RCC and concrete block masonry).



### Employer's Requirements: Particular Specifications for Works

The substructure shall be an underground room, which shall be sized for accommodating the required numbers of wastewater pumps, to be placed at the pump foundation pads, raised from its base slab.

The base level of Dry Well, with respect to those of Wet Wells and Suction Pipe Troughs, shall be such as to meet the minimum suction head requirements of the pumps.

The superstructure of the Dry Well shall form a covered room for accommodating the pump motors, pump control panels (if located therein) and other accessories and for providing circulation space for operation staff and accessibility to the base slab.

- b) The wastewater pumps provided in the Dry Well shall pump the wastewater from the Wet Wells to the Second Wastewater Screening & Grit Chambers Structure(s), through forced transmission pipeline(s), connected to the wastewater pumps.
- c) The RCC base slab of the Dry Well shall be kept at level. At an appropriate location in the base slab, a Sump, of adequate size, shall be made to collect the wastewater leakages from the pumps and piping.

A combination of granolithic flooring with varying thickness (minimum 50 mm) to furnish sloping floor surfaces (at a minimum surface gradient of 1 in 150) and channels, formed in flooring, shall be provided over the top of base slab, in order to drain the leaking wastewaters as well as floor washing water to the Sump.

Granolithic skirting shall be provided along the walls of the basement.

- d) Two (1 duty and 1 standby) submersible-type bilge pumps (minimum capacity: 100 m<sup>3</sup>/h) shall be provided in the Sump, to pump back the collected wastewater, to the Wet Wells. The delivery piping of the bilge pumps shall be such that discharge can be made to any of the Wet Wells.
- e) Each wastewater pump shall be provided with a manually-operated gate valve on suction side and a manually-operated gate and a check valve on delivery side.

The wastewater pumps shall be connected to one or more forced transmission pipeline(s), as determined by the Contractor.

- f) Each Wastewater Pump shall be provided with an automatic On/Off control by means of an appropriate level-controlled switching device installed in the respective Wet Well (with a Lower Level to Stop and an Upper Level to Start) as well as a manual On/Off control.

Each Wastewater Pump may have different On/Off wastewater levels in the Wet Well, for successive switching-on or switching-off of pumps, as the wastewater level in Wet Well increases or decreases, respectively. All the duty wastewater pumps are

### Employer's Requirements: Particular Specifications for Works

to be operating, at the Maximum Allowable Wastewater Level in the Wet Wells and all the pumps are to be shut off, at the Minimum Allowable Wastewater Level in the Wet Wells.

A pump sequence selection switch should also be provided in the pumps control panel.

- g) The RCC retaining walls of the substructure shall be extended to the level of the ground floor slab, meant for supporting the motors, which level shall be minimum 750 mm above the surrounding finished grade level (FGL) and it shall be ensured that the level is above the maximum flood level.

The superstructure of the Dry Well, of internal dimensions in plan equal to that of the substructure, shall be enclosed and covered, by means of RCC frame structure, with minimum 200 mm thick in-fill concrete block masonry walls, and RCC roof slab.

The Dry Well shall be designed and the piping work and equipment including pumps, pump motors, valves and other accessories shall be placed such that:

- All the equipment can, for the purposes of off-site repair and maintenance, be removed from their installed position, taken out of the Dry Well and re-installed in their position, without any obstruction or undue difficulty.
  - There is ample space for the unobstructed movement of the operation staff and their safe access to all the equipment and piping for the purposes of operation and on-site repair and maintenance.
- h) All the equipment and piping works shall be adequately supported and/or anchored, with the structure, as the case may be, with suitable means.
- i) As and where required, galvanized iron (GI) pipe railings shall be provided for complete occupational safety of the operation staff.
- j) An RCC stair (Width: 1200 mm, Risers: 175 mm, Tread: 275 mm), with galvanized iron (GI) pipe railing, shall be run from the ground floor to the base of the Dry Well for access.
- k) For routine access of operation staff from outside to the ground floor, there shall be provision of two appropriately located wooden partly-glazed flush doors (1050 mm x 2100 mm). For outside access to the doors, steps (Risers: 150 mm, Tread: 300 mm), to be made in concrete, shall be provided.

For transfer of equipment, including pumps, pump motors, valves and other accessories, to and from Dry Well, two appropriately located top-hung sliding steel doors, opening from outside to the ground floor, shall be provided. The size of the doors shall be in accordance with the maximum dimensions of the equipment to be moved through the doors. For outside access, a ramp, of width equal to the width of

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the door and with appropriate slope, comprising RCC slab-on-grade with side concrete block masonry walls, shall be provided.

- l) An electrically-operated overhead bridge crane (top-running type), shall be provided in the Dry Well, below the ceiling level, for lifting and moving the equipment, including pumps, pump motors, valves and other accessories, to and from Dry Well, for repair and maintenance purposes. The lift capacity of the crane shall be in accordance with the maximum weight of the equipment to be lifted.

The clear floor height of the ground floor shall be provided, keeping in view the governing dimensions of the overhead bridge crane.

- m) Sliding type anodized aluminum windows shall be provided in the external walls of the Dry Well, at an above-floor level, for purpose of natural ventilation and lighting. The gross area of windows shall not be less than about 15% of the internal area of the Dry Well in plan.
- n) All the RCC elements of substructure of Dry Well shall be with the formed surfaces to be "Fair-Face" and not to receive any plaster.
- o) Granolithic flooring and skirting shall be provided on the ground floor.
- p) Roof shall be provided with all-around RCC parapets (100 mm thick), of height not less than 450 mm above the top of roof slab, roofing treatment and roof drainage, by means of CI pipes.
- q) In the superstructure of Dry Well, all the interior and exterior surfaces of walls and columns and the ceiling surfaces shall be finished with cement-sand plaster.
- r) All the interior walls, columns and ceiling surfaces, with plastered or concrete finish, in the substructure as well as superstructure of the Dry Well, shall be painted with synthetic vinyl emulsion paint.

All the exposed exterior walls, columns and parapet surfaces, with plastered or concrete finish, of the Dry Well, shall be painted with acrylic based exterior emulsion paint.

- s) Plinth protection, in concrete paving (Minimum 900 mm wide) shall be provided, at the finished grade level, all around the Dry Wells.
- t) An epoxy-coated mild steel (MS) spiral stair shall be provided, at an appropriate location outside the Dry Well, from the finished grade level to the roof of the Dry Well, for access.
- u) Adequate numbers of bib cocks shall be provided, at appropriate locations, along walls, in basement and ground floor, for the purpose of floor and equipment washing.

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- v) For building electrification of the Dry Well, a separate distribution board, with an earthing set, shall be provided.

Steel exhaust fans (450 mm dia), of approved make, shall be provided in the external walls of the Dry Well, at an above-floor level, for purpose of forced ventilation. The numbers of the exhaust fans shall be determined on the basis that, under normal conditions, at least two air changes per hour are effected in the Dry Well.

Fluorescent and/or other suitable type of light fixtures (to be approved by the Employer's Representative) shall be provided, on ceilings and/or walls, to provide desirable levels of artificial illumination in the basement and the ground floor. The numbers, locations and ratings of the light fixtures shall be such that illumination intensity is not less than 75 LUX at the floor levels of the basement and the ground floor, at any place (excluding areas under shadows).

On the ground floor, 3-pin switch socket units shall be provided, on walls, above the floor level, at appropriate accessible locations, as follows:

- 5 Amp, at an average spacing of 5 meters (along the walls)
- 15 Amp, at an average spacing of 5 meters (along the walls)

Switch boards, for controlling all the light and fan fixtures, shall be provided close to the main entrance door.

- w) PVC conduit shall be laid in the walls of the Dry Well for carrying wires for telephone/intercom, for 3 points, appropriately located on the walls of the ground floor.

### Design Basis

- a) All the duty and standby pumps shall be of same discharge capacity.
- b) The total discharge capacity of the duty pumps shall be equal to the Design Peak-Hour Wastewater Flow.
- c) The total discharge capacity of the standby pumps shall not be less than 20% of that of the duty pumps. Minimum one standby pump shall be provided, for each Wet Well.

### 4.3 **Second Wastewater Screening & Grit Chambers Structure(s)**

#### 4.3.1 **General**

- a) One or more Second Wastewater Screening & Grit Chambers Structures may be provided, as determined by the Contractor.

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- b) Each Structure shall comprise the following two components in series:
- Second Wastewater Screening Chambers, to further screen the wastewater, received from Wastewater Pumping Station, for removal of large objects
  - Grit Chamber(s), to remove grit (heavier inorganic matter) from the wastewater, prior to its introduction to Primary Settling Tanks
- c) The Structure(s), to be constructed in RCC, shall need to be raised from the ground level in order to afford gravity flows to the Primary Settling Tanks and shall be supported on RCC beam-column structure.
- d) RCC stair(s), one or more as appropriate, of 1000 mm width, with galvanized iron (GI) pipe railing, shall be provided for access from finished grade level to the top of the Structure.
- e) At the top of the Structure, RCC platforms and access ways, of adequate sizes, shall be provided for inspection, cleaning, operation and on-site repair and maintenance of equipment.
- f) As and where required, galvanized iron (GI) pipe railings shall be provided for complete occupational safety of the operation staff.
- g) Concrete paving shall be provided, at the finished grade level, at places, where so required for operation purposes.

4.3.2 **Wastewater Screening Chamber(s)**

Following shall be provided in each of the Second Wastewater Screening & Grit Chambers Structure(s):

- a) The forced transmission pipeline from the Wastewater Pumping Station shall discharge into a Common Influent Chamber, provided at the start of the Screening Chamber, which shall be connected to parallel downstream Screening Channels through manually-operated stainless steel (SS) sluice gates, in order to bring any one of the Screening Channels out of operation, for cleaning or maintenance purposes.
- b) Clear width and numbers (duty) of the isolatable parallel Screening Channels shall be based upon the Peak-Hour Flow, with an approach velocity to screen in the range of 0.6 – 1.0 mps. Velocity through screens at the Peak-Hour Flow shall not be less than 1.0 mps.

In addition to duty Screening Channels, one standby Screening Channel, of same size as of duty Channel, shall be provided, in parallel.

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- c) Mechanically-raked, bar screens (clear bar spacing 15 mm), of monolithic stainless steel (SS) construction, shall be installed, in all the Screening Channels.
- d) At the top of the Screening Channels, arrangement shall be provided for the collection and transfer (to the ground level) of the screenings.
- e) Each Screening Channel, at its downstream end, shall be connected to a Common Effluent Chamber, through manually-operated sluice gates (SS).
- f) Wastewater from the Common Effluent Chamber shall be fed to the downstream Grit Chamber(s), through appropriate means.
- g) Stainless steel (SS) vertical monkey ladder shall be provided from the top of the Chamber to the base, for the purpose of entry, at the following points:
  - Common Influent Chamber
  - Common Effluent Chamber
  - Each Screening Channel, upstream of screens
  - Each Screening Channel, downstream of screens
- h) The dimensions of different components of the Chamber shall be such that the operation staff shall have easy and safe access for proper inspection, cleaning, operation and on-site repair and maintenance of equipment.
- i) Minimum free board over the maximum hydraulic grade level (HGL) in the Chamber shall be 1000 mm.

#### 4.3.3 Grit Chambers

- a) In each of the Second Wastewater Screening & Grit Chambers Structures, at least two Grit Chambers, in parallel, shall be provided.
- b) The Grit Chambers, to be constructed in RCC, shall be cross-flow type, square-in-plan (DETRITOR type).
- c) A Grit Collection Sump, of appropriate size, shall be provided in the bottom of the Chamber, at a suitable location.
- d) A mechanical Grit Scraper shall be installed in the Chamber for continuously scraping and directing grit, settled at the Chamber bottom, towards the Grit Collection Sump.
- e) Mechanical Grit Raking Mechanism (Inclined-Reciprocating type) shall be provided, within a purpose-built Grit Raking Channel, for collecting and transporting grit from the Grit Collection Sump to the top of the Chamber, above HGL, from where it shall be discharged to a purpose-built scum trolley, placed below at finished grade level. A

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concrete paved platform, of appropriate dimensions, duly connected with road network of STP, shall be provided to park the trolley.

- f) Along the Grit Raking Channel, a Scum Sump shall be provided to collect the organic scum, from the Channel. Two Organic Return Pumps (1 duty and 1 standby) shall be installed to pump the scum from Scum Sump to the Chamber.
- g) A fiber-reinforced plastic (FRP) multi v-notch, effluent weir, shall be provided along the effluent side of the Chamber to ensure uniform distribution of flow across the Chamber.
- h) Effluents from the Grit Chambers shall be fed to the Primary Settling Tanks, directly or through Flow Division Structures, through appropriate means, in accordance with the overall arrangement, determined by the Contractor.
- i) The following design criteria shall be adopted for Grit Chambers:

Hydraulic Loading Rate @ Design Peak Flow	65 (m/h)
Hydraulic Detention Time	60 (seconds)
Free Board (over Maximum HGL) – Minimum	500 (mm)

#### 4.4 Flow Division Structures

- a) Numbers, locations and nature of Flow Division Structures, meant for dividing the incoming flow into desired numbers of equal-flow streams for uniform feeding to the downstream parallel facilities, shall be determined by the Contractor, depending upon the numbers and overall physical arrangement of the process-related facilities.
- b) The equal division of the incoming flow, in the Flow Division Structures, to be constructed in RCC, shall be carried out by providing separate sharp-crested rectangular weirs (stainless steel), of equal size and same sill levels.
- c) If the top of the Structure is higher than 1000 mm from the surrounding finished grade level (FGL), then an RCC stair, of 1000 mm width, with galvanized iron (GI) pipe railing, shall be provided for access from finished grade level to the top of the Structure.
- d) At the top of the Structure, RCC platforms and access ways, of adequate sizes, shall be provided for inspection, cleaning, operation and on-site repair and maintenance.
- e) As and where required, galvanized iron (GI) pipe railings shall be provided for complete occupational safety of the operation staff.
- f) Concrete paving shall be provided, at the finished grade level, at places, where so required for operation purposes.

- g) The dimensions of different components of the Structure shall be such that the operation staff shall have easy and safe access for proper inspection, cleaning, operation and on-site repair and maintenance.
- h) Minimum free board over the maximum hydraulic grade level (HGL) in the Structure shall be 1000 mm.

#### 4.5 Primary Settling Tanks

##### 4.5.1 General

- a) Primary Settling Tanks shall receive screened and grit-removed wastewater, through gravity transmission pipelines, for the purpose of sedimentation of the organic suspended matter.
- b) Effluents from each Primary Settling Tank shall be discharged to the respective Primary Effluent Tank(s), provided as part of the Intermediate Wastewater Pumping Facilities.
- c) The Primary Settling Tanks shall be circular-in-plan with central-feed and peripheral outflow and shall be partly underground and partly aboveground, to be constructed in RCC.
- d) The incoming wastewater shall be fed to the Tank, from center, at an appropriate level, through horizontal radial inlet ports. An Inlet Drum, of cylindrical geometry, whether fixed with the Sludge Scraper or to the tank structure, shall be provided, surrounding the inlet ports, for minimizing the turbulence and hydraulic short-circuiting and for ensuring quiescent entry of wastewater from the inlet ports into the settling zone of Tank.

The Inlet Drum shall be made of fiber-reinforced plastic (FRP) sheet, attached to a stainless steel (SS) frame.

- e) A fiber-reinforced plastic (FRP) peripheral, multi v-notch, effluent weir, along with scum plate, shall be attached to the wall of the Effluent Channel, to allow the settled wastewater flow to the Effluent Channel. The multi v-notch effluent weir shall ensure uniform radial distribution of flow across the Tank.
- f) A Sludge Collection Pit shall be provided, in the bottom of the Tank, at center, with base slab of the Tank, sloping in radial direction towards it.
- g) The mechanical Sludge Scraper shall be installed in the Primary Settling Tank for continuously scraping and directing sludge, settled at the Tank bottoms, towards the Sludge Collection Pit. The Scraper shall be equipped with a Scum Skimmer, for



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automatically directing the scum to the Scum Collection Box attached to the Tank wall.

- h) Scum Collection Box shall be provided at an appropriate location inside the Tank wall. The Box shall be connected to a DN 150 CI outflow pipe, with all the bends to be of 45° and with a valved outlet, outside the Tank wall, at such location and level, that the scum can be discharged to a purpose-built scum trolley, placed under it. Scum shall thereupon be disposed of along-with the dewatered sludge.
- i) A sludge pipe shall be laid under the base slab of the Tank, in radial direction, from the Sludge Collection Pit, to be connected to the suction manifold of the Primary Sludge Pumps.
- j) If the top of the Tank is higher than 2000 mm from the surrounding finished grade level (FGL), then a walkway (RCC), with an overall width of 1000 mm, shall be provided all-around along the exterior of the Tank wall, at least 600 mm below the top level of Tank wall, for the purpose of access to the top of the Tank, for inspection, cleaning, operation and on-site repair and maintenance of equipment. On the outer side of the walkway, galvanized iron (GI) pipe railing shall be provided, for safety.

RCC stair, of 1000 mm width, with galvanized iron (GI) pipe railing, shall be provided for access from finished grade level to the walkway.

- k) Plinth protection, in concrete paving (Minimum 900 mm wide) shall be provided, at the finished grade level, all around the Primary Settling Tanks.

4.5.2 **Design Basis**

The following design criteria shall be adopted:

<b>General</b>	
Hydraulic Loading Rate @ Design Daily Flow – Maximum	35 (m/d)
Primary Sludge Concentration – Maximum	30,000 (mg/l)
Removal Efficiencies – Maximum	
Suspended Solids (SS)	60 (%)
Biochemical Oxygen Demand (BOD)	30 (%)
<b>Tank</b>	
Minimum Side Liquid Depth (No-flow Conditions) – Minimum	3,000 (mm)
Free Board @ Minimum Side Liquid Depth – Minimum	500 (mm)
<b>Inlet Drum</b>	
Ratio of Drum Diameter to Tank Diameter – Minimum	0.20
<b>Effluent Channel</b>	
Width – Minimum	600 (mm)

**4.6 Intermediate Wastewater and Primary, Secondary, Thickened & Digested Sludge Pumping Facilities**

**4.6.1 General**

- a) Housing facilities for Intermediate Wastewater and Primary, Secondary, Thickened & Digested Sludge Pumps, may be provided in any appropriate combination, as determined by the Contractor, keeping in view the technical requirements and constraints.
- b) Intermediate Wastewater Pumping Facilities shall comprise the following:
  - Primary Effluent Tank: For providing some balancing storage for the primary effluent
  - Pump housing facilities for Intermediate Wastewater Pumps, to be provided for pumping wastewater from respective Primary Effluent Tank(s) to the Trickling Filters

**4.6.2 Primary Effluent Tank(s)**

General

- a) The Primary Effluent Tank(s) shall receive effluent from the respective Primary Settling Tanks, through gravity-flow pipelines.
- b) The Primary Effluent Tank shall be an uncovered structure to be constructed in RCC and shall be partly underground and partly aboveground.
- c) The base slabs of the Tanks shall be kept at the same and uniform level. A depressed Suction Pipes Trough may be provided along the periphery of the Tank, facing the Pump Room, to accommodate the suction inlets of the Intermediate Wastewater Pumps. Each suction inlet shall comprise a downward 90° bend and a bell-mouth at the end.
- d) If the top of the Tank is higher than 1000 mm from the surrounding finished grade level (FGL), then an RCC stair, of 1000 mm width, with galvanized iron (GI) pipe railing, shall be provided for access from finished grade level to the top of the Tank.
- e) At the top of the Tank, RCC platforms and access ways, of adequate sizes, shall be provided for inspection, cleaning, operation and on-site repair and maintenance.
- f) As and where required, galvanized iron (GI) pipe railings shall be provided for complete occupational safety of the operation staff.

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- g) Stainless steel (SS) vertical monkey ladder shall be provided from the top of the Tank to the base for the purpose of entry.
- h) Plinth protection, in concrete paving (Minimum 900 mm wide) shall be provided, at the finished grade level, all around the Tanks.

### Design Basis

- a) Effective volumetric capacity of the Primary Effluent Tank shall be that lying between the Maximum Allowable Wastewater Level in the Tank, at which level all the Intermediate Wastewater Pumps (excluding standby) are to be operating, and the Minimum Allowable Wastewater Level in the Tank, at which level all the pumps are to be shut off.

The effective capacity of the Tank (including Suction Pipes Troughs) shall be such as that pump motor starts per hour shall not exceed the maximum permissible values for the selected pump-motor sets.

- b) Minimum free board in Primary Effluent Tanks, at maximum HGL, shall be 500 mm.
- c) The size of the Suction Trough, if provided, shall be such as to accommodate the suction inlets and provide suitable hydraulic conditions for entry of wastewater into suction pipelines.

### 4.6.3 **Pumps**

#### General

- a) All the wastewater and sludge pumps shall be horizontal, solids-handling, centrifugal type, suitable for dry installation, to be placed on foundation pads, raised from the floor of the Pump Room.
- b) All the duty and standby pumps shall be of same discharge capacity.
- c) For each pumping facility, the total discharge capacity of the standby pumps shall not be less than 20% of that of the duty pumps and minimum one standby pump shall be provided.
- d) Each pump shall be provided with a manually-operated gate valve on suction side and a manually-operated gate and a check valve on delivery side.
- e) Each Sludge Pump shall be provided with dual control switches, as follows:
  - A local manual On/Off control switch located in the Pump Room
  - A remote manual On/Off control switch located in the Plant Control Room of the Plant Building

Intermediate Wastewater Pumps

- a) The total discharge capacity of the duty pumps shall be equal to the Design Peak-Hour Wastewater Flow.
- b) Each Intermediate Wastewater Pump shall be provided with triple control switches, as follows:
  - An automatic On/Off control by means of an appropriate level-controlled switching device installed in the Primary Effluent Tank (with a Lower Level to Stop, and an Upper Level to Start, all the duty pumps)
  - A local manual On/Off control switch located in the Pump Room
  - A remote manual On/Off control switch located in the Plant Control Room of the Plant Building

Primary Sludge Pumps

- a) Primary Sludge Pumps shall take sludge from the Sludge Collection Pits of the Primary Settling Tanks, through suction pipes, and pump it to the respective Sludge Thickeners, through Waste Sludge Delivery Pipeline(s).

In order to optimize the size of the Waste Sludge Delivery Pipeline(s), sludge wastage operations from different sources, may be assumed to be staggered in time.

- b) The total discharge capacity of the duty pump(s) shall be such that they can deliver the daily volume of primary sludge produced in a period of not more than 3 hours. The pump(s) shall need to be operated, at certain intervals, for required periods of times, for wasting primary sludge from the system.

Secondary Sludge Pumps

- a) Secondary Sludge Pumps shall take sludge from the Sludge Collection Pits of the Secondary Settling Tanks, through suction pipes and pump it to the respective Sludge Thickeners, through Waste Sludge Delivery Pipeline(s).
- b) The total discharge capacity of the duty pump(s) shall be such that they can deliver the daily volume of secondary sludge produced in a period of not more than 3 hours. The pump(s) shall need to be operated, at certain intervals, for required periods of times, for wasting secondary sludge from the system.

Thickened Sludge Pumps

- a) Thickened Sludge Pumps shall take sludge from the Sludge Collection Pits of the Sludge Thickeners, through suction pipes and pump it to it to the respective Sludge Digesters, through Thickened Sludge Delivery Pipeline(s).

- b) The total discharge capacity of the duty pump(s) shall be such that they can deliver the daily volume of thickened sludge produced in a period of not more than 3 hours. The pump(s) shall need to be operated, at certain intervals, for required periods of times, for transmitting thickened sludge from the system.

Digested Sludge Pumps

- a) Digested Sludge Pumps shall take sludge from the Sludge Digesters, through suction pipes and pump it to the Sludge Drying Beds, through Digested Sludge Delivery Pipeline(s).

In order to optimize the size of the Digested Sludge Delivery Pipeline(s), digested sludge pumping operations, from different Sludge Digesters, may be assumed to be staggered in time.

- b) The total discharge capacity of the duty pump(s) shall be such that they can deliver the daily volume of digested sludge produced in a period of not more than 3 hours. The pump(s) shall need to be operated, at certain intervals, for required periods of times, for transmitting digested sludge from the system.

**4.6.4 Pump Rooms**

- a) Each Pump Room shall be constructed in RCC frame structure, comprising RCC slab supported on RCC beams, which shall thereupon be supported on monolithic RCC columns, with RCC footings. All the walls shall be made of in-fill concrete block masonry (200 mm thick). The masonry walls shall be supported on RCC plinth-beams monolithically connected with the RCC columns.
- b) The finished floor level (FFL) of the Pump Rooms shall be minimum 750 mm above the surrounding finished grade level (FGL) and it shall be ensured that the level is above the maximum flood level.
- c) The floor height, measured from the finished floor levels (FFL) to the soffit of the slab, shall not be less than 4,000 mm.
- d) The flooring of the Pump Rooms shall comprise the following:
- 20 mm thick granolithic topping, of 1:2 cement-aggregate mortar (using ordinary Portland cement and crushed aggregate, of size 1/4" to 1/8") and ground to a smooth finish by means of mechanical stone grinder OVER
  - 150 mm thick RCC (Class C) slab, monolithic with the plinth beams OVER
  - 100 mm thick plain cement concrete, Class E (using ordinary Portland cement, clean local sand and crush) OVER
  - Compacted subgrade

Granolithic skirting shall be provided along the walls of the Pump Room.

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- e) The floor of the Pump Room shall be kept at level. At appropriate locations, in the floor, floor traps (PVC) shall be provided to collect the wastewater leakages from the pumps and piping. The floor traps shall be connected, through PVC pipes (laid under the floor), to the external Supernatant-Filtrate Pipeline (RCC), which shall carry it back to the Wet Well, for retreatment.
- f) The Pump Room shall be designed and the piping work and equipment including pumps, pump motors, valves and other accessories shall be placed such that:
  - All the equipment can, for the purposes of off-site repair and maintenance, be removed from their installed position, taken out of the Pump Room and re-installed in their position, without any obstruction or undue difficulty.
  - There is ample space for the unobstructed movement of the operation staff and their safe access to all the equipment and piping for the purposes of operation and on-site repair and maintenance.
- g) The pumps shall be placed at the pump foundation pads, raised from the RCC floor slab. The level of the Pump Room shall be such as to meet the minimum suction head requirements of the pumps.
- h) All the equipment and piping works shall be adequately supported and/or anchored, with the structure, as the case may be, with suitable means.
- i) For routine access of operation staff from outside, an appropriately located wooden, partly-glazed, flush door (1050 mm x 2100 mm) shall be provided. For outside access to the doors, steps (Risers: 150 mm, Tread: 300 mm), to be made in concrete, shall be provided.

For transfer of equipment, including pumps, pump motors, valves and other accessories, to and from Pump Room, at least one, appropriately located, top-hung sliding steel door, shall be provided. The size of the door shall be in accordance with the maximum dimensions of the equipment to be moved through the doors. For outside access, a ramp, of width equal to the width of the door and with appropriate slope, comprising RCC slab-on-grade with side concrete block masonry walls, shall be provided.

- j) A manually-operated hoisting chain-pulley, horizontally movable on a steel beam, placed below the roof slab of the Pump Room, shall be provided, for lifting and moving the pumps, motors and other heavy ancillaries, from the Pump Room to outside, for repair and maintenance purposes. The lift capacity of the arrangement shall be in accordance with the maximum weight of the equipment to be lifted.
- k) Sliding type anodized aluminum windows shall be provided in the external walls of the Pump Room, at an above-ground level, for purpose of natural ventilation and lighting. The gross area of windows shall not be less than about 15% of the internal area of the Pump Room in plan.

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- l) Roof shall be provided with all-around RCC parapets (100 mm thick), of height not less than 450 mm above the top of roof slab, roofing treatment and roof drainage, by means of CI pipes.
- m) All the interior and exterior surfaces of walls and columns and the ceiling surfaces, of the Pump Room, shall be finished with cement-sand plaster.
- n) All the interior walls, columns and ceiling surfaces, with plastered or concrete finish, of the Pump Room, shall be painted with synthetic vinyl emulsion paint.

All the exposed exterior walls, columns and parapet surfaces, with plastered or concrete finish, of the Pump Room, shall be painted with acrylic based exterior emulsion paint.

- o) Plinth protection, in concrete paving (Minimum 900 mm wide) shall be provided, at the finished grade level, all around the Pump Room.
- p) An epoxy-coated mild steel (MS) spiral stair shall be provided, at an appropriate location outside the Pump Room, from the finished grade level to the roof of the Pump Room, for access.
- q) At least, one bib cock shall be provided, in the Pump Room, at appropriate location along walls, for the purpose of floor and equipment washing.
- r) For building electrification of the Pump Room, a separate distribution board, with an earthing set, shall be provided.

Plastic exhaust fans (300 mm diameter) shall be provided in the external walls of the Pump Room, at an above-ground level, for purpose of forced ventilation. The numbers of the exhaust fans shall be determined on the basis of 1 per 25 m<sup>2</sup> of the internal area of the Pump Room in plan.

Fluorescent and/or other suitable type of light fixtures (to be approved by the Employer's Representative) shall be provided, on ceilings and/or walls, to provide desirable levels of artificial illumination in the Pump Room. The numbers, locations and ratings of the light fixtures shall be such that illumination intensity is not less than 75 LUX at the floor level of the Pump Room, at any place (excluding areas under shadows).

In the Pump Room, 3-pin switch socket units shall be provided, on walls, above the floor level, at appropriate accessible locations, as follows:

- 5 Amp, at an average spacing of 5 meters (along the walls)
- 15 Amp, at an average spacing of 5 meters (along the walls)

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Switch boards, for controlling all the light and fan fixtures, shall be provided close to the main entrance door.

- s) PVC conduit shall be laid in the wall of the Pump Room for carrying wires for telephone/intercom, for one point, appropriately located on the walls of the Pump Room.

### 4.7 Trickling Filters

#### 4.7.1 General

- a) Trickling Filters shall be the main biological treatment process, provided for the removal of the soluble and colloidal BOD.
- b) Each Trickling Filter shall receive wastewater from the respective Intermediate Wastewater Pumps, through a forced transmission pipeline.
- c) The Trickling Filters shall be circular-in-plan and shall be partly underground and partly aboveground, to be constructed in RCC.
- d) Stone/rock shall be adopted as filter media for the Trickling Filters.
- e) Wastewater shall be applied to the top of the Filters, through hydraulically-driven Rotary Distributors.
- f) Effluents from Trickling Filters shall be carried through gravity pipeline(s) to the Secondary Settling Tanks.
- g) No circulation of Trickling Filter effluents shall be provided for.
- h) Natural air circulation shall be provided for.
- i) Hydraulically-driven, four-arm, Rotary Distributer shall be provided, in each Trickling Filter, to uniformly spread the incoming wastewater over the top of the filter media.
- j) Filter media shall be supported, preferably, on a cast-in-situ horizontal RCC slab, provided with perforations by means of placing vertical PVC pipe pieces at certain spacing in both orthogonal directions, for the purpose of drainage of Filter effluents and air circulation in the Filter bed. The opening area of the perforations, in the Media Support Slab, shall not be less than 15 % of the effective area of Filter in plan.

The Media Support Slab may be supported on beams and/or columns, as the case may be, or the Contractor may provide an alternate structural arrangement, in RCC, for supporting the filter media; provided that all the applicable functional and hydraulic requirements are duly satisfied.



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- k) Below the Media Support Slab, an RCC under-drainage system, comprising under-drainage floor and/or channels, shall be provided to collect the Filter effluents. The under-drainage system shall qualify the following criteria:
- Under-drainage floors may be sloped towards center or to the periphery or to any other orientation.
  - In order to prevent the settling of humus sludge, gradient of the under-drainage floors shall not be less than 3%.
  - In order to provide free passage to the air, the under-drainage floors or channels shall not flow more than half-full.
- l) Below the level of the Media Support Slab and above the under-drainage system, Ventilation Ports shall be provided along the periphery of the Filter, in order to provide air circulation in the Filter bed. The total area of the Ventilation Ports shall not be less than 4.5 % of the effective area of Filter in plan.
- In case the Ventilation Ports are, partly or fully, below the surrounding finished grade level (FGL), an RCC peripheral channel shall be provided, to retain the surrounding earth.
- m) An RCC stair, of 1000 mm width, with galvanized iron (GI) pipe railing, shall be provided for access from finished grade level to the top of the Filter, for the purposes of inspection, cleaning and on-site repair and maintenance of equipment.
- n) Plinth protection, in concrete paving (Minimum 900 mm wide) shall be provided, at the finished grade level, all around the Filters.

### 4.7.2 Design Basis

The following design criteria shall be adopted:

Hydraulic Loading Rate @ Design Daily Flow – Maximum	30 (m/d)
Organic Loading Rate @ Design Daily Flow – Maximum	1.4 (kg-BOD/m <sup>3</sup> .d)
Filter Media Depth – Maximum	2,000 (mm)
Net Secondary Sludge Production Rate – Minimum	0.80 (kg-SS/kg-BOD)
Free Board – Minimum	300 (mm)

## 4.8 Secondary Settling Tanks

### 4.8.1 General

- a) Secondary Settling Tanks shall receive Trickling Filters effluents, through gravity transmission pipelines, for the purpose of sedimentation of the humus sludge, produced in the Trickling Filters.

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- b) Treated Effluents from Secondary Settling Tanks shall be discharged to the Treated Effluent Pipeline(s).
- c) The Secondary Settling Tanks shall be circular-in-plan with central-feed and peripheral outflow and shall be partly underground and partly aboveground, to be constructed in RCC.
- d) The incoming wastewater shall be fed to the Tank, from center, at an appropriate level, through horizontal radial inlet ports. An Inlet Drum, of cylindrical geometry, whether fixed with the Sludge Scraper or to the tank structure, shall be provided, surrounding the inlet ports, for minimizing the turbulence and hydraulic short-circuiting and for ensuring quiescent entry of wastewater from the inlet ports into the settling zone of Tank.

The Inlet Drum shall be made of fiber-reinforced plastic (FRP) sheet, attached to a stainless steel (SS) frame.

- e) A fiber-reinforced plastic (FRP) peripheral, multi v-notch, effluent weir, along with scum plate, shall be attached to the wall of the Effluent Channel, to allow the settled wastewater flow to the Effluent Channel. The multi v-notch effluent weir shall ensure uniform radial distribution of flow across the Tank.
- f) A Sludge Collection Pit shall be provided, in the bottom of the Tank, at center, with base slab of the Tank, sloping in radial direction towards it.
- g) The mechanical Sludge Scraper shall be installed in the Secondary Settling Tank for continuously scraping and directing sludge, settled at the Tank bottoms, towards the Sludge Collection Pit. The Scraper shall be equipped with a Scum Skimmer, for automatically directing the scum to the Scum Collection Box attached to the Tank wall.
- h) Scum Collection Box shall be provided at an appropriate location inside the Tank wall. The Box shall be connected to a DN 150 CI outflow pipe, with all the bends to be of 45° and with a valved outlet, outside the Tank wall, at such location and level, that the scum can be discharged to a purpose-built scum trolley, placed under it. Scum shall thereupon be disposed of along-with the dewatered sludge.
- i) A sludge pipe shall be laid under the base slab of the Tank, in radial direction, from the Sludge Collection Pit, to be connected to the suction manifold of the Secondary Sludge Pumps.
- j) Plinth protection, in concrete paving (Minimum 900 mm wide) shall be provided, at the finished grade level, all around the Tanks.

4.8.2 **Design Basis**

The following design criteria shall be adopted:

<b>General</b>	
Hydraulic Loading Rate @ Design Peak Flow – Maximum	1.2 (m/h)
Secondary Sludge Concentration – Maximum	10,000 (mg/l)
<b>Tank</b>	
Minimum Side Liquid Depth (No-flow Conditions) – Minimum	3,000 (mm)
Free Board @ Minimum Side Liquid Depth – Minimum	500 (mm)
<b>Inlet Drum</b>	
Ratio of Drum Diameter to Tank Diameter – Minimum	0.20
<b>Effluent Channel</b>	
Width – Minimum	600 (mm)

4.9 **Sludge Thickeners**

4.9.1 **General**

- a) Sludge Thickeners shall receive waste primary and secondary sludge, through Waste Sludge Delivery Pipeline(s). The purpose of the Sludge Thickeners is to thicken and reduce the volume of the waste primary and secondary sludge, by increase in its solids concentration, prior to its digestion and consequent dewatering and drying.
- b) The Sludge Thickeners shall be circular-in-plan with central-feed and peripheral outflow and shall be partly underground and partly aboveground, to be constructed in RCC.
- c) The incoming sludge shall be fed to the Tank, from center, at an appropriate level, through horizontal radial inlet ports. An Inlet Drum, of cylindrical geometry, whether fixed with the Sludge Scraper or to the tank structure, shall be provided, surrounding the inlet ports, for minimizing the turbulence and hydraulic short-circuiting and for ensuring quiescent entry of sludge from the inlet ports into the settling/thickening zone of Thickener.

The Inlet Drum shall be made of fiber-reinforced plastic (FRP) sheet, attached to a stainless steel (SS) frame.

- d) A Sludge Collection Pit shall be provided, in the bottom of the Thickener, at center, with base slab of the Thickener, sloping in radial direction towards it.

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- e) The mechanical Sludge Scraper shall be installed in the Sludge Thickener for continuously scraping and directing thickened sludge, settled at the Thickener bottoms, towards the Sludge Collection Pit. The sludge scraper shall be equipped with vertical pickets.
- f) A sludge pipe shall be laid under the base slab of the Thickener, in radial direction, from the Sludge Collection Pit, to be connected to the suction manifold of the Thickened Sludge Pumps.
- g) A Supernatant Channel shall be provided circumferentially along the side wall to collect supernatant.
- h) A fiber-reinforced plastic (FRP) peripheral, multi v-notch, effluent weir shall be attached to the wall of the Supernatant Channel, to allow the supernatant flow to the Channel. The multi v-notch effluent weir shall ensure uniform radial distribution of flow across the Thickener.
- i) Supernatant from Thickener, collected in the Supernatant Channel, is a polluted stream and shall be discharged through a manhole to the Supernatant-Filtrate Pipeline (RCC), which shall carry it back to the Wet Well of the Wastewater Pumping Station, for re-treatment.
- j) If the top of the Thickener is higher than 2000 mm from the surrounding finished grade level (FGL), then a walkway (RCC), with an overall width of 1000 mm, shall be provided all-around along the exterior of the Thickener wall, at least 600 mm below the top level of wall, for the purpose of access to the top of the Thickener, for inspection, cleaning, operation and on-site repair and maintenance of equipment. On the outer side of the walkway, galvanized iron (GI) pipe railing shall be provided, for safety.  
  
RCC stair, of 1000 mm width, with galvanized iron (GI) pipe railing, shall be provided for access from finished grade level to the walkway.
- k) Plinth protection, in concrete paving (Minimum 900 mm wide) shall be provided, at the finished grade level, all around the Thickeners.

4.9.2 **Design Basis**

The following design criteria shall be adopted:

<b>General</b>	
Suspended Solids Loading Rate – Maximum	60 (kg/m <sup>2</sup> .d)
Hydraulic Overflow Rate – Minimum	5 (m/d)

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Thickened Sludge Concentration – Maximum	50,000 (mg/l)
<b>Tank</b>	
Minimum Side Liquid Depth (No-flow Conditions) – Minimum	4,000 (mm)
Free Board @ Minimum Side Liquid Depth – Minimum	500 (mm)
<b>Inlet Drum</b>	
Ratio of Drum Diameter to Tank Diameter – Minimum	0.20
<b>Supernatant Channel</b>	
Width – Minimum	300 (mm)

### 4.10 Sludge Digesters

#### 4.10.1 General

- a) Sludge Digesters shall receive thickened sludge, through Thickened Sludge Delivery Pipeline(s), from the Sludge Thickeners. The purpose of the Sludge Digesters is to stabilize the solids and bio-solids, reduce the pathogens, eliminate the odors and inhibit or reduce the potential for putrefaction, in the sludge, prior to its dewatering and drying.
- b) The Sludge Digesters shall anaerobic, complete-mix type digesters, without recycling.
- c) The design basis for the Digesters shall be that the Retention Time, at the Design Temperature of 30 °C, shall not be less than 15 days.
- d) The Digesters shall, preferably, be circular-in-plan and shall be fully-covered, partly-underground and partly-aboveground tanks, to be constructed in RCC.
- e) From the Digesters, the digested sludge shall be pumped to the Sludge Drying Beds, through Digested Sludge Delivery Pipeline(s), by means of Digested Sludge Pumps.
- f) An RCC stair, of 1000 mm width, with galvanized iron (GI) pipe railing, shall be provided for access from finished grade level to the top.
- g) Plinth protection, in concrete paving (Minimum 900 mm wide) shall be provided, at the finished grade level, all around the Digesters.

#### 4.10.2 Contents Mixing System

- a) Each Sludge Digester shall be provided with contents mixing system, comprising Recirculation Pumps, placed outside the Digester, which shall take sludge from the bottom of the Digester and continuously re-circulate it to the top of the Digester,

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through specially-designed Nozzles which shall discharge it, in form of jets, to impart the hydraulic energy for mixing the contents.

- b) The discharge Nozzles shall be of a design and construction such as to have little or no risk of blockage.
- c) For each Digester, at least three numbers of Recirculation Pumps (all duty), of equal discharge capacity, shall be provided. No standby pumps are required. The Recirculation Pumps shall be placed along the periphery of the Digester at equal spacing.
- d) The minimum total discharge capacity of the Recirculation Pumps, for each Digester, shall be equal to the hydraulic volume of the Digester divided by a time period of the 2.5 hours.
- e) The Recirculation Pumps shall be horizontal, solids-handling, centrifugal type, suitable for dry installation.
- f) Each Pump shall be provided with a manually-operated gate valve on suction side and a manually-operated gate valve on the delivery side.
- g) Each Pump shall be provided with dual control switches, as follows:
  - A local manual On/Off control switch
  - A remote manual On/Off control switch located in the Plant Control Room of the Plant Building
- h) The Recirculation Pumps shall be placed on the Platforms, of sufficient size to accommodate the pumps and valves. The Platforms shall comprise the following components:
  - The main platform body shall comprise a base slab, end & intermediate walls and top slab-on-grade, all in RCC, to form a monolithic cellular structure, filled with sand. The platform body shall be of sufficient weight to control the transfer of vibration to the surrounding soil.
  - In order to provide protection to the pumps from direct rain and sun, the platform shall be covered with an RCC slab (with adequate projections) supported on columns, raised from the top slab of the platform.

#### 4.10.3 *Biogas Flare System*

- a) Biogas, generated in the Sludge Digesters shall be collected, from the top of the Digesters and carried, through HDPE pipes network, to the appropriately located Open Biogas Flare.

- b) The Biogas Flare System shall comprise the following components:
- Foundation: RCC
  - Stack: Carbon steel structure with sand blasted & marine grade coating or galvanization
  - Shut-Off Device: Stainless steel solenoid valve or actuator valve
  - Biogas Blower
  - Biogas Water Separator
  - Biogas Filter
  - Biogas Regulator
  - Biogas Flow Meter
  - Thermocouple: Type N
  - End-of-Line Flame-Arrester: Stainless steel to European Standard EN 12874
  - Inline Flame Arrester(s)
  - Lightning Arrester
  - Flame Detector: Ionization Type
  - Ignition System: Ignition Transformer
  - UPS for Actuator

#### 4.11 Sludge Drying Beds

##### 4.11.1 General

- a) Sludge Drying Beds shall preferably be grouped together in a separate contiguous space.
- b) The purpose of the Sludge Drying Beds shall be to dewater and dry the digested sludge, received from Sludge Digesters, by process of drainage and evaporation, prior to its disposal or land application, as the case may be.
- c) Sludge Drying Beds shall be of the conventional, un-paved type with sand used as filter media.
- d) Individual Beds shall be rectangular in plan, with their shorter and longer dimensions not to be more than 6,000 and 15,000 mm, respectively, to be enclosed within RCC walls on RCC footings.
- e) In the center of each Bed across shorter direction, a perforated PVC pipe (of diameter not less than 150 mm and gradient not less than 1 in 150) shall be placed along the full length of the bed, in an earthen trench, excavated below the subgrade level of bed, to collect and carry the sludge filtrate. The pipe shall be duly surrounded with gravel.

The filtrate pipe of the individual Bed shall be extended to the end of the Bed, where it shall be connected, through a manhole, to the Main Sludge Filtrate Pipeline of the battery of individual Beds, which shall thereupon be connected, through a manhole,

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to the Supernatant-Filtrate Pipeline, which shall carry the filtrate, which is a polluted stream, back to the Wet Well of the Wastewater Pumping Station, for re-treatment.

- f) Subgrade of the individual Bed shall be sloped, from the side walls towards the central trench (accommodating the filtrate pipe), at a gradient of not less than 1 in 100. Subgrade shall be well compacted.
- g) Over the compacted subgrade, following layers of gravel and sand shall be provided, from bottom to top:
  - Coarse gravel, of varying thickness, with minimum thickness of 75 mm at the side walls
  - Medium gravel, with minimum uniform thickness of 75 mm
  - Fine gravel, with minimum uniform thickness of 75 mm
  - Sand, with minimum uniform thickness of 300 mm

Sand media shall have a uniformity coefficient of not more than 4 and effective size of 0.3 to 0.75 mm.

- h) To each individual Bed, digested sludge shall be fed by a valved inlet (of diameter not less than 100 mm), branched from one of common Digested Sludge Delivery Pipelines, carrying digested sludge from Digested Sludge Pumps.

The sludge inlet shall comprise a gate valve and a downward 45° bend, at the end and shall be easily accessible for its operation. The sludge inlet shall be placed horizontally at the center of a shorter wall of the individual Bed and vertically at the top of wall.

- i) In each Bed, a pre-cast RCC splash slab, of appropriate size, shall be placed on the top of the sand bed, at the point where inflow jet of the sludge shall strike the bed, in order to avoid the erosion.
- j) The dewatered sludge shall be transported, by tractor-trolleys, to the site for disposal or land application, as the case may be. At least, one side of each individual Bed shall be accessible by a road for parking the sludge trolleys and for loading the dried sludge on them.
- k) Plinth protection, in concrete paving (Minimum 900 mm wide) shall be provided, at the finished grade level, all around the Sludge Drying Beds.



**4.11.2 Design Basis**

The following design criteria shall be adopted:

Sludge Drying Period – Minimum	8 (d)
Idle Time Period – Minimum	2 (d)
Sludge Charge Depth – Maximum	300 (mm)
Free Board over Top of Sand Bed – Minimum	300 (mm)
Solid Contents of Dried Sludge – Maximum	30 (%)

**4.12 Process Piping Works**

**4.12.1 Types of Piping**

Except where otherwise specifically laid down in the relevant sections, following types of piping shall be adopted for the transmission of wastewater, supernatants, filtrates and sludge:

- a) All exposed pipelines, whether gravity or pressure, shall be of cast iron (CI) pipe (flanged) with cast iron (CI) fittings (flanged).
- b) Following underground pipelines shall be of reinforced cement concrete (RCC) pipe with manholes:
  - Wastewater Pipeline from Last Manhole of Sewerage System to First Wastewater Screening Chamber
  - Wastewater Pipelines from First Wastewater Screening Chamber to Wet Wells
  - Treated Effluent Pipelines
  - All pipelines carrying supernatants from Sludge Thickeners and sludge filtrate
  - All pipelines carrying overflows under gravity
- c) The underground pipelines, except for those included in (b) above, whether pressure or gravity flow, shall be of one of the following materials:
  - Asbestos cement (AC) pipe with cast iron (CI) fittings (socket-spigot)
  - Fiber-reinforced plastic (FRP)
  - Un-plasticized Polyvinyl Chloride (UPVC)

**4.12.2 Supernatant-Filtrate Pipelines**

- a) The Supernatant-Filtrate Pipeline (gravity-flow) shall be provided primarily to carry the polluted streams of the supernatant from the Sludge Thickeners and filtrate from the Sludge Drying Beds, back to the Wet Well, for re-treatment.

- b) The manholes shall be provided on the RCC pipelines, at all changes of size, direction, slope or level; at all the pipe junctions; at all inlet points; and on all the straight reaches, at a spacing of not more than 100 times the diameter of the pipe.

#### 4.12.3 **Treated Effluent Pipeline(s) and Marine Disposal Outlet**

- a) Treated Effluent Pipeline(s) shall be provided to receive and carry the treated effluents from the Secondary Settling Tanks, for their ultimate disposal to the sea, located in south-west of the Site.
- b) For marine disposal of the treated effluents, a properly designed RCC Marine Disposal Outlet shall be provided, at an appropriate location within the sea, at the end of the Treated Effluent Pipeline.

The crown level of the pipe outlet shall be at least 1,000 mm below the minimum seawater surface level during the low tide.

In the Marine Disposal Outlet, a removable stainless steel (SS) screen shall be provided to prevent the entry of aquatic or other animals into the Treated Effluent Pipeline.

#### 4.12.4 **Sludge Piping**

- a) In both gravity as well as forced sludge pipelines, as far as practicable, bends at 90° shall be avoided and instead bends at 45° shall be provided, in order to minimize the chances of pipe clogging.
- b) In exposed gravity as well as forced sludge pipelines, as far as practicable, tees and wyes shall be used instead of 90° and 45° bends, respectively, on the changes of direction (horizontal or vertical), in order to provide clean outs, for removal of clogging. For this purpose the access ends of these fittings shall be closed with blank flanges.

#### 4.12.5 **Flow Velocities**

The design flow velocities in the gravity and forced transmission pipelines for wastewater, supernatants, filtrates and sludge shall not exceed 2.00 mps.

#### 4.13 **On-Site Process Monitoring Works**

##### 4.13.1 **On-line Real-time Wastewater Flow Meters**

- a) Electromagnetic flow meters shall be provided, at appropriate locations, on the delivery pipeline of each of the Wastewater Pumps, placed in the Dry-Well of the Wastewater Pumping Station.

- b) The electronic display of the meters shall be located in the Plant Control Room of the Plant Building, for continuous measurement of the wastewater flows.
- c) The flow meter shall measure and indicate the instantaneous flows (accuracy:  $\pm 5\%$ ) as well as the cumulative flows, measured from a baseline time, with a provision to set and reset the baseline time.

#### 4.13.2 Venturi Flow Meter

A Venturi type Flow Meter, to be constructed in RCC, shall be provided, at an appropriate location of the final section of Treated Effluent Pipeline, carrying all the treated flows from STP. The meter shall be provided with all the appurtenances, required for the manual flow measurement.

### 5. BUILDINGS

#### 5.1 Plant Building

- a) The Plant Building shall be planned and provided to accommodate offices, office associated facilities, Plant Control Room, Laboratory, stores, Workshop and workers' facilities.
- b) The Building shall, preferably, be located close to the Entrance Gate of the STP. The Building may be planned in one contiguous block or alternatively in multiple functional blocks, interconnected through corridors.
- c) The Plant Building shall be a double-storey building; though certain parts may be of single-storey, with a total covered area of not less than 1300 m<sup>2</sup>.
- d) The Plant Building shall be planned and provided to accommodate at least the following component facilities:

Component Facilities	Description
Car Port	1 NO, at Entrance, with capacity for 10 cars
Podium	1 NO, at Entrance
Reception Area	1 NO with Seating Capacity for Min 8 Persons
Stair Hall	Min 1 NO (Stair Width: 1500 mm)
Officer Rooms with attached Toilets	2 NO (Min Room Area: 18 m <sup>2</sup> each)
Officer Rooms	4 NO (Min Room Area: 15 m <sup>2</sup> each)
Officer Cabins (Low-Height)	8 NO (Min Cabin Area: 10 m <sup>2</sup> each)
Working Halls	2 NO with provision for 4 Work Stations Each

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<b>Component Facilities</b>	<b>Description</b>
Admin & Purchase Staff Area	
Officer Cabins (Low-Height)	1 NO (Min Cabin Area: 12 m <sup>2</sup> each)
Staff Area	Provision for 6 Work Stations
Accounts Staff Area	
Officer Cabins (Low-Height)	1 NO (Min Cabin Area: 12 m <sup>2</sup> each)
Staff Area	Provision for 6 Work Stations
Employer's Personnel Area	
Officer Room with attached Toilet	1 NO (Min Room Area: 18 m <sup>2</sup> each)
Officer Cabins (Low-Height)	2 NO (Min Cabin Area: 10 m <sup>2</sup> each)
Staff Area	Provision for 6 Work Stations
Plant Control Room (Air Conditioned)	1 NO (Min Area: 60 m <sup>2</sup> )
Laboratory	1 NO (Min Area: 35 m <sup>2</sup> )
Laboratory Staff Area	
Supervisor Cabin (Low-Height)	1 NO (Min Cabin Area: 12 m <sup>2</sup> )
Support Staff Area	Provision for 2 Work Stations
Office Stores	2 NO (Min Room Area: 18 m <sup>2</sup> each)
Conference Room	1 NO with seating capacity of 30 persons
Officers Dining Room	1 NO with seating capacity of 30 persons
Mosque	1 NO with capacity of 30 persons
Office Kitchens	1 NO (Min Area: 15 m <sup>2</sup> each), 1 on each Floor
Ladies Toilets – Private	2 NO, 1 on each Floor
Gents Toilets – Public	2 NO, 1 on each Floor, each with a Basin Area (with 3 Wash Hand Basins) and 3 separate WC Rooms
Ablution Area	1 NO with 6 Taps & Ablution Seats
Janitors' Closet	1 NO
Workers Canteen	1 NO (Min Area: 100 m <sup>2</sup> each)
Workers Kitchen & Pantry	1 NO (Min Area: 30 m <sup>2</sup> each)
Workers Toilets – Public	1 NO, with a Basin Area (with 6 Wash Hand Basins), 6 separate WC Rooms & 1 Shower Room
Staff Change & Lockers Rooms	1 NO (Min Area: 30 m <sup>2</sup> each)
Workshop	1 NO (Min Area: 100 m <sup>2</sup> each)
Materials & Equipment Store	1 NO (Min Area: 40 m <sup>2</sup> each)

- e) Except for the Workshop, the floor heights, measured from the finished floor levels (FFL) to the soffit of the slabs shall be 3,000 mm in the Plant Building. The floor height of Workshop shall be determined on the basis of the specific functional requirements, but in no case shall be less than 4,500 mm.

## 5.2 **Civil & Architectural Works for Buildings**

### 5.2.1 **General**

- a) Covered area of a building shall be the sum of the areas of all the floors, with area of each floor to be that enveloped by the exterior faces of the outer walls or by the lines joining the exterior faces of the outer columns of the building, as the case may be.
- b) The finished floor level (FFL) of the buildings shall be of the order of 600 mm above the adjoining road level.
- c) Where provided, in general, the width of corridors shall not be less than be 1500 mm.

### 5.2.2 **Structural System**

- a) All the buildings shall be constructed in RCC frame structure, comprising RCC slabs supported on RCC beams, which shall thereupon be supported on monolithic RCC columns, with RCC footings.
- b) All the walls shall be made of in-fill concrete block masonry (200 mm thick).
- c) The masonry walls at ground floors shall be supported on RCC plinth-beams monolithically connected with the RCC columns.

### 5.2.3 **Plaster Work**

All the interior and exterior surfaces of the internal and external walls, columns and parapets and ceiling surfaces shall be finished with cement-sand plaster.

### 5.2.4 **Roof Parapet**

Roof shall be provided with all-around RCC parapets (100 mm thick) of height 450 mm above the top of slab.

### 5.2.5 **Flooring, Dado and Skirting**

- a) Ceramic tile finish, with height of 1200 mm from the finished floor level (FFL), shall be provided on walls of the all the toilets.
- b) The floor of toilets shall be sloped (@ 1 in 50) towards the floor traps, provided for floor drainage.

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- c) Except for the workshops and areas to receive or store heavy equipment, which shall be provided with granolithic flooring and skirting, all the other areas of the buildings shall be provided with ceramic tile flooring and skirting.

**5.2.6 Stairs**

- a) In case of double-storey buildings, RCC stairs, from ground floor to first floor, shall be provided with a width of 1500 mm, risers of 175 mm and treads of 275 mm.
- b) Chemically polished marble slab topping shall be provided on the treads & risers of stairs and stair landings.
- c) The stair railing shall be of galvanized iron (GI) pipe.

**5.2.7 Painting**

- a) All the interior walls, columns and ceiling surfaces, with plastered or concrete finish, shall be painted with synthetic vinyl emulsion paint.
- b) All the exterior walls, columns and parapet surfaces, with plastered or concrete finish, shall be painted with acrylic based exterior emulsion paint.

**5.2.8 Windows and Fixed Glazed Panels**

- a) Sliding type anodized aluminum windows and fixed glazed panels shall be provided in the external walls of the buildings, at an above-floor level, for purpose of natural ventilation and lighting.
- b) Gross area of the windows and the fixed glazed panels shall not be less than about 12 % of the covered area of the building.

**5.2.9 Doors**

- a) In toilets and WC rooms, wooden flush doors of sizes 900 mm x 2100 mm and 750 mm x 2100 mm, respectively, shall be provided.
- b) In the workshops and areas to receive or store heavy equipment, doors meant for the transfer of equipment, shall be top-hung sliding steel door. The size of the door shall be in accordance with the maximum dimensions of the equipment to be moved through the doors. For outside access, a ramp, of width equal to the width of the door and with appropriate slope, comprising RCC slab-on-grade with side concrete block masonry walls, shall be provided.

- c) Except for those included in (a) and (b) above, all the internal doors and main entrance doors in the buildings shall be wooden partly-glazed flush doors, of sizes 1050 mm x 2100 mm and 1200 mm x 2100 mm, respectively.

#### 5.2.10 ***Kitchen Cabinets***

- a) Kitchen Cabinets including Base Cabinets and Hanging/Wall-mounted Cabinets shall be provided in each kitchen of the buildings, such that:
- Base Cabinet shall cover two sides of the kitchen, excluding space for fuel gas oven and kitchen sink.
  - Lengths of Hanging Cabinet shall be equal to that of the Base Cabinet.

#### 5.2.11 ***Plinth Protection***

Plinth protection, in concrete paving (900 mm wide) shall be provided, at the finished grade level, all around the buildings.

#### 5.2.12 ***Epoxy-Coated Mild Steel (MS) Spiral Stair***

In each Building, an epoxy-coated mild steel (MS) spiral stair shall be provided, at an appropriate location outside the Building, from the finished grade level to the roof of the Building, for access.

#### 5.2.13 ***Overhead Water Tank***

- a) An RCC Overhead Water Tank shall be provided over the roof of the Plant Building, to cater for the requirements of the whole of the STP.
- b) The effective storage capacity of the Tank shall be equal to the 50% of the maximum day water requirement of the STP or 50 m<sup>3</sup> whichever is greater.
- c) The level of the Tank shall be such that it can deliver water, at required pressures, to all the consumption points of the STP.

### 5.3 **Building Plumbing Works**

#### 5.3.1 ***Plumbing Sanitaryware, Fixtures and Accessories***

- a) In each Private Toilet, a water closet (WC) and a wash hand basin (with single-hole basin mixer) shall be provided.
- b) Water closets (WC) shall be of European or Asian type, as required by the Employer.
- c) With each water closet (WC), a bib cock and a toilet paper holder shall be provided.
- d) With each wash hand basin, a towel rail and a bath mirror shall be provided.

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- e) With each shower, a soap dish and a towel rail shall be provided.
- f) In Office Kitchens, each, and in Workers Kitchen, one and two kitchen sinks (with Wall Sink Mixers), respectively, shall be provided.
- g) In Laboratory, two laboratory sinks (with wall sink mixer with small-hole nozzle fitting) and a towel rail shall be provided.

### 5.3.2 Water Distribution System in Buildings

- a) Water for plumbing systems of all the buildings shall be taken from the external water supply network, fed by the Overhead Water Tank, placed on the roof of the Plant Building.
- b) The water distribution network, from source to the plumbing fixtures, shall be branched type. The following table may be employed for sizing of water distribution network in buildings:

Pipe Diameter	Numbers of Connected Fixtures with Simultaneous Operation	
	(Cold & Hot Pipes)	Common-Cold Pipes
12 mm (½")	1	
19 mm (¾")	2	1
25 mm (1")	3 – 6	2 – 4
31 mm (1¼")	7 – 12	5 – 9
38 mm (1½")	13 – 20	10 – 15
50 mm (2")	21 – 40	16 – 30
63 mm (2½")		31 – 50
75 mm (3")		51 – 80

Following is the basis for using the above table, for sizing of water distribution network:

- Common-cold pipes are the pipes from source to the point, where branch is taken for feeding the water heater. Downstream of the said point, the pipes carrying the cold and the hot water shall be cold and hot water pipes, respectively.
- A private toilet, with multiple plumbing fixtures, shall be taken equal to 2 fixtures for cold pipe, 1 fixture for hot pipe and 2 fixtures for common-cold pipe.
- Each separate and independent basin mixer and sink mixer shall be taken equal to 1 fixture for cold pipe, 1 fixture for hot pipe and 1 fixture for common-cold pipe.
- Each separate and independent water closet inclusive of the bib cock shall be taken equal to 2 fixtures for cold pipe and 2 fixtures for common-cold pipe.



- c) Except for the piping within the toilets and kitchens, which shall be recessed in the walls, all the other water piping shall be, as far as practicable, exposed and attached to the building walls.

**5.3.3 Storage Type Fuel-Gas Water Heaters**

- a) One or more storage-type fuel-gas water heaters, of adequate capacity and to be located as close as practicable to the served hot water fixtures, shall be provided, for each Building.
- b) The capacity of water heaters (in liters) shall be sum of the requirements for the shift staff and the resident staff. The basis shall be 3 liters per shift staff (on the basis of shift with maximum numbers of users) and 10 liters per resident staff, with the minimum capacity of a heater to be 90 liters.

**5.3.4 Building Drainage**

- a) Following shall be the main components of the building drainage system:
  - Soil stacks (vertical pipes) and horizontal branches (drain pipes extending laterally from external sewer or stack, receiving the discharges from one or more fixtures), conveying discharges of water closet or fixtures having similar functions, with or without the discharge from other fixtures
  - Waste stacks and horizontal branches conveying only the liquid wastes free of any fecal matter
  - Vent pipes, installed to provide flow of air to and from a drainage system or to provide a circulation of air within such system to prevent accumulation of foul air and to protect breaking of trap seals due to siphonage and back pressure
- b) Single Stack System, with the following features, shall be adopted for building drainage:
  - For toilets, kitchens and other facilities at ground floor, underground soil and waste horizontal branches shall be provided from fixtures to the inspection chambers on external sewer.
  - For each toilet, kitchen and other facility at above-ground floors, under-floor soil and waste horizontal branches shall be provided from fixtures to a single common stack (exposed and attached with the exterior face of the building), which shall be connected, through an underground pipe, to the inspection chambers on external sewer.
  - The top of the stack shall be extended to roof level by providing 50 mm (2") diameter vent pipe, with a cowel at its top.
  - No horizontal connection shall be allowed between a waste and a soil horizontal branch.

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- c) Floor traps shall be provided in toilets and kitchens for the drainage of floors.
- d) Cleanouts shall be provided in the horizontal branches, at appropriate locations in order to facilitate roding to remove clogging and obstructions in the pipes.
- e) Sizing of soil and waste piping shall be as follows:

Soil Horizontal Branches and Stacks	75 mm (3")
Waste Horizontal Branches and Stacks	100 mm (4")

5.3.5 **Rainwater Drainage for Buildings**

- a) No soil or waste pipe for building drainage shall be used for the purpose of rainwater drainage.
- b) Following shall be the main components of the rainwater drainage system for flat roofs and terraces:
  - Roofing over Structural Slabs: The top surface of roof/terrace shall be sloped, at surface gradients of not less than 1 in 150, towards the rainwater trough, to concentrate rainwater towards it.
  - Rainwater Trough: The function of the rainwater trough is to collect the rainwater and divert it to the rainwater downpipe.
  - Rainwater Downpipe: The function of rainwater down pipe is to carry rainwater to the ground level for onward disposal.
- c) Rainwater troughs shall have the following features:
  - The surface of rainwater trough shall be sloped to divert rainwater towards the rainwater down pipe.
  - The size of rainwater trough in plan shall be 750 mm x 750 mm.
  - Minimum depth of the trough shall be 50 mm.
- d) The following table may be employed for sizing of rain water down pipes:

Rainwater Down Size	Maximum Area to be Drained (m <sup>2</sup> )
75 mm (3")	200
100 mm (4")	400

5.3.6 **Fuel-gas Distribution System in Buildings**

- a) Fuel gas shall be taken from the external fuel gas supply network, to be laid within the STP Site, and be supplied to the following equipment, provided in the buildings:
  - Two gas ovens in the Workers Kitchen
  - One gas oven in the Office Kitchen
  - All the Fuel-Gas Water Heaters
- b) Except for the piping within the kitchens, which shall be recessed in the walls, all the other gas piping shall be, as far as practicable, exposed and attached to the building walls.

5.4 **Building Illumination and Electrification Works**

- a) All the building electrification systems shall be concealed type with wires laid in heavy duty PVC conduits and conduit accessories, recessed in walls, columns and slabs.
- b) The minimum sizes of the wiring cables shall be as follows:

Point wiring, for light fixtures, fans, switch socket units (5 Amp) and other fixtures, from fixture to switch board	1.5 mm <sup>2</sup>
Wiring for switch socket units (5 Amp), away from room switchboard	1.5 mm <sup>2</sup>
Light circuit wiring from switch boards to one MCB in Distribution Boards at the same floor	2.5 mm <sup>2</sup>
Wiring for switch socket units (15 Amp), from unit to one MCB in Distribution Boards at the same floor	4.0 mm <sup>2</sup>

- c) Not more than 8 numbers of light points (light fixtures, fans, 5 Amp switch socket) shall be connected to a light circuit.
- d) All points and circuits wiring shall be solidly earthed by means of cables of the following minimum sizes, to serve as Earth Continuity Conductor (ECC), which shall be run all along the conduit's length as required:

Point wiring, Wiring for switch socket units (5 Amp), Light circuit wiring	1.0 mm <sup>2</sup>
Wiring for switch socket units (15 Amp)	2.5 mm <sup>2</sup>

- e) Each building shall be served by, at least, one, appropriately located, distribution board (with an earthing set).
- f) Switch boards, for controlling the light and fan fixtures, shall be provided close to the respective entrance door, for each of the room or other isolated space of the buildings.

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On each switch board, one 2-pin socket (5 Amp) with controlling switch shall be provided.

- g) Plastic body exhaust fans (300 mm diameter), of approved make, shall be provided in the following areas of the buildings, for purpose of forced ventilation:
- Toilets
  - Kitchens
  - Laboratories
  - Workshops
- h) Except for toilets, ceiling fans (56" sweep) shall be provided in all the covered areas of the buildings such that in each of the room or other isolated space, maximum of only 15 m<sup>2</sup> is covered by one fan.
- i) Except for toilets, 3-pin switch socket units (5 Amp), away from room switchboard, shall be provided, on walls at appropriate locations, in all the covered areas of the buildings such that in each of the room or other isolated space, maximum of only 10 m<sup>2</sup> is covered by one unit.
- j) Except for toilets, 3-pin switch socket units (15 Amp), away from room switchboard, shall be provided, on walls at appropriate locations, in all the covered areas of the buildings such that in each of the room or other isolated space, maximum of only 25 m<sup>2</sup> is covered by one unit.
- k) Fluorescent tube-light fixtures (4-20W, 600 mm x 600 mm) shall be provided on the ceilings, to provide illumination for all the covered areas of the buildings such that in each of the room or other isolated space, maximum of only 10 m<sup>2</sup> is covered by one fixture.

In addition to the afore-mentioned ceiling light fixtures, wall light fixtures (of the types to be approved by the Employer's Representative), may need to be provided, where required.

- l) PVC conduits, of adequate sizes, shall be laid in the walls/floors of the buildings, for carrying wires for telephone/intercom, from the outside to a central point within each building and from that central point to the users points, appropriately located on the walls, such that in each of the room or other isolated space, maximum of only 15 m<sup>2</sup> is covered by one point.
- m) PVC conduits, of adequate sizes, shall be laid in the walls/floors of the building, for carrying wires for computer-network/internet, from the outside to a central point within the building and from that central point to the users points, appropriately located on the walls, such that in each of the room or other isolated space, maximum of only 15 m<sup>2</sup> is covered by one point.

**6. MISCELLANEOUS WORKS**

**6.1 General**

Maximum seawater surface level (during high tide) is reported to be 80.500 m. This data is however tentative only. The Contractor shall be required, to collect and ascertain all the requisite data and information on the marine and coastal conditions, including particularly the risks of coastal storms and flooding, for carrying out proper design of the STP, particularly the following components:

- Treated Effluent Pipeline(s) and Marine Disposal Outlet
- Land Grading and Site Development Works
- Boundary Walls
- Stormwater Drainage Works for the Site

**6.2 Land Grading and Site Development Works**

- a) Natural surface levels (NSL) of the STP Site, as shown in Annexure 2 of these Design Requirements, vary from 80.500 to 82.000 meters.
- b) Only a part of the STP Site, comprising the contiguous area enveloped in between and not less than 10 meters beyond, all the facilities constructed under this Contract, shall be graded to the finished grade levels (FGL).

The remaining Site area shall be left as such.

- c) The finished grade levels (FGL) of the STP site shall be determined and provided on the following basis:
  - FGL along the south-western boundary shall be kept at least 500 mm above the maximum seawater surface level (during high tide).
  - From south-western boundary, FGL shall be raised in a uniform gradient towards the north-eastern boundary, to an FGL which can be achieved by using the surplus/suitable materials, excavated for the facilities constructed under this Contract, without any substantial use of imported fill materials.

**6.3 Entrance Gates**

- a) One number epoxy-coated mild steel (MS) Main Entrance Gate shall be provided along the boundary wall, at the main Site entrance point, for the vehicles. The gate shall have a clear opening (width) of not less than 6,000 mm and a shutter height of not less than 2,000 mm.
- b) One number epoxy-coated mild steel (MS) Wicket Gate shall be provided along the boundary wall, at an appropriate location, for entrance of the pedestrian staff and

visitors. The gate shall have a clear opening (width) of not less than 1,200 mm and a shutter height of not less than 2,000 mm.

#### 6.4 Boundary Walls

- a) For the STP Site, all the boundary walls, with their total length of about of 5,270 meters, shall be constructed.
- b) Top of all the boundary walls shall be of the order of 1800 from the finished grade levels (FGL).
- c) In general, the boundary wall shall be, 100 mm thick, plastered, concrete-block masonry wall, placed on the precast pre-stressed RCC I-Section girders, resting on either side on top of the block type foundations, and inset between the precast pre-stressed RCC I-Section boundary columns, inserted in the block foundation. However, the parts of the boundary walls, which are expected or foreseen to be subjected to the coastal flooding or marine wave action, the extent of which shall be established and ascertained by the Contractor, to the satisfaction of the Employer's Representative, shall be designed accordingly, for complete structural safety.

#### 6.5 Roads, Pavements and Vehicle Parking Areas

##### 6.5.1 General

- a) Flexible type asphaltic pavements shall be provided for the following:
  - Roads
  - Car Parking Area near Plant Building
  - Tractor-Trolleys Parking Area
- b) Levels of roads and parking areas shall be about 300 mm above the surrounding finished grade levels.

##### 6.5.2 Roads

- a) A road network shall be provided within the STP Site, starting from the main leading road in front of the STP, to have vehicular access to all the buildings and all the major treatment units, in order to facilitate the transportation of the following:
  - Operation and maintenance staff
  - Equipment for repair and/or re-installation, during the operation
  - All the materials and goods, required for operation and maintenance
  - Dewatered sludge from STP to the disposal site
- b) Minimum widths of road pavement and shoulders shall be 4,000 mm and 1,500 mm, respectively.

**6.5.3 Car Parking Area near Plant Building**

A car parking area for parking of staff and visitors vehicles, with a capacity of at least 7 vehicles, shall be provided near the Plant Building.

**6.5.4 Tractor-Trolleys Parking Area**

Separate parking area, at one or more places, duly connected to the road network of the STP, shall be provided for all the tractor-trolleys, required for the sludge transport.

**6.6 Walkways**

A network of walkways (1200 mm wide in concrete paving), raised by about 100 mm from the finished grade levels (FGL), shall be provided within the STP Site, for pedestrian access from nearby roads to entrance points of all the buildings including pumping stations and to the treatment units or to stairs of the treatment units, as the case may be.

**6.7 Stormwater Drainage Works for the Site**

**6.7.1 General**

- a) A separate stormwater drainage system shall be provided, within the STP Site, for drainage and disposal of the rainwater to the sea, located in south-west of the Site.
- b) The stormwater drainage system shall be provided only for those areas, which are to be graded and developed under this Contract, as laid down in Section 6.2 (c).
- c) The stormwater drainage system may comprise of RCC channels or RCC pipes, with provision of rainwater inlet chambers, to collect and divert the rain water, to the system.
- d) Local surface gradients in the finished grade levels (FGL) shall be provided for directing the rain water to the rainwater inlet chambers

**6.7.2 Design Criteria**

- a) Design rainfall intensity for the stormwater system shall be taken as 25 mm per hour.
- b) In case of stormwater sewers, minimum pipe size shall be 225 mm.
- c) The minimum slopes for the stormwater sewers and channels shall those associated with the flowing-full velocity of 0.75 mps.

**6.8 External Water Supply Works in the Site**

**6.8.1 General**

- a) Potable water shall be provided to all the plumbing and water usage fixtures, installed in the STP.
- b) Total water requirements shall be the sum of process water, human water and irrigation water requirements.

Maximum day water requirements, on account of human consumption, shall be sum of the requirements for the shift staff and the resident staff. The basis shall be 50 liters per shift-staff per shift and 200 liters per resident-staff per day.

**6.8.2 Water Supply System**

- a) Source of water for STP shall be service connection from the municipal water supply main.
- b) A pipe from the service connection shall be laid and connected, through a flow-control valve and a float valve installed in series, to an appropriately located Underground Water Tank (UWT). The purpose of the UWT shall be to provide emergency storage.
- c) In addition, all the necessary provisions shall be made for the UWT to receive water from the water tankers.
- d) Two Water Pumps (1 operating and 1 standby) , in parallel, of equal size, shall be provided on the top slab of the Underground Water Tank, for pumping water to the Overhead Water Tank placed on the top of the Plant Building, through a forced water transmission pipeline.
- e) For supply of water to all the consumption points, a branched water supply network, originating from the Overhead Water Tank on the Plant Building, shall be provided.

**6.8.3 Underground Water Tank**

- a) Underground Water Tank shall be made in RCC and covered with top slab. It may be rectangular or circular in plan.
- b) The effective storage capacity of the tank shall be equal to the 100% of the ultimate maximum day water requirement of the STP or 100 m<sup>3</sup>, whichever is greater.



**6.8.4 Water Pumps**

- a) The water pumps shall be horizontal, single-stage, centrifugal type.
- b) The discharge capacity of the each water pump shall be adequate to account for the water requirements of the STP, but shall not be less than 50 m<sup>3</sup>/h.
- c) Each water pump shall be provided with an automatic On/off control by means of an appropriate level-controlled switching device installed in the Overhead Water Tank of the Plant Building (with a Lower Level to Start and an Upper Level to Stop) as well as a manual On/Off control, located close to the pumps.
- d) The suction pipe of each water pump, with a flow-control valve, shall be lowered into the Underground Water Tank, with a foot valve at the end, in order keep the pump primed.
- e) With a flow-control valve and a check valve on delivery side of each water-pump, both the pumps (1 operating and 1 standby), shall be provided with a common delivery pipe to deliver water to the Overhead Water Tank of the Plant Building.
- f) A cover made of galvanized iron (GI) pipes and fiberglass sheets, shall be provided over the pumps, to protect them from rain and direct sun.

**6.8.5 External Water Supply Pipe Network**

- a) All the underground piping for water supply shall be polyvinyl chloride (PVC), whereas all the exposed piping shall be galvanized iron (GI).
- b) The pipe network shall be designed on the basis of the peak flows.
- c) The design flow velocities in the gravity and forced transmission pipelines shall not exceed 2.00 mps.

**6.8.6 Yard Taps**

A network of yard taps (threaded brass nozzle type), shall be installed at different locations in the STP, for the purposes of washing of in-place equipment and areas and irrigation of green areas.

**6.9 External Sewerage Works in the Site**

**6.9.1 General**

- a) An internal sewerage system shall be provided in the STP to collect sewage from the buildings and carry it to the Wet Well, for treatment.

- b) The sewerage system shall comprise the RCC pipe sewers, inspection chambers and manholes.
- c) Supernatant-Filtrate Pipeline may be used for the conveyance of the sewage.

**6.9.2 Sewerage Network**

- a) All the sewers shall be 150 mm RCC pipes, laid at a minimum slope of 1 in 150.
- b) The manholes shall be provided on the sewers, at all changes of direction, slope or level; at all the pipe junctions; at all inlet points; and on straight reaches, at a spacing of not more 100 times diameter of the pipe.

**6.10 External Fuel-gas Supply Works in the Site**

Fuel gas shall be supplied to the Plant Building, from the service connection taken from the external main, through a branched network of galvanized iron (GI) pipes.

**6.11 External Illumination Works**

- a) The objective of the external illumination system shall be to provide illumination to all the external areas and facilities of the STP.
- b) The external illumination system shall be provided only for those areas, which are to be graded and developed under this Contract, as laid down in Section 6.2 (c).
- c) External illumination shall be provided by means of mercury vapor lamps installed on single-arm or double-arm steel poles.
- d) The numbers, locations, and heights/levels of poles and ratings of the mercury vapor lamps shall be such as to provide the minimum levels of illumination intensities, as follows:
  - 10 LUX at ground level, at any place, except for roads
  - 20 LUX at road pavements and parking
  - 25 LUX at the top of the following facilities:
    - First Wastewater Screening Chamber
    - Wet Wells
    - Second Wastewater Screening & Grit Chambers Structure(s)
    - Flow Division Structures
    - Primary Settling Tanks
    - Primary Effluent Tank(s)
    - Trickling Filters
    - Secondary Settling Tanks
    - Sludge Thickeners
    - Sludge Digesters

- e) External lights shall be provided with manual On/Off control as well as with timer-controlled automatic switching devices.
- f) Suitable light fixtures shall be installed on the pillars of the Entrance Gate.

**6.12 External and Plant (Equipment) Electrification Works**

- a) External and Plant (equipment) electrification works shall comprise all the works required for delivering electricity from the source (HT – 11kV electricity connection from KESC) to the following facilities:
  - All the Plant (equipment) to be installed in STP including, but may not be limited to, the following:
    - First Wastewater Screening Chamber
      - Mechanical (Motorized) Hoisting Assemblies for Bar Screens
    - Wastewater Pumping Station
      - Dry Well
        - Wastewater Pumps
        - Bilge Pumps
        - Electrically-operated Overhead Bridge Crane
        - Flow Meters
    - Second Wastewater Screening & Grit Chambers Structure(s)
      - Wastewater Screening Chamber(s)
        - Mechanically-raked Bar Screens
      - Grit Chambers
        - Mechanical Grit Scraper
        - Mechanical Grit Raking Mechanism
        - Organic Return Pumps
    - Primary Settling Tanks
      - Mechanical Sludge Scrapers
    - Intermediate Wastewater and Primary, Secondary, Thickened & Digested Sludge Pumping Facilities
      - Intermediate Wastewater Pumps
      - Primary Sludge Pumps
      - Secondary Sludge Pumps
      - Thickened Sludge Pumps
      - Digested Sludge Pumps
    - Secondary Settling Tanks
      - Mechanical Sludge Scrapers
    - Sludge Thickeners
      - Mechanical Sludge Scrapers
    - Sludge Digesters

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- Recirculation Pumps
  - Biogas Flare System
  - External Water Supply Works in the Site
    - Water Pumps
  - Distribution Boards (DB) of all the buildings including, but may not be limited to, the following:
    - Plant Building
    - Dry Well
    - Intermediate Wastewater and Primary, Secondary, Thickened & Digested Sludge Pumping Stations
    - KESC Metering Room
    - Electrical Substations
    - Standby Electric Generators Building
  - External Illumination Works
- b) The metering facilities for the electric connection to the STP shall be housed in a purpose-built KESC Metering Room. The room shall be located along the front boundary wall of STP, with locked access from outside. Metering Panel shall also be housed in this room.
- c) External and Plant (equipment) electrification works shall include provision for connection to standby electricity generation facilities, described in Section 6.13.
- d) All the HT Switchgear Panels, LT Switchgear Panels and Transformer Protection Panels shall be housed in Electrical Substations. The design and covered area of these Substations and KESC Metering Room shall be such as to provide easy access to all the housed components for operation & maintenance and to furnish adequate ventilation. Except where otherwise required by any regulation of the KESC, the specifications of all these housing facilities shall, in general, be same as laid down in Section 4.6.4 "Pump Rooms".
- e) All the Transformers (11000/400/230 V) shall be outdoor type, to be placed on raised transformer platforms, with minimum height of 1500 mm, above the surrounding finished grade levels (FGL).
- f) All the LT Switchgear Panels shall be provided with Power Factor Improvement (PFI) plants, capable of alignment to Panels.
- g) Independent earthing systems shall be provided for all the HT Switchgear Panels, LT Switchgear Panels and Transformers.
- h) Except where to be attached with a building or a sanitary structure, all the HT (11 kV) and LT power and control cables shall be laid underground.

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Where to be attached with a building or a sanitary structure, the exposed power and control cables shall be laid in cable trays, in both horizontal as well vertical directions.

- i) All the HT (11-kV) power cables shall be XLPE type suitable for underground installation.
- j) All the LT power and control cables shall be as follows:
  - Underground: Armored cables (PVC/SWA/PVC)
  - Exposed: PVC-Insulated/PVC-Sheathed (PVC/PVC)
- k) All the HT (11 kV) electrical systems shall be provided with earth fault protection.
- l) All the HT (11 kV) and LT electrical systems shall be provided with following protections:
  - Short circuit protection
  - Overload protection
- m) The provisions for manual and/or automatic switching controls, for different Plant (equipment) shall be in accordance with the requirements, laid down elsewhere in this document.
- n) All the LT distribution systems shall be designed such that system voltage drop shall not exceed 2.5%.
- o) The sizing of the HT (11 kV) power cables shall be governed by current carrying capacity, as given by the manufacturer, after applying de-rating factors due to ambient temperature, cable grouping factors and others.

#### 6.13 Standby Electricity Generation Facilities

- a) Standby electricity generation facilities, to be provided for the STP, shall comprise the following main components:
  - Low-Voltage Diesel Electric Generator Sets
  - Fuel Supply System
  - Control/Instrument Panels
  - Synchronized Auto Main Failure (AMF) Panels
  - Standby Electric Generators Building
- b) The Standby Generator Sets shall be diesel-based, rated at 400 V, 50 Hz supply.

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- c) Required electrical load (in kW) for the Standby Generator Sets shall be determined as 20% above the maximum operational load of STP (in kW). The rated output (in kVA) of the Sets shall be determined by employing a power factor of 0.80.
- d) At least two Standby Generator Sets, in parallel operation, shall be provided.
- e) The Fuel Supply System, for the Generation Sets, shall comprise the following components:
- Underground Fuel Storage Tank (Common for all Generator Sets)
  - Fuel Transfer Pumps and Piping Network (For each Generator Set)
  - Fuel Day Tank (For each Generator Set)
- f) The Underground Fuel Storage Tank, to store fuel for the operation of the all the Generator Sets, shall be made of glass-reinforced plastic (GRP), complete with all the accessories and shall have the storage capacity equal to 56 hours of operation of all the Sets at the rated output.
- g) An explosion-proof, electrically-driven, self-priming, fuel pump (duty) shall be provided, for transferring fuel (diesel) from the Underground Fuel Storage Tank to the Fuel Day Tank of each Generator Set. The discharge capacity of the pump shall be such as to fill the Fuel Day Tank in a period of 30 minutes or lesser.

A manual fuel pump (as a standby) shall also be provided, in parallel to the electrically-driven fuel pump, for transferring the fuel from the Underground Fuel Storage Tank to the Fuel Day Tank of each Generator Set. The discharge capacity of the pump shall be such as to fill the Fuel Day Tank in a period of 2 hours or lesser.

- h) Fuel piping comprising pipes & fittings (HDPE), control/shutoff valves (brass ball valves), check valves (brass) and accessories shall include the following:
- Suction piping from Underground Fuel Storage Tank to electrical and manual fuel pumps
  - Delivery piping from electrical and manual fuel pumps to the Fuel Day Tank
  - Bypass piping from manual fuel pump to fuel drainage sump
- i) Each Generator Set shall have a skid mounted Fuel Day Tank, , complete with all the accessories, with a fuel storage capacity equal to 8 hours of operation of the Set at the rated output.
- j) All the Generator Sets and their accessories shall be housed in the Standby Electric Generators Building. The Building may be an isolated one or may be combined with other buildings of STP, as appropriate. The design and covered area of the Building

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shall be such as to provide easy access to all the housed components for operation & maintenance and to furnish adequate ventilation.

Except as follows, the specifications of the Building shall, in general, be same as laid down in Section 4.6.4 "Pump Rooms".

For transfer of Generator Sets and other accessories, to and from the Generator Hall, rolling shutters, of appropriate dimensions, shall be provided in front of each Set. For outside access, a ramp, of width equal to the width of the shutter and with appropriate slope, comprising RCC slab-on-grade with side concrete block masonry walls, shall be provided.

An electrically-operated Overhead Bridge Crane (Top-Running Type), of appropriate lift capacity, shall be provided, in the Generator Hall, below the ceiling level, for lifting and moving the heavy parts and other ancillaries, of standby generators, for repair and maintenance purposes.

The clear floor height shall be provided, keeping in view the governing dimensions of the Generator Sets and overhead bridge crane.

Steel exhaust fans (450 mm dia.), of approved make, shall be provided in the external walls of the Building, at an above-floor level, for purpose of forced ventilation. The numbers of the exhaust fans shall be determined on the basis that, under normal conditions, at least two air changes per hour are effected in the Building.

## 7. STRUCTURAL ANALYSIS AND DESIGNS

### 7.1 General

- a) Except where otherwise proposed by the Contractor and accordingly approved by the Employer's Representative, all the structural analysis and designs, under this Contract, shall be carried in accordance with provisions laid down in this Section 7.
- b) Notwithstanding anything contained in any document referred to herein, no design work shall conflict with the applicable requirements, for the time being in force, prescribed by the city district government, the provincial government, the federal government and the various bodies and agencies constituted under law.

### 7.2 Structural Foundations

- a) Subsoil parameters, for the design of structural foundations, for buildings, sanitary structures and other structures shall be in accordance with the duly approved Contractor's Document: "Site Subsoil Surveys and Geo-technical Investigation Report".

- b) The depths of the structural foundations, for buildings, sanitary structures and other structures, shall in no case be less than 1.00 meters from the natural surface levels (NSL).

**7.3 General Code**

The following document shall be considered the general code, for all the structural designs:

1997 Uniform Building Code, International Conference of Building Officials (ICBO), California, USA

**7.4 Concrete Structures Other than Environmental Engineering (Sanitary) Structures**

Structural designs of concrete structures, other than the environmental engineering (sanitary) structures, shall conform to the requirements of the following document:

Building Code Requirements for Structural Concrete (ACI318-02) and Commentary (ACI 318R-02), ACI 117-90, American Concrete Institute, USA

**7.5 Environmental Engineering (Sanitary) Concrete Structures**

Structural designs of the environmental engineering (sanitary) concrete structures shall conform to the requirements of the following document:

Code Requirements for Environmental Engineering Concrete Structures (ACI 350-01) and Commentary (ACI 350R-01)

**7.6 Structural Steel Works**

The designs of structural steel shall conform to the requirements of the following document:

Specifications for Structural Steel Buildings, American Institute of Steel Construction, ANSI/AISC 360-05, 2005, American Institute of Steel Construction, Inc., Illinois, USA

**7.7 Culverts**

The designs of culverts shall conform to the requirements of the following document:

Standard Specifications for Highway Bridges, Sixteenth Edition, 1996, American Association of State Highway and Transportation Officials, Washington, D.C., USA



7.8 **Design Loads**

- a) Minimum design loads, for buildings and other structures, shall conform to the requirements of the following document:

Minimum Design Loads for Buildings and Other Structures, SEI/ASCE 7-02, Second Edition, American Society of Civil Engineers, USA

- b) Design live loads (un-factored) shall, in no case, be less than the followings:

Buildings	
Floors	300 (kg/m <sup>2</sup> )
Roofs	150 (kg/m <sup>2</sup> )
Sanitary Structures	
Inclined Ladders, Stairs, Platforms, Walkways, Gratings	500 (kg/m <sup>2</sup> )

8. **HYDRAULIC ANALYSIS AND DESIGN**

- a) The hydraulic design of all the wastewater conveyance and transfer components shall be carried out at peak hour flows.
- b) The profile of hydraulic grade levels in the facilities shall be such as to deliver the wastewater flows, successfully, with any one unit of parallel process-related facilities being closed or non-operational and flow diverted to other parallel units.
- c) Following relationships may be employed for hydraulic analysis and design:

Frictional Headloss for Water and Wastewater Flow in Pressure Circular Pipes

$$H_F = 6.82 (V/C)^{1.852} (L/D)^{1.167}$$

Minor Head-losses for Water and Wastewater Flow in Pressure Circular Pipes

$$H_M = K (V^2/2g)$$

Wastewater Flow over Sharp-Crested Rectangular Weirs (with End Contraction)

$$Q = 6600 (H_w)^{1.5} (L_w - 0.2 H_w)$$

Wastewater Flow over Sharp-Crested Triangular Weirs

$$Q = 5000 (H_w)^{2.5}$$

Wastewater Flow in Open Channels

$$V = (1/n) (R)^{2/3} (S)^{1/2}$$

**Employer's Requirements: Particular Specifications for Works**

Where

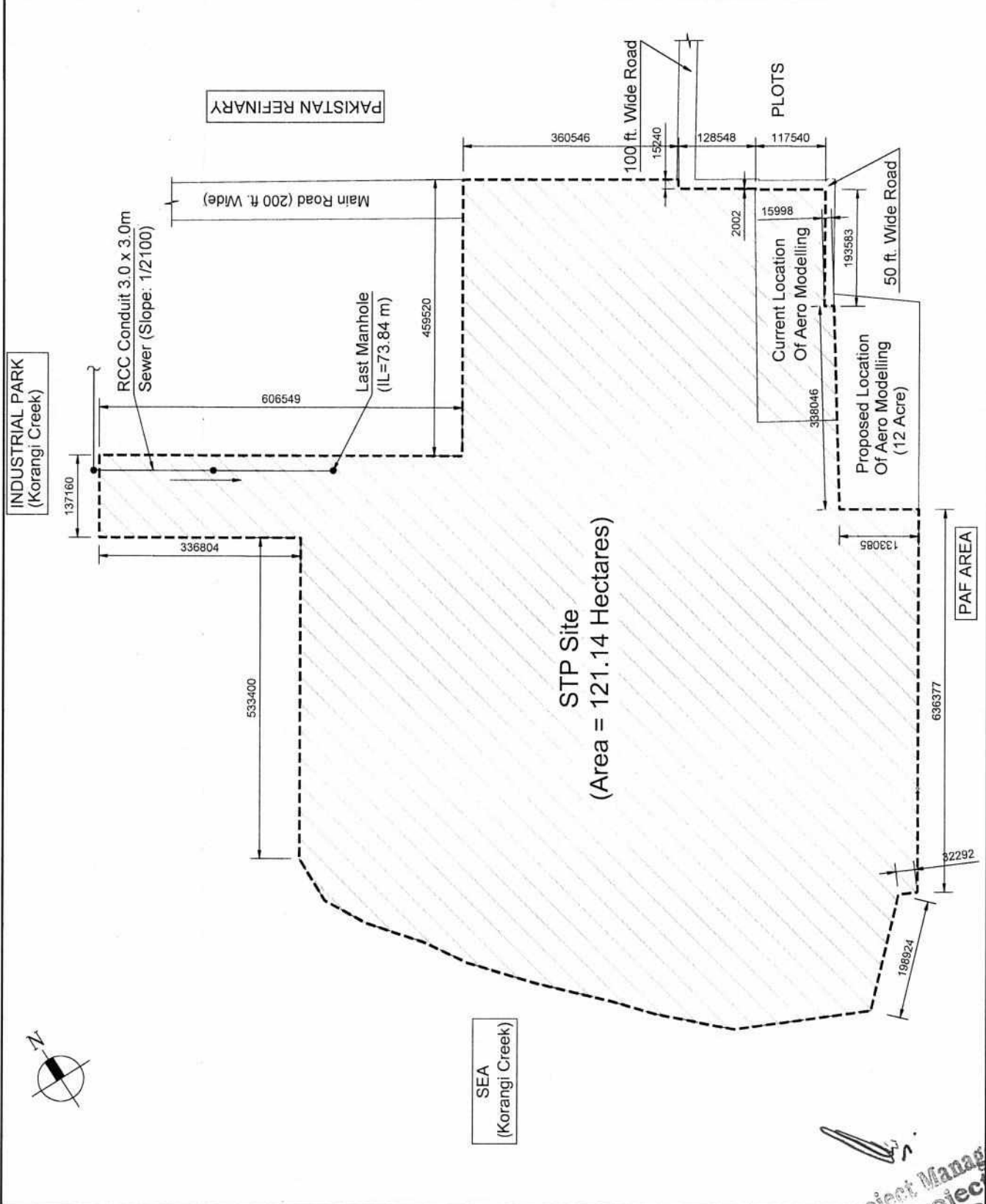
Q	Flow (m <sup>3</sup> /h)
V	Flow velocity (mps)
H <sub>F</sub>	Frictional headloss in pipe (m)
C	William-Hazen Coefficient = 100 – Minimum
L	Pipe length (m)
D	Pipe diameter (m)
H <sub>M</sub>	Minor headloss (m)
K (Entrance)	0.50 – Minimum
K (Exit)	1.00 – Minimum
K (90° Bend)	0.50 – Minimum
K (45° Bend)	0.25 – Minimum
K (Tee)	1.80 – Minimum
K (Gate Valve)	0.20 – Minimum
K (Check Valve)	2.50 – Minimum
H <sub>w</sub>	Weir head (m)
L <sub>w</sub>	Length of rectangular weir (m)
(n)	Manning's Coefficient = 0.013 (Concrete)
R	Hydraulic Radius (m) = A/P
A	Cross-sectional Area of Flow (m <sup>2</sup> )
P	Wetted Perimeter (m)
S	Bed Slope

Headloss for Sludge Flow in Circular Pipes: Headloss in sludge carrying pipes shall be determined by multiplying the headloss (frictional + minor), computed for equivalent wastewater carrying pipe, with the Sludge Headloss Magnification Factors, with their minimum values as give below:

Velocity (mps)	Concentration of Solids in Sludge (%)					
	2%	4%	6%	8.5%	10%	12%
1.00	1.5	2.9	4.6	7.4	9.6	10.7
1.25	1.5	2.5	4.0	6.7	8.8	9.5
1.50	1.5	2.3	3.6	6.4	8.0	8.7
1.75	1.5	2.0	3.4	5.9	7.5	8.3
2.00	1.5	2.0	3.1	5.4	7.1	8.0
2.25	1.5	2.0	3.0	5.0	6.7	7.7
2.50	1.5	1.9	3.0	4.9	6.6	7.6

**NOTES :**

1. All dimensions are in mm, except where otherwise mentioned.
2. All levels are in meters, except where otherwise mentioned.



**BID DRAWINGS**

No.	Issued For	By	Date
0	ISSUED FOR BID		Sep. 18

Client: **KARACHI WATER & SEWERAGE BOARD**  
 Project: **(TP - IV BOUNDARY WALL)**

Consultants: **Techno-Consult International**  
 in association with **WS Atkins International U.K.**  
 and **NEC Consultants**

Drawing Title: **SEWAGE TREATMENT PLANT TP-IV SITE PLAN**

Designed By: SSP	Date: September, 2015
Drawn By: HA	Scale: 1:6000
Checked By: SM	Dwg No: KWS/SD/GEN/003-01
Approved By: MBL	Revision: 0

**Dy. Project Manager**  
**S.M. Project**  
**KW & SB**

**NOTES :**

1. All dimensions are in mm, except where otherwise mentioned.
2. All levels are in meters, except where otherwise mentioned.



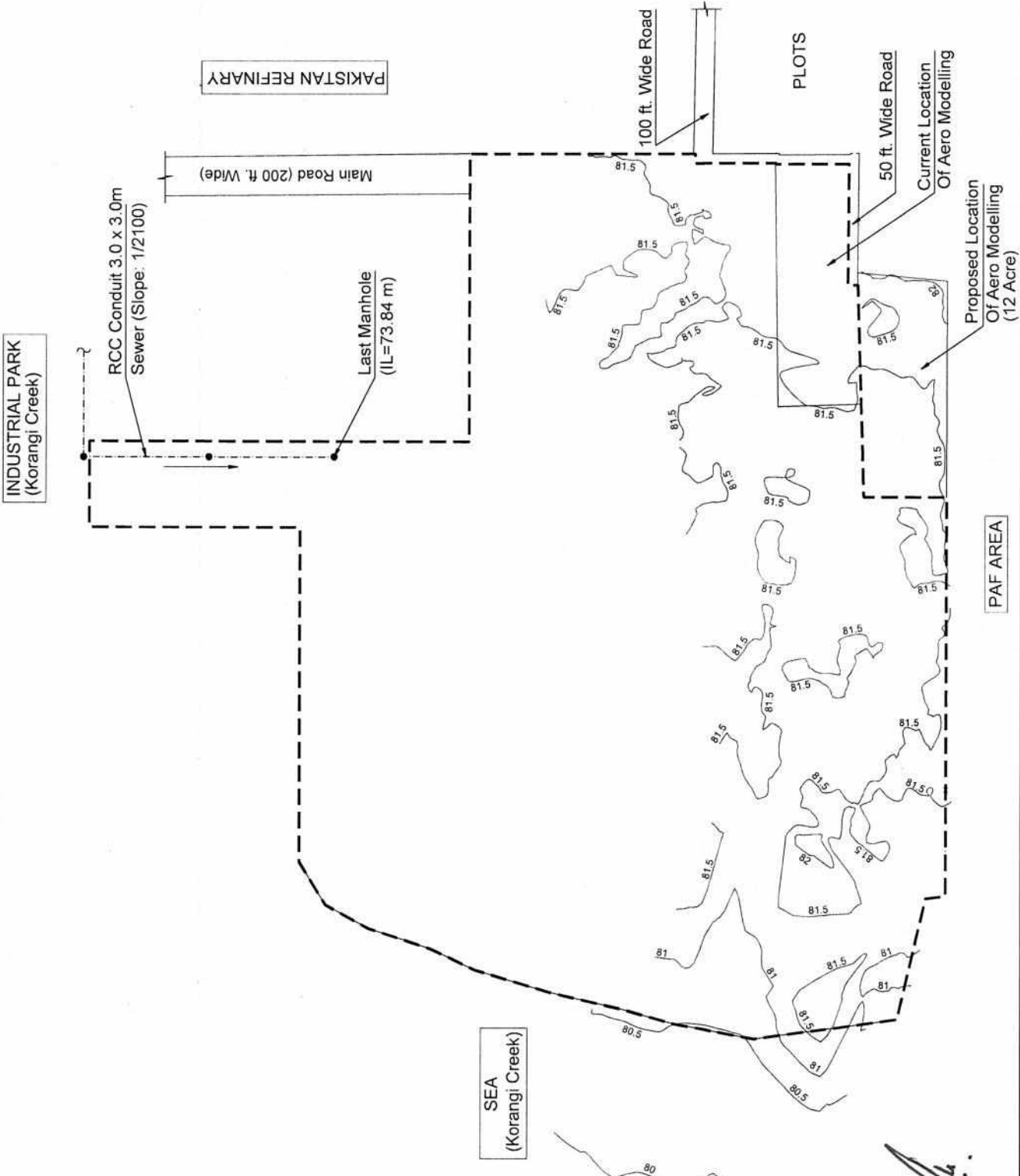
**BID DRAWINGS**

No.	Issued For	By	Date
	ISSUED FOR BID		
	Revision		

Client: **KARACHI WATER & SEWERAGE BOARD**  
 Project: **(TP - IV BOUNDARY WALL)**

Consultants: **Techno-Consult International**  
 In association with **WS Atkins International U.K.**  
 NEC Consultants

Drawing Title: **SEWAGE TREATMENT PLANT TP-IV Site NSL Contour Plan**  
 Designed By: SSK Date: September, 2016  
 Drawn By: RA Scale: 1 : 5000  
 Checked By: SM Dig No:   
 Approved By: MBL Revision:   
 KYSS/BD/GEN/003-02 0



**Dy. Project Manager**  
**S. ID Project**  
**KW & SB**

Part 2

# Operation Management Requirements

  
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SITI Project  
KW & SB

**Employer's Requirements**  
Part 2  
**Operation Management Requirements**

**C O N T E N T S**

1. **OPERATION OF THE WORKS**
2. **PERFORMANCE DATA COLLECTION**
3. **MAINTENANCE OF WORKS**
  - 3.1 General Requirements
  - 3.2 Maintenance Program
  - 3.3 Maintenance Records
4. **MONTHLY PERFORMANCE REPORTS**
5. **WORKS**
6. **CONTRACTOR'S EQUIPMENT**
7. **MATERIALS**
8. **TRAINING OF EMPLOYER'S PERSONNEL**

  
**Dy. Project Manager**  
**S.I.D. Project**  
**K W & S B**

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*In these Operation Management Requirements, terms "Works" and "STP" (meaning Sewage Treatment Plant TP-IV, Karachi) are synonymous.*

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1. **OPERATION OF THE WORKS**

The Contractor shall operate the Works in a proper, effective and careful manner, in accordance with the recognized good professional practices.

The Contractor shall maintain the Plant and the portions of the Works, which are on the standby mode, in a manner that they remain protected and functional.

The Contractor shall operate the Works on a continuous 24 hours per day, 7 days per week basis, such that:

- a) all the wastewaters received, except when exceeding the Design Peak-Hour Wastewater Flow of 46,030 m<sup>3</sup>/h, which excess flows shall be bypassed through an overflow pipe, provided at an upstream point in the sewerage network, shall pass through the Works for treatment; and
- b) the average of the grab sample characteristics of the treated effluents at the outlet of the Works, prior to their disposal, of any three consecutive days, during the Operation Service Period, shall be within the following limits:

Biochemical Oxygen Demand (BOD)	50 (mg/l)
Total Suspended Solids (TSS)	50 (mg/l)

provided that the daily influent wastewater pollution loads to Works remain within the following design values:

Biochemical Oxygen Demand (BOD)	163,570 (kg/d)
Total Suspended Solids (TSS)	122,680 (kg/d)

The Contractor shall ensure by his own means and guarantee that the composition of the influent wastewater, in terms of its constituents and their variations, of whatsoever nature, shall not prevent him from achieving the desired performance results, in every respect, in accordance with the Contract.

The operation of the Works shall include, but may not be limited to, the following functions and activities:

## Employer's Requirements: Operation Management Requirements

- a) Operation of the Plant and the Contractor's Equipment
- b) Dosing of process control chemicals, if required
- c) All the process and Plant control measures and activities
- d) All the process and Plant related troubleshooting
- e) Collection, handling and conveyance of the solid and semi-solid wastes and residues generated by the operation of the Works, within the Site of Works

The Contractor shall employ its best efforts to contain and control odors emitted from the Works, in order to minimize nuisance for the surrounding areas.

## 2. PERFORMANCE DATA COLLECTION

The Contractor shall, at his cost, collect and document the performance data pertaining to the operation of the Works, as stated herein, and shall submit it to the Employer's Representative as part of the Monthly Performance Reports or separately, where so required by the Employer's Representative, in a form and format approved by the Employer's Representative.

For the purpose of performance data collection, an Operation Day of the Works shall be taken as 0600 (06:00 AM) of a calendar day to 0600 (06:00 AM) of the next calendar day, except where otherwise instructed by the Employer's Representative.

The performance data pertaining to the operation of the Works, to be collected and documented by the Contractor, including the measurements, monitoring, sampling and laboratory-testing, shall include, but may not be limited to, the following:

- a) Wastewater Flows: Daily influent wastewater flows per Operation Day, measured from the installed on-line wastewater flow meters
- b) Wastewater and Effluent Quality Characteristics: Laboratory-determined grab sample characteristics of wastewater and effluents, with quality parameters, sampling sources/locations and sampling frequency, as follows:

Quality Parameter	Unit	Grab Sampling Source/Location		
		IW	PS	TE
pH		Daily	Monthly	Daily
Temperature	°C	Daily	-	Daily
Biochemical Oxygen Demand (Total)	(mg/l)	Daily	Monthly	Daily
Biochemical Oxygen Demand (Settled)	(mg/l)	Biannually	Biannually	Biannually
Biochemical Oxygen Demand (Filtered)	(mg/l)	Biannually	Biannually	Biannually
Chemical Oxygen Demand (Total)	(mg/l)	Daily	Monthly	Daily
Chemical Oxygen Demand (Settled)	(mg/l)	Biannually	Biannually	Biannually
Chemical Oxygen Demand (Filtered)	(mg/l)	Biannually	Biannually	Biannually



**Employer's Requirements: Operation Management Requirements**

Quality Parameter	Unit	Grab Sampling Source/Location		
		IW	PS	TE
Total Suspended Solids (TSS)	(mg/l)	Daily	Monthly	Daily
Volatile Suspended Solids (VSS)	(mg/l)	Biannually	Biannually	Biannually
Settleable Solids (SS)	(ml/l)	Daily	Monthly	Daily
Oil & Grease (O&G)	(mg/l)	Daily	Monthly	Daily
Sulfides	(mg/l)	Biannually	-	Biannually
Sulfates	(mg/l)	Biannually	-	Biannually
Chlorides	(mg/l)	Biannually	-	Biannually
Total Dissolved Solids (TDS)	(mg/l)	Biannually	-	Biannually
Total Kjeldahl Nitrogen (TKN)	(mg/l)	Biannually	-	Biannually
Ammonia Nitrogen	(mg/l)	Biannually	-	Biannually
Nitrite Nitrogen	(mg/l)	Biannually	-	Biannually
Nitrate Nitrogen	(mg/l)	Biannually	-	Biannually
Total Phosphorous	(mg/l)	Biannually	-	Biannually

**IW:** Influent Wastewater from Wet Well

**PS:** Combined Effluent after Primary Settling Tanks

**TE:** Combined Treated Effluent from Treated Effluent Pipe

- c) Requirements of Regulatory Agencies: Laboratory-determined characteristics of the treated effluents, as required by any government regulatory agency, with sample type, frequency and quality parameters, to be in accordance with the requirement of the agency
- d) Sludge Quantities Data: Daily volumes per Operation Day (measured or estimated) of the following sludge generated by the Works:
- Primary Sludge (Primary Settling Tanks to Sludge Thickeners)
  - Secondary Sludge (Secondary Settling Tanks to Sludge Thickeners)
  - Thickened Sludge (Sludge Thickeners to Sludge Digesters)
  - Dewatered Sludge (from Sludge Drying Beds)
- e) Sludge Concentrations Data: Laboratory-determined concentrations of the grab samples of the following sludge, on weekly basis:
- Combined Primary Sludge (Source: Primary Settling Tanks)
  - Combined Secondary Sludge (Source: Secondary Settling Tanks)
  - Combined Thickened Sludge (Source: Sludge Thickeners)
  - Combined Digested Sludge (Source: Sludge Digesters)
  - Combined Dewatered Sludge (Source: Sludge Drying Beds)

## Employer's Requirements: Operation Management Requirements

- f) Screenings Data: Daily volumes (measured or estimated) of screenings (per Operation Day) generated by the Works
- g) Grit Data: Daily volumes (measured or estimated) of grit (per Operation Day) generated by the Works
- h) Electric Energy Consumption: Daily overall electricity consumption (per Operation Day) of the Works, measured (in kWh) from the main energy meter
- i) Operation Duration of the Plant: Daily operation durations (per Operation Day) in hours of each major Plant (electrical and mechanical equipment)

### 3. MAINTENANCE OF WORKS

#### 3.1 General Requirements

During the Operation Service Period, the Contractor shall be fully responsible for, and carry out, the maintenance of the Works and the Contractor's Equipment, including the predictive maintenance investigations and routine, preventive and corrective maintenances, as stated herein.

The Contractor shall carry out all the required rectification and remedial measures, in respect of any defect and fault, identified during maintenance, as early as possible.

The predictive maintenance investigations and routine, preventive and corrective maintenances of the Works including Plant and the Contractor's Equipment including vehicles, shall include, but may not be limited to, the following:

- a) Predictive Maintenance Investigations for the Plant and the Contractor's Equipment, including, but may not be limited to, measurements, tests and analyses of performance and associated parameters like noise, vibrations etc, in order to establish the conditions and reliability of the equipment and identify any fault or defect, therein
- b) Corrective Maintenance of the Plant and the Contractor's Equipment including, but may not be limited to, non-routine repair of parts or replacement with like-kind parts, consequent to a failure, or in order to avert a potential failure identified by the Predictive Maintenance Investigations or otherwise, during the normal useful life of the equipment
- c) Preventive Maintenance of the Plant and the Contractor's Equipment including, but may not be limited to, the routine lubrication, oil replacement and replacement of parts like belts, oil and air filters etc. and other tasks, which occur on a scheduled frequency as recommended by the equipment manufacturer or as established by the practice of the trade

d) Routine Maintenance of the Works including, but may not be limited to, the following:

- Upkeep of the landscaping works including irrigation of the green areas and plants, plant trimmings etc, on the Site of Works
- Upkeep of the grounds of Site of the Works
- Maintenance and upkeep, including all repair and replacement works, of the Works including buildings, sanitary structures, roads, walkways, vehicle parking areas, entrance gates, boundary walls, piping works, stormwater drainage works, water supply works, sewerage works, external illumination works and external & Plant electrification works, in order to maintain their original form, finish, structural & mechanical integrity and functional efficacy, excepting the normal wear and tear
- Carrying out inspection and taking remedial measures to control corrosion of the metal works
- Routine maintenance and upkeep of the buildings, forming part of the Works, including, but may not be limited to, all repair and replacement works, for plumbing fittings & fixtures, electrical fittings & fixtures, air conditioners, land-line telecommunication system, furniture and furnishings
- Maintaining general cleanliness and appearance of the Works, at all the times
- Regular cleaning of all the accessible surfaces of the sanitary structures, weirs, notches, gratings and like, in order not to allow accumulation and solidification of the undesirable materials adhering to them
- Internal cleaning/scouring of pipelines, valves, inspection chambers and manholes in order to remove obstructions and clogging
- Regular cleaning of all the sensors and probes of instruments like flow meters, level controllers etc
- Manual removal of the floating substances and scum, from the sanitary structures, not provided with scum removal devices
- Regular sweeping, cleaning, mopping and/or washing of building floors, road and other pavements, walkways, platforms, etc

### 3.2 Maintenance Program

The Contractor shall carry out maintenance of the Works, in accordance with the Maintenance Program, prepared and submitted by the Contractor and agreed upon by the Employer' Representative.

The Contractor shall submit the Maintenance Program to the Employer' Representative prior to the commencement of the Operation Service.

The Maintenance Program shall lay down the maintenance schedules, methods and procedures, which shall in general be in accordance with recognized standards and practices and equipment manufacturers' instructions.

**3.3 Maintenance Records**

The Contractor shall maintain detailed records and reports of the major maintenance activities performed.

These maintenance records shall contain information on the nature of each major maintenance activity, its date, the time spent, the Materials used and any other information reasonably required by the Employer' Representative.

The Contractor shall submit these maintenance records and reports to the Employer' Representative, as part of the Monthly Performance Reports.

**4. MONTHLY PERFORMANCE REPORTS**

The Contractor shall, at his cost, prepare and submit to the Employer' Representative, a Monthly Performance Report on the operation and maintenance of the Works, in form and format approved by the Employer' Representative, for each month, not later than 10<sup>TH</sup> day of the next month.

Each Monthly Performance Reports shall contain, but may not be limited, to the following data and information, for the respective month:

- a) Record of operational changes and adjustment, if any
- b) Performance data, in accordance with Section 2
- c) Maintenance records, in accordance with Section 3.3
- d) Data on the process and Plant related troubleshooting, if any
- e) Data on operating process parameters
- f) All the relevant laboratory test results
- g) Data on Contractor's Equipment utilization
- h) Data on Materials and their consumption
- i) Data on manpower utilization
- j) All the relevant accounting and financial data, as required by the Employer' Representative

**5. WORKS**

Works, including Plant, handed over to the Contractor, for the provision of the Operation Service, shall include the Works, designed, executed and completed, by the Contractor, under Design-Build component of the Contract and the following works, whether or not forming the part of the Works designed, executed and completed, by the Contractor:

- a) Air conditioners in the buildings, to the extent deemed necessary by the Employer' Representative
- b) Land-line telecommunication system comprising telephone exchanges, wiring and telephone sets, in the buildings, to the extent deemed necessary by the Employer' Representative

## Employer's Requirements: Operation Management Requirements

- c) Furniture and furnishings, in the buildings, to the extent deemed necessary by the Employer' Representative, for the operation and maintenance of the Works and for the use of Contractor's and Employer's Personnel, to be housed in these buildings
- d) All the laboratory equipment, instruments, glassware and accessories for the following tests of wastewater and sludge samples:
  - pH Value
  - Temperature
  - Biochemical Oxygen Demand (BOD)
  - Chemical Oxygen Demand (COD)
  - Total Dissolved Solids (TDS)
  - Total Suspended Solids (TSS)
  - Volatile Solids (VS)
  - Settleable Solids (SS)
  - Oil & Grease
- e) All the major workshop equipment
- f) All the soft landscaping works including plants on the Site

### 6. CONTRACTOR'S EQUIPMENT

The Contractor shall, at his cost, provide and maintain all the Contractor's Equipment, required for the operation and maintenance of the Works, under the Contract.

The Contractor's Equipment shall include, but may not be limited to, the following:

- a) All the vehicles including cars, vans, trucks, tractor-driven trolleys or other modes of transportation to be used for transporting of the following or to be used for other functions for the operation and maintenance of the Works:
  - People
  - Goods or things
  - Conveyance of the solid and semi-solid wastes and residues generated by the operation of the Works, within the Site of Works
- b) All the chemicals dosing facilities, including chemical dosing vessels, chemical dosing pumps, instrumentation and piping, if and when required
- c) All the office equipment including, but may not be limited to, computers, printers, fax machines, photocopiers and stationery items
- d) All the minor laboratory, workshop and other equipment and instruments, not included in the Works, under Section 5

### 7. MATERIALS

The Contractor shall, at his cost, provide and use all the Materials, required for the operation and maintenance of the Works, under the Contract.

OMR-7

  
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S.M. Project  
KW & SB

## Employer's Requirements: Operation Management Requirements

The Materials shall include, but may not be limited to, the following:

- a) All the fuels and lubricants for the operation of the Plant and Contractor's Equipment including vehicles
- b) All the treatment process chemicals, if and when required
- c) All the laboratory chemicals
- d) All the stationery items and materials for the operation and maintenance of the office equipments including, but may not be limited to, computers, printers, fax machines, and photocopiers
- e) All the materials including replacement items and spares for the Predictive Maintenance Investigations and Routine, Preventive and Corrective maintenance of the Works including Plant and Contractor's Equipment including vehicles

All the Materials shall be subject to the approval of the Employer' Representative.

### 8. TRAINING OF EMPLOYER'S PERSONNEL

During the Operation Service Period, the Contractor shall, at his cost, carry out training of such reasonable number of Employer's Personnel in different disciplines and trades, as designated by the Employer' Representative, in the operation and maintenance of the Works. The training shall comprise both on-job as well as instructional training.

The program and scheduling of the instructional training shall be agreed with the Employer' Representative and the Contractor shall provide experienced training staff, and all training materials, for this purpose.

OMR-8

  
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