APPENDIX-4

FACILITY PLANNING

1. PLANNING PRINCIPLE

1.1 PLANT DESIGN

1.1.1 Plant Design and Operation

The plant design and operation will be such as to minimize any real or perceived nuisance to the surrounding community, and flexible so that any unanticipated future changes in the effluent requirements could be accommodated without having to scrap the existing process components.

The plant design will contain elements of flexibility, which will ensure changes in operation, for the plant performance enhancement and which could be implemented with ease.

1.1.2 Process Control

With the objective of simplicity of operation, the process control using sensors will be kept to a minimum and only used in such areas where it will have visible financial pay back. The process must be robust and hence not easily upset. Any changes in process, including additional processes, must match the operational skills developed and acquired by the plant operators through both experience and structured training program.

1.1.3 Operation and Maintenance

One underlying factor which is fundamental to the protection of the investment to be made in building plant facility, and also to the successful functioning of the WWTP (meeting the design objectives), is the existence of a comprehensive and well structured training program for the plant operators. It is important that the plant operators become intimately familiar with the treatment plant components, their function and interdependence with each process unit. This will be achieved only through a comprehensive training program.

1.2 FLOW CONDUITS

All piping and channels for the secondary treatment process are designed to carry the maximum hourly flow of 3.3 m^3/sec, but for the primary treatment process the hydraulic maximum flow of 6.6 m^3/sec are used.

Bottom corners of the channels are to be filleted and designed to avoid creation of pockets and corners where solids can accumulate. Suitable gates are placed in channels to seal off unused sections that might accumulate solids. The incoming sewer is designed for unrestricted flow.

The plant facilities are checked for both of the dry- and wet-weather hydraulic conditions with one largest unit out of service. No over-topping of any structure under any condition is considered.

1.3 FLOW DIVISION CONTROL

The design will provide for flow division control facilities to insure organic and hydraulic loading control to various process units. Convenient, easy and safe access, change, observation, and maintenance should be considered in the design of such facilities. Flow division shall be measured using flow measurement devices to assure uniform loading of all unit processes and operations.

1.4 UNIT BYPASSES

A minimum of two units in the liquid treatment process train will be provided for all unit processes and operations in the plant. The design will provide for properly located and arranged bypass structures and piping so that each unit of the plant can be removed from service independently. The bypass design will facilitate plant operation during unit maintenance and emergency repair so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode.

1.5 PIPE CLEANING AND MAINTENANCE

Fittings, valves, and other appurtenances should be provided for pipes subject to clogging, to facilitate proper cleaning through mechanical cleaning or flushing. Pipes subject to clogging, such as pipes carrying sludge, shall be lined with a material which creates a smooth and non-adhering surface, thereby reducing clogging and resistance to flow.

1.6 CONSTRUCTION MATERIALS

The materials of construction and equipment will be resistant to hydrogen sulfide and other corrosive gases, greases, oils, chemicals, and similar constituents frequently present in sewage. This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided to minimize galvanic action, and consequent corrosion.

1.7 GRADING AND LANDSCAPING

The plant site will be graded and landscaped upon completion of the plant. Concrete or asphalt paved walkways will be provided for access to all units. Steep slopes are to be avoided to prevent erosion.

1.8 PLANT OUTFALL LINES

The outfall sewer will be located and designed to discharge the effluent to the Danube River in a manner not to impair the beneficial uses of the receiving stream, providing for:

- Free fall or submerged discharge at the site selected; and
- Limited or complete dispersion of discharge across stream to minimize impact on aquatic life movement, and growth in the immediate reaches of the receiving stream.

The outfall sewer will be so constructed and protected against the effects of floodwater, ice, or other hazards as to reasonably insure its structural stability and freedom from stoppage. The outfall line will have a safe and convenient access, preferably using a manhole, so that a sample of the effluent can be obtained at a point after the final treatment process, and before discharge to or mixing with the receiving waters.

2. ESSENTIAL FACILITIES

2.1 MECHANICAL EQUIPMENT

Selected equipment must be readily available, can be serviced locally, and also supported by uncomplicated and understandable operation and maintenance manuals. Equipment replacement parts must be available without major delays.

2.2 EMERGENCY POWER FACILITIES

The plant shall have an alternate source of electric or mechanical power to allow continuity of operation during power failures.

Methods of providing alternate sources include:

- Provision of at least two independent sources of power, such as feeders, grid, etc., to the plant;
- Portable or in-place internal combustion engine equipment which will generate electrical or mechanical energy; or
- Portable pumping equipmont when only emergency pumping is required.

Although standby power generating capacity normally is not required for aeration equipment used in the activated sludge type processes, auxiliary power for minimum aeration of the activated sludge is required to protect downstream uses. Standby power generating capacity will also include the capacity needed for continuous disinfection of wastewater during power outages.

2.3 PLANT SANITARY SYSTEM

An adequate supply of potable water under pressure shall be provided for use in the laboratory and for general cleanliness around the plant. No piping or other connections shall exist in any part of the treatment works which, under any conditions, might cause the contamination of a potable water supply.

Potable water from the municipal water supply may be used directly at points above grade for hot and cold supplies in lavatory, water closet, laboratory sink (with vacuum breaker), shower, drinking fountain, eye wash fountain, and safety shower. Hot water for any of the above units shall not be taken directly from a boiler or piping used for supplying hot water to a sludge heat exchanger or digester heating unit.

Where a potable water supply is used for any purpose in a plant, a break tank, pressure pump, and pressure tank shall be provided. Water shall be discharged to the break tank through an air gap at least 15 cm above the maximum flood line or the spill line of the tank, whichever is higher.

Toilet, shower, lavatory, and locker facilities shall be provided in convenient locations to serve the expected staffing level at the plant.

2.4 FLOW MEASUREMENT

A Parshall flume will be provided after the preliminary treatment facility to continuously indicate, totalize and record volume of the wastewater entering the plant in a unit time. Locations close to turbulent, surging or unbalanced flow, or a poorly distributed velocity pattern will be avoided.

Parshall flumes will be permitted only in locations where free discharge conditions exists on the downstream side at the average design flow. Submergence must not exceed 60 percent at the maximum design flow.

2.5 PLANT BYPASS

The wastewater treatment plant design calls for accepting the daily maximum DWF of 2.72 m^3/ sec and the WWF of 6.6 m^3/sec. Flows in excess of 6.6 m^3/sec. will be bypassed to the nearby waterways through stormwater overflow chambers on the way to the WWTP. In the flow by-pass structure a broad-crested weir will be set at a calculated hydraulic gradeline elevation, which will accomplish this maximum hydraulic plant loading limitation. This plant bypass will be constructed at the location ahead of the WWTP.

2.6 LABORATORY

The WWTP will include a laboratory for making the necessary analytical determinations and operating control tests. The laboratory size, bench space, equipment and supplies shall be such that it can perform analytical work for:

- All self-monitoring parameters required by discharge permits;
- The process control necessary for good management of each treatment process included in the design; and
- Industrial waste control or pretreatment programs.

3. SITE DEVELOPMENT

3.1 PROPERTY

Presently available land for the Galati WWTP is a farmland of about 20-hectare area, located 500 m north of the river left bank. This land area is considered sufficient to provide all the facilities required for the preliminary, primary and secondary treatment facilities for the conditions in 2010. There will be a space for any future plant expansion facilities.

The surrounding areas of the plant site are agricultural lands and presently neither residences nor major structures exist within 2km m from the site.

3.2 SITE ACCESS

Access to the site can be made through the major road DN 2B, running from west toward east along the railway lines.

3.3 DANUBE RIVER WATER SURFACE ELEVATIONS

The treatment plant structures and all related equipment shall be protected from physical damage by the 100-year flood. The treated plant effluent will be disposed of to the Danube River at a point about 10 km downstream from the central part of the City.

The Danube River water surface elevations at the different return periods are as given in the following table:

Danube River Water Surface Elevations at Galati by Probability

Water surface conditions	Surface elevations (in meter above MWL)
River water elevation (Highest recorded)	7.44
River water elevation (Average)	3.87
River water elevation (Lowest)	0.38
River water elevation (2% return period)	7.20

Source: "The Development of Sewerage System for Used Water from Galati City, September 1992."

3.4 GROUND PREPARATION

The selected treatment plant site measures approximately 500 m by 500 m, having a total surface area of about 25 hectares. At present, the site is a cultivated farmland with sandy surface soil with a relatively high permeability. The land surface is relatively flat with elevations ranging between the highest point of 4.0 m and the lowest point of 3.8 m the difference being about 0.2 m.

From the above discussions the ground preparation requirements can be summarized as follows:

- Plant operation and maintenance: No particular constraint.
- Flood prevention: Need landfill (higher than the highest river water elevation of 7.44 m).
- Entry from the access road: Asphalt paved road of 6 m wide.
- Reduction of earth works: Present elevation + excess soil = 3.8 + 3.7 = 7.5 m above M.W.L.

The site natural ground elevations range from +3.8 m to +4.0 m M.WL, and the proposed finished ground elevation of + 7.5 m M.W.L is considered appropriate for developing the site from both economical and technical viewpoints.

3.5 WATER TABLE/SOIL PROFILES

The groundwater table in the site is relatively high, and may affect to the deep underground structures. Soil bores were prepared at the site.

4. PROCESS DESIGN

This section describes details of the various required process components in Galati WWTP. It has to be used as a preliminary step to the detailed design.

4.1 HYDRAULIC LOADINGS OF COMPONENT FACILITIES

The hydraulic loading rates used for the design of the various process components are summarized as follows:

Design Hydraulic Loads of Plant Component Facilities

	Component Facilities	Maximum daily flow	Maximum hourly flow	Wet weather flow
1	Preliminary Treatment	2.720	-	(6.600)
2	Influent pumping station	-	-	6.600
3	Primary Treatment	2.720	-	(6.600)
4	Secondary Treatment	2.720	(3.300)	-
5	Chlorine tanks	2.720	-	(6.600)
6	Effluent pumping station	-	-	6.600
7	Sludge management	2.720	(3.300)	-
8	Process pipes and conduits	-	3.300	-
9	Preliminary/primary conduits	-	-	6.600

Note: Wet weather flow rates over two times the dry weather flow will be by-passed.
Figures in the parenthesis are the maximum hydraulic flow rates that the facilities can accommodate.

The secondary treatment process component facilities are checked for the hydraulic conditions of average daily, maximum daily, and maximum hourly flows, whereas the preliminary and primary treatment facilities, which handle the wet weather flows, are hydraulically designed to accommodate up to twice as much the maximum hourly dry weather flow rate without hydraulic hindrance.

4.2 PRELIMINARY TREATMENT

The process units and structures associated with the preliminary treatment are the influent gates, screens (coarse/ fine), aerated grit removal, flow measurement, and influent pumping.

4.2.1 Influent Gate

At the entrance to the plant, influent gates will be provided to control or bypass the influent flows. The design data of the gates are as follows:

- Number of gates: 4 units
- Type: Sluice gate (manually operated)
- Gate size: 1.2 x 1.2 m
- Maximum head loss: about 100 mm
- Invert elevation of the channel: - 3.45 m M.W.L.

The gates will be opened and closed to flow following the wastewater inflow rates; two gates open for the average and maximum daily flows, three gates for the maximum hourly flow, and four gates for the wet weather flow.

4.2.2 Screening System

In view of the necessity for the efficient operation of the rakes and also for reducing the hydraulic head losses in the screens, the wastewater flow velocity reaching at the channels is planned to be at around 1.0 m/sec.

Coarse screens: Manually-cleaned coarse screening facilities will be provided ahead of the fine screens. The criteria for the coarse screens are:

- Number of screens 4 units
- Channel width 1.6 m
- Clear bar spacing 100 mm
- Slope from vertical 60 degrees
- Maximum head loss 100 mm

Fine screens: All the wastewater inflows require fine screening. The fine screens will be mechanically cleaned. The criteria for the fine screens will be as follows:

- Number of screens 4 units
- Channel width 1.6 m
- Clear bar spacing 20 mm
- Slope from vertical 75 degrees
- Maximum head loss 100 mm

Arrangement of screening facility: The number of individual screening units should be such that when one unit is taken out of service for maintenance or repair, the remaining units can accommodate the additional screening load with ease. Captured screenings should be kept in closed containers until the screenings are transported to the disposal site for sanitary landfill.

Attention must be paid in the design so that drainage from the screenings is not spilled on the floors. Facilities for down washing the equipment and storage areas must also be provided. This includes appropriate floor drains and piping to return the wastewater back to the head of the plant.

Screenings disposal: The screenings will contain organic and putrescible materials, and if not disposed of quickly, will represent an attraction and breeding ground for flies and other insects. As a minimum, screenings must be disposed of daily. All collected screenings will be dumped to one common belt conveyor and sent to a hopper for storage, then, dumped into a truck for hauling it to a sanitary landfill.

Controls: The electric motors of the mechanically-cleaned bar screens are to be controlled either manually by an on-off switch or automatically by clock-operated timing switches. The clock-operated timers will be set on the basis of experience, which has provided a record of the number of raking operations required during an average day. These timers are set to operate the raking mechanism for the number of times required per day.

Degree of instrumentation: The degree of instrumentation will consist of clock-operated timing switches.

Data Logging: It is essential that records of the quantities of collected screenings be kept, so that a basis for screenings disposal scheduling can be provided. The collected quantity of screenings is to be measured by keeping a record of the number of containers of known volume filled during each shift.

Operational: The operational controls are the setting of timers for the screen raking mechanism. This will be accomplished by operational experience.

4.2.3 Influent Pumping Station

The pumping station is of dry-well type, being separated completely from wet-wells. A special attention is given in the inflowing channel and wet-well designs to prevent grit settling in the wells.

Provision shall be made to facilitate easy removing of pumps, motors and other auxiliary equipment. Suitable safe means of access should be designed to the dry well of the pumping station, including stairways, handrails and gratings where necessary.

Adequate ventilation should be considered for the wet- and dry wells. For the pump room floor below the ground surface, mechanical ventilation is provided, so arranged as to independently ventilate the dry well. The wet-wells will be open and no mechanical ventilator will be provided.

Pump equipment and operation control: Totally eight units of pump are planned, four pumps each for the wastewater and stormwater, including two-standby. The pumps are designed to have the same capacity and size where practicable, with the sufficient capacity for handling the flow in excess of the estimated maximum inflow. In case of power failure, the standby diesel engine operated pump will accomplish the pumping station operation.

The pump sizes, numbers and capacities of the wastewater pumps are as follows:

Wastewater Pumps

- No.1 Pump Units
  Type of pumps : Vertical centrifugal mixed flow pump
  Pump diameter : 600 mm
  Pump discharge capacity: 50 m^3/min
  Total dynamic head : 16 m
  Number of pump unit : 4 units
  Motor output : 192 kW
- No.2 Pump Units
  Type of pumps : Vertical centrifugal mixed flow pump
  Pump diameter : 900 mm
  Pump discharge capacity: 100 m^3/min
  Total dynamic head : 16 m
  Number of pump units : 2 units(1 standby)
  Motor output : 370 kW

Stormwater Pumps

Type of pumps : Vertical centrifugal mixed flow pump
Number of pumps : 2 units (1 standby)
Pump diameter : 900 mm

Pump discharge capacity: 100 m^3/min
Pump total dynamic head: 16 m
Number of pump units : 2 units
Engine output : 554 ps

Wet-wells (pump wells): The wet-well is divided into two separated compartments for the convenience of cleaning and inspection of the well. Each well is designed to have an individual wastewater inlet.

In order to prevent unnecessary vortices forming in the wells, particular considerations are to be given to the bottom slopes and arrangement of suction pipes, thereby providing optimum hydraulic condition for the pump operation.

The wet-well size is to be determined considering the required space between pumps and proper pump suction conditions. The shape of the well and the detention is determined so as to minimize deposition of solids and prevent the wastewater to become septic.

Dry-well (pump room): In the dry-well, sufficient room is to be maintained between pumps to move the pump off its base with ample clearance left over between suction and discharge piping, and room for on site repairs, inspection, or removal from the room to the surface for repairs.

The size of dry well is to be determined based on the number and type of pumps selected and piping arrangement. A sufficient space between the pumps should be taken each at the both end of the room. The width should provide a sufficient space for the required length for pipes, valves and clearance for maintenance and repairs.

All safety and other requirements are also to be implemented in accordance with local and national safety codes and regulatory agencies. Provisions should also be made for drainage from pump water seal connections.

Piping and valves: Suction, discharge and header piping in the station are sized to be handle the flows adequately. Pipes are sized so that the velocity in the suction line should not exceed 1.5 m/sec, and the discharge piping 2.4 m/sec.

Valves are to be provided on the suction and discharge side of each pump to allow proper maintenance of the unit. To the discharge pipeline, electric motor-operated butterfly valves and the check valves shall be installed to ensure the operation of each pump.

Hoisting equipment: An electric overhead bridge traveling crane will be provided in the motor room for handling of equipment and materials which cannot be lifted readily or removed from the station by manual labor.

The crane will be provided in the motor room for handling of equipment and materials, which cannot be lifted readily or removed from the station by manual labor.

4.2.4 Aerated Grit Removal

Type of grit chamber: Grit settled by aeration at the bottom of the grit chambers is removed by sand pumps to grit separators and then transported by screw conveyors to grit hoppers. The grit is washed by water to remove organic matters contained in the grit. The grit will be finally loaded on trucks for final disposal.

Configuration: The grit removal of the wastewater will be accomplished in 4 trains, one blower each comprising 2 grit chambers. Each train the dimension of each chamber will be as follows:

- Number of units : 8 chambers
- Width : 3 m (including oil separator)
- Length : 22 m
- Depth : 2.35 (side depth) to 3.05 m
- Blowers : 5 units(one-standby) x 30 m3/min.
- Influent gates : 8 units, 800mm x 800 mm
- Effluent gates : 8 units, 600mm x 600 mm
- Grit removers : 4 units with sand pump
- Screw conveyors : 2 units

Air supply: For the total tank length of 176 m, air supply rate requirement is 119 m^3/min. Five units (one-standby) of turbo blowers, each with an air supply rate of 30 m^3/min., will be provided. It is important to have almost equal static head losses for all of the process aeration requirements so that air can be supplied under one common air supply pressure zone.

Grit removal: A screw conveyor for grit removal from each chamber as well as one grit pump for each chamber will be operated intermittently on a timer basis. The timers will be set based on operational experience.

The grit water pumps convey the grit mixed with water to the grit separator for grit removal. The removed grit will be conveyed by the grit separator screw into a hopper which will dump the grit into a truck for hauling it to a sanitary landfill. The water collected at the grit separator will be returned to the head of the plant for further treatment.

Controls: Control of the air supply to the grit chambers will be made through valves on the air down-corner pipes leading into each chamber. The air flows to each down-comer will be set manually by the valve which is followed with a mechanical air flow meter to indicate and control equal air quantity to each chamber.

Degree of instrumentation: The total air quantity supplied to the chambers will be indicated and transmitted to the main central room.

Data logging: The data to be logged will be the total air flow supplied to the chambers.

Operational: The only operational control of air quantity supplied to each chamber is by setting the mechanical valves to a flow quantity rate indicated on the downstream mechanical orifice type flow meter. The total air quantity provided by the blowers to the chambers will be indicated and transmitted automatically to the main control room through an electrical signal attached to the orifice flow meter located downstream from the blowers.

4.2.5 Flow Measurement

Because of a simplicity of function and ease of operation, 2 Parshal flumes (7 feet) will be installed for measurement of flows after having passed through the grit chambers.

Degree of instrumentation: The degree of instrumentation for the flow meter is minimal. Conversion of water flow to a flow rate signal is required.

Data logging: Records of flow rate will be logged.

4.3 PRIMARY TREATMENT

Primary treatment consists of gravity liquid/solid separation in circular clarifiers. The clarifier system will consist of two clusters, each having clarifier modules of 4 units.

4.3.1 Flow Distribution

Following the Parshall flumes, the wastewater will flow through two separate conduits to the distribution chamber located at the center of each cluster of 4 primary clarifiers, from where the flow will be distributed to each individual clarifier. The flow split is proportional to the tank surface area.

4.3.2 Primary Clarifiers

Hydraulic loading and area requirements: The hydraulic loading rate for the clarifiers is 35 m^3/m^2/day at the maximum daily average flow of 2.720 m^3/sec. Thus, the total required surface area is calculated to be 6,744 m^2. The primary clarifier design criteria are summarized as follows:

- Surface loading (at maximum daily flow): 35 m^3/m^2/day
- Design flow rate : 235,000 m^3/day
- Surface area of each clarifier : 839 m^2
- Clarifier diameter : 35 m
- Effective water depth : 2.0 m
- Number of clarifiers : 8 units
- Number of clarifier clusters : 2

Primary sludge production: The primary and excess sludge production (when excess sludge is returned to the primary tanks) for the daily average flow rate is 2,315 m^3/day or 1.6 m^3/min. at an average solids concentration of 2 %. For the maximum process and operational flexibility, the design will enable biological excess (excess) sludge withdrawal handling be either accomplished directly from the secondary clarifiers or from the primary clarifiers.

Sludge pumping to digestion facilities: The sludge pumping cycle is based on a sludge blanket measurement. The quantities of sludge, primary plus excess sludge from the average flow of 2,311 m^3/day have been calculated and shown as follows:

- Sludge volume : 2,311 m^3/day
- TSS : 46,210 kg/day
- Solids concentration : 2.0 %

Scum management: Scum is removed from the clarifier surface by a rotating scum removal mechanism to a scum pit located near the tanks and is pumped from there to a scum drum screen for scum removal. The filtrate is then passed through an oil trap for oil removal and then returned to the plant inlet channel for further treatment. All removed scum and oil will be disposed of at the sanitary landfill. A single, common sump serves all the sedimentation tanks. The frequency of scum pumping will be determined on the basis of the scum pit level control.

Controls: The clarifier operation is manually controlled, but scum and sludge pumps will be operated both automatically or manually. The clarifiers will be provided with a torque limit control and an alarm system.

Scum pumps in the scum pit will be operated both automatically and manually. The automatic operation will be controlled by the water elevations in the scum pit.

Sludge pumps will be operated by timer settling. Whether primary sludge only or primary plus excess sludge from the biological stage is pumped to the sludge drum screen and then to the digesters. The removal of sludge from the primary clarifiers will be controlled using timers. The pumping cycles will be established on the basis of operational experience.

The sludge pumping from the primary clarifiers is based on manual operation, by measuring the sludge blanket height (usually twice a day, morning and afternoon). Once the sludge blanket height has been determined, the timing cycle for sludge pumping to the digestion facilities is manually set for each clarifier.

Degree of instrumentation: Instrumentation will be simple and consist of a report on the running time totalizer for each of the pumps. This information will be transmitted to and recorded at the central control room. Indication of the sludge scraper mechanism operation (torque alarm) will be provided at the central control station.

4.4 BIOLOGICAL TREATMENT

4.4.1 Aeration Tanks

The design parameters for this process component are established as follows:

- Design inflow rate : 235,000 m^3/day or 2.72 m^3/sec
- Average inflow BOD_5 concentration : 119 mg/l
- Total BOD_5 : 27,965 kg/day
- F/M : 0.3 kg BOD_5/kg MLVSS/d
- MLSS : 1,667 mg/l
- Hydraulic detention time : 6.3 hours at maximum daily flow
- Recycle capability : 50 % of maximum daily flow.
- Liquid depth : 5.5 m
- Aeration system : Bubble diffusers
- BOD removal efficiency : 89.5 % (combined with clarifiers)

Reactor geometry: The biological system layout will be in tank modules. The selection of aeration tank geometry is determined to make the maximum use of the available space. The contact reactor geometry is summarized as follows:

- Tank width : 5.5 m
- Liquid depth : 5.5 m
- Tank length : 67 m
- Number of tanks : 32 units
- Effective tank volume : 62,176 m^3

Flow distribution: The design calls for maximum process flexibility. Hence, in the tank layout, a provision is made to make even flow distribution among all tanks, and ability to isolate individual tanks. The reactors are able to handle the maximum daily flow rate of 2.72 m^3/sec. plus maximum recycle flow of 50 percent based on the maximum daily flow.

Air supply: The air requirements for the reactor tanks have been calculated on the basis of 0.0772 Q (kg O_2/day). Distribution of air to the tanks expected to be even to every ditch, however, there may be occasions when this will change. Thus, the design of the air distribution system takes this into account and have the ability to respond to such changes in air demand. The air delivery system will consist of air diffusers. The system will have the capability of maintaining a mixed liquor dissolved oxygen concentration of 2.0 mg/l.

Dissolved oxygen and SS monitors: A minimum dissolved oxygen concentration of 2.0 mg/l will be maintained in the tanks. Sensors to measure the in-situ dissolved oxygen concentration will be used.

4.4.2 Final Clarifiers

Hydraulic loading and area requirements: The hydraulic loading rate for the clarifiers is 21 m^3/m^2/day at the maximum daily flow rate of 2.720 m^3/sec. Thus, the surface area required of each clarifier is calculated to be 1,424 m^2.

The final clarifier design criteria are summarized as follows:

- Surface loading (at Q max.) : 21 m^3/m^2/day
- Design inflow rate : 2.720 m^3/sec
- Tank surface area : 1,424 m^2
- Clarifier diameter : 45 m
- Sidewater depth : 3.5m
- Number of clarifiers : 8 units

Sludge production: The secondary sludge production data for the daily average flow rate of are as follows:

- Total SS : 23.13 ton/day
- Sludge concentration : 0.5 %
- Sludge volume : 4,626 m^3/day

The excess sludge withdrawal handling be either accomplished directly from the clarifiers or through the primary clarifiers. In the latter case, the excess sludge is pumped from the clarifiers to the flow distribution chamber of each clarifier. The excess sludge settles with the primary sludge and then pumped to anaerobic sludge digesters.

Return sludge pumps: The pump capacity is determined based on the maximum 100 % sludge return ratio of the reactor tank inflows. The pump design parameters are as follows:

No.1 pumps

- Pump type : Centrifugal screw pump
- Pump diameter : 250 mm
- Capacity : 8.2 m^3/min.

- TDH : 10 m
- Number of pumps : 10 sets
- Motor output : 30 kW

No.2 Pumps

- Pump type : Centrifugal screw pump
- Pump diameter : 350 mm
- Capacity : 8.2 m^3/min.
- TDH : 10 m
- Number of pumps : 6 sets (for additional 50% return sludge)
- Motor ouput : 37 kW

Excess sludge pumps: The excess sludge of 5,859 m^3/day or 4.1 m^3/min. will be sent either directly or through the primary clarifiers to the sludge thickeners. The criteria for the pump equipment are as follows:

- Pump type : Centrifugal screw pump
- Pump diameter : 250 mm
- Capacity : 1.1 m^3/min.
- TDH : 10 m
- Number of pumps : 6 sets (including 2-standby)
- Motor output : 22 kW

Controls: Clarifiers will be operated manually, whereas sludge pumps will be operated both automatically or manually. The clarifiers will be provided with a torque limit control and an alarm system.

The sludge pumping from the secondary clarifiers is based on manually measuring the sludge blanket height. Once the sludge blanket height has been determined, the timing cycle for sludge pumping to primary clarifiers or thickener facilities is manually set for each clarifier. The pumps turn on/off sequentially based on the on off time increments for each of the clarifiers. There would be readout showing that pumps are on and the individual pump running times.

Degree of instrumentation: Instrumentation will be simple and consist of a report on the running time totalizer for each of the pumps. This information will be transmitted to and recorded at the control room. Indication of the sludge scraper mechanism operation (torque alarm) will be provided at the control station.

4.4.3 Chlorine Contact Tanks

Chlorination system: For disinfection of the wastewater before its discharge to watercourses, the disinfection system capacity is sufficient to produce an effluent that will meet the coliform bacteria limits specified by the standards for that installation at all time (e.g. total coliform bacteria and fecal coliform bacteria numbers are 1 million and 10,000 MPN/100 ml, respectively). This condition must be attainable when maximum flow rates occur and during emergency conditions.

The solution chlorine disinfection system consists of contact tank, chlorination equipment, housing and storage, and ancillary services. Means of removal of solids from the tank bottom are to be provided. Skimming devices will be provided in all contact tanks.

Design parameters: The design parameters for the chlorine contact tank are as follows:

- Hydraulic maximum flow rate : 235,000 m^3/day
- Contact time : 15 minutes at the design rate of flow
- Capacity of chlorine feed system : 3 mg/l at the maximum flow rate
- Hypochlorite storage capacity : 80 m^3 (8 days)

Duplicate disinfection systems will be provided. Where only two units are installed, each will be capable of feeding the expected maximum dosage rate.

Contact tank geometry: The primary purpose of the contact tank is to provide the detention time necessary for the chlorine compounds to reduce the bacteria to acceptable level. The design aim is to minimize the short-circuiting and dead spaces through basin configuration and flow pattern control. The chlorine contact tank will be of reinforced concrete longitudinal baffled basin, which will have a large effective length-to-width ratio. The contact tank geometry is summarized below:

- Number of tank units : 1
- Channel width : 4 m
- Channel depth : 4 m
- Channel length : 204 m
- Tank effective volume : 2,448 m^3
- Effective water depth : 3 m

Equipment: The installed capacity of a chlorine feed system will be sufficient to provide a dosage of 3 milligrams per liter at the maximum design rate of flow. The feed equipment will consist of the following:

Solution storage tank

- Type : FRP cylinder type
- Internal diameter : 2,800 mm
- Height : 3,900 mm
- Tank capacity : 20 m^3
- Number of tanks : 4 units

No.1 feed pumps

- Type : Diaphragm pump
- Discharge capacity : 6 L/min.
- Number of pumps : 2 units

No.2 feed pumps

- Type : Diaphragm pump
- Discharge capacity : 13 L/min.
- Number of pumps : 3 units(one standby)

Housing and storage: Local, state and federal safety requirements, including fire code, will be carefully followed in storing and handling of chlorine containers, cylinders or tank cars.

Ventilation: Forced, mechanical ventilation is to be installed which will provide one complete air change per minute when the room is occupied. Adequate provisions will be made to insure that one complete air change per minute is provided when the room is occupied.

The pumping station is of dry-well type, being separated completely from wet-wells. A special attention is given in the inflowing channel and wet-well designs to prevent grit settling in the wells.

Provision shall be made to facilitate easy removing of pumps, motors and other auxiliary equipment. Suitable safe means of access should be designed to the dry well of the pumping station, including stairways, handrails and gratings where necessary.

Adequate ventilation should be considered for the wet- and dry wells. For the pump room floor below the ground surface, mechanical ventilation is provided, so arranged as to independently ventilate the dry well. The wet-wells will be open and no mechanical ventilator will be provided.

4.4.4 Effluent Pumping Station

Pump equipment and operation control: Totally eight units of pump are planned, four pumps each for the wastewater and stormwater, including two-standby. The pumps are designed to have the same capacity and size where practicable, with the sufficient capacity for handling the flow in excess of the estimated maximum inflow. In case of power failure, the standby diesel engine operated pump will accomplish the pumping station operation.

The pump sizes, numbers and capacities of the wastewater pumps are as follows:

- No.1 Pump Units
  Type of pumps : Vertical centrifugal mixed flow pump
  Pump diameter : 600 mm
  Pump discharge capacity: 50 m^3/min
  Total dynamic head : 5.0 m
  Number of pump unit : 4 units
  Motor output : 60 kW
- No.2 Pump Units
  Type of pumps : Vertical centrifugal mixed flow pump
  Pump diameter : 900 mm
  Pump discharge capacity: 100 m^3/min
  Total dynamic head : 5.0 m
  Number of pump units : 2 units(1 standby)
  Motor output : 116 kW
- No.3 Pump Units
  Type of pumps : Vertical centrifugal mixed flow pump
  Number of pumps : 2 units (1 standby)
  Pump diameter : 900 mm
  Pump discharge capacity: 100 m^3/min
  Pump total dynamic head: 5 m
  Number of pump units : 2 units
  Engine output : 173 ps

Wet-wells (pump wells): The wet-well is divided into two separated compartments for the convenience of cleaning and inspection of the well. Each well is designed to have an individual wastewater inlet.

In order to prevent unnecessary vortices forming in the wells, particular considerations are to be given to the bottom slopes and arrangement of suction pipes, thereby providing optimum hydraulic condition for the pump operation.

The wet-well size is to be determined considering the required space between pumps and proper pump suction conditions. The shape of the well and the detention is determined so as to minimize deposition of solids and prevent the wastewater to become septic.

Dry-well (pump room): In the dry-well, sufficient room is to be maintained between pumps to move the pump off its base with ample clearance left over between suction and discharge piping, and room for on site repairs, inspection, or removal from the room to the surface for repairs.

The size of dry well is to be determined based on the number and type of pumps selected and piping arrangement. A sufficient space between the pumps should be taken each at the both end of the room. The width should provide a sufficient space for the required length for pipes, valves and clearance for maintenance and repairs.

All safety and other requirements are also to be implemented in accordance with local and national safety codes and regulatory agencies. Provisions should also be made for drainage from pump water seal connections.

Piping and valves: Suction, discharge and header piping in the station are sized to be handle the flows adequately. Pipes are sized so that the velocity in the suction line should not exceed 1.5 m/sec, and the discharge piping 2.4 m/sec.

Valves are to be provided on the suction and discharge side of each pump to allow proper maintenance of the unit. To the discharge pipeline, electric motor-operated butterfly valves and the check valves shall be installed to ensure the operation of each pump.

Hoisting equipment: An electric overhead bridge traveling crane will be provided in the motor room for handling of equipment and materials which cannot be lifted readily or removed from the station by manual labor.

The crane will be provided in the motor room for handling of equipment and materials, which cannot be lifted readily or removed from the station by manual labor.

4.5 SLUDGE MANAGEMENT

4.5.1 Gravity Sludge Thickeners

The design of gravity sludge thickeners should consider the type and concentration of sludge, the sludge stabilization processes, the method of ultimate sludge disposal, chemical needs, and the cost of operation. The pumping rate and piping of the concentrated sludge should be selected such that anaerobic conditions are prevented.

Design basis: Equipment and piping must be designed to deliver sufficient dilution water to gravity thickeners. Hydraulic loading to produce overflow rates of 16~33 $m^3/m^2/day$ will be maintained to prevent septicity.

The loading rates and resulting solids concentration for gravity thickening are as follows:

- Average sludge production volume : 6,705 m^3/day
- Sludge withdrawal rate : 1,056 m^3/day
- Input sludge solids : 46.21 t/day
- SS loads : 60 $kg/m^2/day$

Tank geometry: Thickener tanks geometry is summarized as follows:

- Tank shape : Circular
- Number of tanks : 4 units
- Internal diameter : 16 m
- Sidewater depth : 4 m
- Effective tank surface area : 804 m^2
- Thickening mechanism : Rotating type scraper supported by center column with pickets

Equipment features: Heavy-duty scrapers capable of withstanding extra heavy torque loads should be provided. The thickener mechanism may be provided with pickets to help facilitate the release of water from the sludge. The drive mechanisms will be attached with a skimmer. The collected scum will be discharged into a central scum pit located at the thickeners. Ability to add chlorine solution should be provided to prevent septicity. Tank covers and odor control systems may be considered depending on adjacent land use.

Sludge pumps: The pump capacity is so determined that the pumps can send the thickened sludge within 8 hours. Specifications of these equipment are as follows:

- Type : Sludge pump with suction screw
- Number of pumps : 3 sets (one standby)
- Diameter : 100 mm
- Discharge capacity : 1.2 m3/min.
- TDH : 20 m
- Motor output : 15 kW

Drum screen: Prior to pumping the primary or secondary excess sludge to the sludge thickeners, the sludge will be screened by a revolving drum screen for the removal of coarse materials. The sludge pumps send the sludge to the drum screen and then screened sludge flows into the sludge thickeners. All removed coarse materials will be dumped from the screen and collected in a bin that will be emptied manually into trucks and hauled to sanitary landfill for final disposal. The specifications of the drum screen are as follows:

- Type : Rotary drum screen
- Number of screen : 1 set
- Screen openings : 4mm
- Screening capacity : 2 $m^3/min.$

- Motor output : 0.4 kW

Controls: Tanks will be operated manually, but sludge pumps will be operated both automatically or manually. The pickets will be provided with a torque limit control and an alarm system.

Sludge pumps will be operated using on/off pump controls and timers. The sludge blanket height will be determined manually. Flow rate of dilution water when used will be measured and recorded.

4.5.2 Anaerobic Digestion Tanks

Digestion process: Active digestion, concentration and storage will undergo in single anaerobic digestion tanks. There will be two clusters consisting of 2 independent digestion tanks. Mechanical mixing system, heating and gas collection systems will be provided in each of the tanks.

The thickened sludge will be pumped to the digestion tanks after passing through a drum screen. The digested sludge will be drawn by gravity to the storage tanks in the sludge dewatering building. The produced gas will be led to gas holders after desulfurizing in gas scrubbers for the use of boilers.

Design basis: The total digestion tank capacity are determined by rational calculations based upon the following factors:

- Input sludge solids : 36.97 t/day
- Sludge input : 1,056 m^3/day
- Sludge output : 801 m^3/day
- Temperature to be maintained in the digesters : 35 ℃
- Solid detention time : 20 days
- The degree and extent of mixing in the digesters : Moderately mix
- Required tank capacity : 21,126 m^3

Tank geometry: The tank shape will be high vertical cylinder with conical floors. The digester tank capacity is calculated based on the estimated sludge production in 2010. The total number of anaerobic digestion tanks required is 4 tanks in two clusters, with the same capacity and configuration. Tank dimensions are as follows:

- Tank shape : Single stage, high vertical cylinder with conical floors
- Tank capacity : 5,580 m^3
- Tank diameter : 17.5 m
- Tank effective water depth : 31 m

Sludge inlets and outlets: Recirculation, withdrawal and return points, should be provided, to enhance flexible operation and effective mixing. The returns will be discharged above the liquid level and be located near the center of the tank. Raw sludge feed to the digesters will be made either through heat exhangers or directly to the tank.

Sludge withdrawal to dewatering system and disposal will be from the bottom of the tank. This pipe should be interconnected with the recirculation piping, to increase versatility in mixing the tank contents. Additional alternative withdrawal lines will be provided.

Sampling: Sampling hatches will be provided in all tank covers with water seal tubes extending to beneath the liquid surface.

Mixing systems: Sludge mixing systems will be mechanical recirculation type. The mixing system will be designed such that routine maintenance can be performed without taking the digester out of service.

4.5.3 Sludge Gas System

Gas collection, piping and appurtenances: All portions of the gas system, including the space above the tank liquor, storage facilities and piping, will be so designed that under normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure. All enclosed areas where any gas leakage might occur will be adequately ventilated. Gas meters, with by-pass, will be provided to meter total and waste gas production.

All safety equipment will be provided where gas is produced. Pressure and vacuum relief valves, flame traps, gas detectors, and automatic safety shut off valves, will be provided.

Gas Utilization equipment: Gas-fired boilers for heating digesters will be located in a separate room not directly connected to the digester gallery. Gas lines to these units will be provided with flame traps. Gas piping will be of adequate diameter for gas flow rate and will slope to condensate traps at low points.

Electrical fixtures: Electrical fixtures and controls in enclosed places where hazardous gases may accumulate will comply with the local or national codes. Digester galleries will be isolated from normal operating areas to avoid an extension of the hazardous location.

Waste gas: Waste gas burners will be readily accessible and will be located at least 8 meters away from any plant structure if placed at ground level, or they may be located on the roof of the control building at a height of not less than 0.9 m from the top of the roof.

All waste gas burners will be equipped with automatic ignition, such as a pilot light or a device using a photoelectric cell sensor. Necessary approvals from the local authorities concerned will be obtained for burning any waste gas and any other emissions from the treatment plant.

Any underground enclosures connecting with digesters or containing sludge or gas piping or equipment will be forced ventilated. The piping gallery for digesters should not be connected to other passages.

Digester heating: Digesters will be constructed above ground water level and suitably insulated to minimize heat loss.

Sludge will be heated by circulating the sludge through external heaters. Piping may be designed to provide for the preheating of feed sludge before introduction to the digesters. Provisions will be made in the layout of the piping and valving to facilitate cleaning of these lines. Heat exchanger sludge piping will be sized for heat transfer requirements.

The boiler should be provided with suitable automatic controls to maintain the boiler temperature at a fixed rate, to minimize corrosion, and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, or excessive temperatures. Thermometers will be provided to show temperatures of the sludge, hot water feed, hot water return, and boiler water.

Access manholes: At least two 90-cm diameter access manholes will be provided in the top of the tank in addition to the gas dome. There should be stairways to reach the access manholes. A separate sidewall manhole will be provided.

Safety: Local, and national safety requirements must be reviewed and complied with. Those requirements take precedence over the requirements stated herein, if more stringent, and should be incorporated in the design. Nonsparking tools, safety lights, rubber-soled shoes, safety harness, gas detectors for inflammable and toxic gases, and at least two self-contained breathing units will be provided for emergency use.

4.5.4 Gas Holders

The digestion gas is led to gas holders via gas scrubbers, whereby the gas will be de-sulfarized and used for the boilers. Waste gas burners will be provided to be used in case the gas boilers malfunction. The gas production is estimated assuming that 70 % of the input solid components are biodegradable organic materials, 1 kg of which produces 0.425 m^3 of sludge gas. Thus, the total daily gas production is estimated to be 10,999 m^3. The gas holders will have the minimum gas storage capacity of 8-hour gas production. The geometry of the gas is as follows:

- Type	:	Dry seal gas holder (membrane seal type)
- Number of units	:	2
- Diameter	:	16 m
- Height	:	17 m
- Capacity	:	2,000 m^3

4.5.5 Belt Filter Press Sludge Dewatering

The daily digested sludge of 801 m^3 is drawn by gravity into the storage tanks located in the dewatering building. The digested sludge production rate and the required dewatering equipment are as summarized in the following:

- Total digested sludge production	:	801 m3/day
- Total sludge solids	:	24.03 t/day
- Dewatering equipment type	:	Belt filter press
- Yields per unit length	:	130 kg/m/hr.
- Filter width	:	3 m
- Daily operation time	:	6 hours
- Working days per week	:	: 5 days
- Solids load per hour	:	5,607 kg/hr.
- Required filter press equipment	:	14 units

Compositions and Functions: An air cylinder operated eccentric valve will be installed on the line between the digester and the storage tank. The sludge from the storage tank is pumped to the coagulation tank of the dewatering equipment (belt filter press) by sludge feed pumps.

The coagulation tank is to mix the polymer with the sludge. On the other hand, polymer solution are mixed and then pumped into the coagulation tank of the belt filter press. For the above, dry polymer is stored in hoppers, and led into dosage tanks by metering feeders and finally dissolved and stored in the dosage tanks. The polymer system shall have units of motorized hoist for unloading chemicals from the truck.

The dewatered sludge (sludge cake) is conveyed to a cake yard by trough belt conveyors. The filtrate, together with belt filter cleansing wastewater is returned to the process wastewater storage tanks by gravity and then pumped to the inlet of the screen chamber by process wastes return pumps. Two units of electrically operated overhead crane are provided in the building for dismantling and repairing the dewatering equipment.

4.5.6 Process Wastewater Return Pump Facilities

The process wastewater return pump system is to return the process wastes (i.e. building wastewater, digester supernatant, belt press filtrate and scum filtrate) to the screen inlet chamber for further treatment.

5. LAYOUT OF FACILITIES

Lists of equipment are summarized in *Table AII.4.1*. Main structures of the WWTP, such as primary sedimentation tank, aeration tank, final sedimentation tank, sludge thickener, sludge digester, grit chamber and oil separator, chlorination chamber, screening & pumping station, and effluent pumping station are shown in *Figure AII.4.1* to *AII.4.9*. The structures and the layout of facilities is designed based on the design basis described above and the actual site conditions.

6. ELECTRICAL, INSTRUMENTATION AND CONTROL FACILITIES

This purpose, functions and outline of the major electrical equipment, instrumentation and control works are described here. The numbers, shapes, sizes, and brief specifications of the equipment are provided for the preliminary engineering design purposes, and are subject to minor changes at the detailed design stage. The numbers, sizes and motor outputs of the equipment are listed in *Table AII.4.1*.

6.1 GENERAL

The basic requirements for the electrical, instrumentation and control equipment at the wastewater treatment plant are adequacy, reliability and safety. Adequacy of the major equipment such as circuit breakers, power transformers and the motor control centers are determined largely by the continuous current requirements of the treatment plant loads and the available short-circuit capability of the power supply.

The reliability of the equipment concerns the capacity of the electrical system to deliver power when and where it is required under abnormal, as well as normal, conditions.

Safety involves the protection of plant personnel as well as the safeguarding of equipment under all conditions of operation and maintenance.

The electrical system should be designed with enough flexibility to permit one or more compounds to be taken out of service at any time without interrupting the operation of the plant.

The generation of power from wastewater gas production will be economical if the power is effectively utilized for the plant operation or other purposes.

The design of the wastewater treatment plant electrical system must conform with the applicable local codes and regulations.

6.2 Electric Power Facility

6.2.1 General

The basic power distribution system can best be described as a secondary single selective system. One electric power line shall be received at the main substation. Another separated line should be planned as a stand-by use in the future.

The received power will be stepped down by the two main transformers and connected to the 380 V bus line. Each transformer shall have a capacity for all loads in the treatment plant by the year 2010.

The 380 V will be stepped down to auxiliary power distribution voltage (lighting and receptacles, etc.) by transformers that are installed at required locations.

The protective relay system shall be considered for proper protection of the electrical equipment in adequate/proper manner. Extensive zone protection will be considered for the parallel operation of the generator with utility power.

Specifications of the electric power facility, current-capacity, short-circuit-capacity, etc., shall be designed taking into consideration any future expansion.

7.2.2 Power Requirements of the WWTP

As described in some detail in *TableAII.4.1,* the WWTP mechanical equipment require the maximum electric power supply of 365935 kW, excluding standby equipment. The electric power requirements by process are as summarized in the following:

No.	Process	Equipment	Motor outputs (kW)
1.	Screens	Mechanical screens/auxiliary equipment	12.3
2.	Grit chambers	Blowers	319.6
3.	Influent pumps	Pumps, valves	1,147.0
4.	Primary clarifiers	Scrapers, sludge pumps	15.0
5.	Aeration tanks blowers	Blower, filters, cranes,	763.2
6.	Final clarifiers	Scrapers, sludge pumps,	544.4
7.	Chlorine contact tanks	Chemical supply pumps	1.2
8.	Sludge thickeners	Scrapers, sludge pumps, valves, screen	32.8
9.	Sludge digestion tanks	Mixers, pumps, valves, heaters, fans, blowers	209.5
10.	Sludge dewatering	Belt filters, conveyors, pumps, hoists, auxiliaries	248.8
11.	Effluent pumps	Pumps, valves	365.0
	Total power requirements		3,659

Note: Standbys are excluded.

6.2.3 Power Generator

An emergency electric power generator of minimum 800 kW capacity should be provided. The generator is driven by a diesel engine and will be used as the minimum plant electric power source when the power supply is suspended. In order to attain the intent of the above design concept, the generator power line should be connected to the 380 V bus line which is charged by the utility supplied power.

6.2.4 D.C. Power Supply

Uninterruptable D.C. power is supplied to breaker control circuit and an emergency lighting facility. Consequently, uniterruptable A.C. power supply for instrumentation and PC system is converted from D.C. by means of an inverted unit.

A sealed lead-acid stationary battery set shall be selected for this purpose due to its excellent quality features. The capacity of the battery set shall be designed by the required current and 30 minutes discharge time.

Each building within the plant will have its own independent uninterruptable power source unit for better and more effective utilization of the filtered/undistorted power source.

6.2.5 Motor Control Facility

Power feeder to the motors and wiring to the controlling equipment is accomplished through motor control center and relay cubicles. The motor control center and the relay cubicles are divided into individual facility center and relay cubicles such as one set for clarifiers and another for scum screen area.

Each motor must be operated manually from the control station to be located adjacent to the equipment. The control panel will be equipped with switches for operation status indication and meters as required.

Major control sequence is to be accomplished through the relay cubicle as required for each mechanical equipment.

The sub-monitoring panel is to be provided in the room for the purpose of detailed monitoring and back-up operation.

Type of cables/wiring to be utilized, conductor sizes, cable routing/layout and arrangement methods, etc. shall be determined appropriately through the detailed design stage of the project.

6.3 INSTRUMENTATION

6.3.1 Design Basis

Instrumentation is an important tool of the wastewater treatment plant because it insures an easy and proper operation and maintenance of such facilities. The equipment should be selected carefully considering its purpose, reliability, locations and costs. They should meet the specific functional needs of the particular equipment with special attention directed toward operation requirements.

6.3.2 Major Monitoring Instrument

Major equipment to be installed are summarized below. Each equipment has an indication meter, an alarm, etc.

- Water level in entrance chamber ; Suspended type level meter

- Grit chambers ; Parshall flume
- Gates opening at influent chamber, screen and grit chambers, primary bypass gates, and plant effluent gate ; Potentionmeters
- Primary settling tank, incoming flow ; Ultrasonic flow meters
- Primary sludge flow ; Electro-magnetic flow meters
- Receiving water level at plant effluent gate box ; Suspended type level meter
- Dissolved oxygen at aeration tanks ; DO meters, air flow meters
- Secondary sludge flow ; Electromagnetic flow meter
- Digestion tank temperature ; Thermo-coil
- Digester outlet gas flow ; Orifice flowmeter
- Generator/Heater gas flow ; Orifice flowmeter
- Digested sludge flow ; Electromagnetic flowmeter
- Feed sludge/polymer dosage flow ; Electromagnetic
- Sludge tank/dosage tank level ; Bubble tube level meter
- Thickened sludge flow to digesters ; Electromagnetic flowmeter
- Biogas flow rate to power generator and gas heater ; Orifice flow meter
- Temperature digester return water basin temperature and hot water basin temperature (outlet water from engine generators) ;Thermocoil

6.3.3 Supervisory Control and Data Acquisition System

The system can best be described as a local, independent, process control network with supervisory, central, monitoring station consisting of hard graphic indication (MIMIC) panels and soft monitoring/control station consisting of graphic screens, keyboards, printers, etc. The basic design of the system will be classified as follows:

- Local instrumentation/control station;
- Local process control units (Programmable logic controllers);
- Hard graphic/MIMIC panel;
- Redundant data highway;
- Host computer system and real time data storage;
- Historical data retrieval
- Workstations

6.3.4 Local Instrumentation/Control Station

The local instrumentation/control station will provide a monitoring/control point for each process equipment in the event of computer failure, data highway failure, etc. These will be four local instrumentation/control panels, one for each of the following areas:

- Preliminary treatment facility;
- Primary treatment facility;
- Secondary treatment facility;
- Sludge digestion facility;

- Sludge dewatering facility; and
- Power generating facility.

Equipment control, status indication, alarm conditions, indication of measured quantities of process variables, equipment runtime, etc. will be hand wired to the aforementioned local panels as back-up plant operating and monitoring station. Instrumentation/control panels will be located in the electrical room of the respective plant process control building.

The electrical rooms will be environmentally controlled for equipment protection. Local instrumentation/control cabinet will also house the individual instrument loop power supply unit.

6.3.5 Local Process Control Units (Programmable Logic Controllers)

Programmable Logic Controllers, hereinafter named as PLC,will be utilized as the interfacing/control means with field equipment. The PLC technology is adopted for several logical reasons, one of which is the minimum amount of closed loop control required for this plant as well as the rapid development /enhancements made to today's PLC's in comparison to the distributed process controller technology.

Each PLC with its respective I/O's, power supply, etc. will be housed in a separate cabinet independent of any other local control and/or local instrument panel. The design concept derives the installation of one PLC unit or PLC with hot back-up (as applicable) in the following areas:

- Primary treatment facility (single PLC unit);
- Secondary treatment (single PLC unit);
- Sludge digestion facility (single PLC unit);
- Sludge dewatering facility (single PLC unit);
- On-site power generating facility (single PLC unit); and
- Central control room in administration building (PLC unit with hot back-up).

6.3.6 MIMIC Panels (Hard Graphics)

MIMIC panels will be installation (Digital meters) of selected measured process variables (crucial variables) as depicted by the process and/or process design engineers. The foregoing indicating devices/instruments, etc. will be driven by the I/O modules of the PLC installed in the administration building. However, each MIMIC panel will be interfaced with its own utility (one panel).

Adequate speed is necessary to improve and insure proper response time, rapid overall dynamic data update, avoid network crashes, adequate service of host computer to each local processing unit, considerable reduction of CPU halt-time and interrupts of the host computer thereby utilizing execution time of the utility in terms of length of runs (Considerably less restriction associated with length of highway), higher communication speed, lower in cost including cost impact on PLC's and installation cost relative to any other highway.

6.3.7 Historical Data Retrieval

Utilizing historical data retrieval unit will assist plant engineers, laboratory personnel, operating/ maintenance personnel considerably. Row and/or manipulated data will be automatically transferred from the hand disc to the historical data retrieval unit.

Additionally, automatic filing system will be adopted. Actual size of this unit will be determined based on real time capacity required by the system with consideration given to additional space for crunched data, manually entered data, etc.

6.3.8 Work Stations

A single engineering/report generating station will also be installed in the Central Control Room. The operator's workstation will mainly be utilized for plant graphics, equipment control, a point of monitoring live/dynamic/station data, alarms, etc. All events historical data retrieval unit and the hard disc drives.

Equipment will be installed on computer grade furniture. The engineering workstations will mainly be used for reports, trending, manual data entry, engineering computations, etc. The third engineering/report generating workstation will be installed in the plant's superintendent's office.

Emergency lighting will consist of emergency lighting for the required minimum illumination and the guiding lamps. Battery supplied D.C. power is suitable for the power source until the plant gas generator is on.

The motor control center and the relay cubicles are divided into individual facility center and relay cubicles such as one set for clarifiers and another for scum screen area. Each motor must be operated manually from the control station located adjacent to the equipment. The control panel will be equipped with switches for operation.

7. MAJOR PLANT BUILDINGS AND UTILITY SERVICES

7.1 General Layout

Administrative building may consist of several main areas comprising the control room, laboratory, conference room, administrative personnel area, etc.

The garden with vegetation, which along with the shape of the administrative building, contributes to the control of odors coming from the processes buildings.

All the buildings will be of one story type but some of them have double height ceiling as required for the functional and mechanical needs included in that building.

The workers area should include workshop, storage rooms, restrooms, and a cafeteria for workers. The workshop should be related directly to the service road of the lot to permit easy transport of materials and machinery to be repaired.

The service road will be joined through a gate to the entrance for visitors and parking area that may be open for emergency purposes. Only authorized personnel may visit the plant. For vehicles of inspection or visits to the plant, a parking area with the fiberglass type will be provided.

7.2 Architectural Works

The uncovered preliminary facilities could be a source of odors, and as such, trees should be planted alongside the plant fence to help minimize odors. A landscape design is conceived for the whole lot. There should be trees and grasses wherever they do not disturb wastewater treatment processes.

The workers and administrative buildings are to be separated from other buildings, surrounded by roads and communicated with the outside by an entrance. Shrubs and trees should be planted in front of these buildings to help control odor dispersion.

Administrative building: The largest areas may be covered with concrete slabs. All the areas may have brick walls, natural light and air conditioning. The floor level of this building is raised more than 30 cm from the ground to protect it from flooding.

Office room may have the capacity of twenty (20) persons with air conditioning system, lighting from 300 to 400 lx. With necessary lockers, desks and chairs.

In addition to the space for laboratory, this area may also include restroom and storage room, with air conditioning, natural and artificial light, and necessary desks and water analysis equipment.

Control and electrical equipment room may have air conditioning and ventilation system. Lighting from 400 to 600 Lx, including electric room which is separated by a partition.

Workers room: This area consists of restroom for operation and maintenance workers with showers and lockers. This room is also raised 30 cm from the ground level.

Depot/workshop: This room will be for small and big parts of the plant equipment, roof with metallic structure, brick walls, natural light and fans for ventilation. Lighting is 200 Lx. Rooms separated by partitions for tools storage, welding works, electric works, etc.

Generator room: Main electrical building shall have a floor level raised 30-cm from the planned ground elevation to avoid possible flooding. The building should face a road to permit the flow of machinery. Noise and vibration prevention measures shall be considered. Mechanical ventilation system shall be provided.

7.3 General Criteria for the Structural Design

Foundations: The soil study performed under the feasibility study includes a sub-surface survey of the plant site and surrounding areas. A total of four soil test borings, each 30 m deep, were performed within the site in addition to the neighboring area.

All the collected soil samples were tested in the field and laboratory to determine the characteristics of the soils, classify them, analyze their behavior during construction or under constant loads.

Such recommendations refer to excavation systems, control of groundwater, foundation levels, inclination of slope, coefficient of lateral pressure, bearing capacity, expected settlements, and all aspects that should be considered in the design and construction of the treatment plant facilities.

The floor levels of the various component buildings of the plant will be installed at a minimum level of 30 cm above the site finished mean grade level of 7.9 m above mean Black Sea water level (M.W.L).

Structures: The main structures of the plant are cylindrical and rectangular tanks in shape; pipes with large diameters; pumping facilities, and buildings for the administration, operation and maintenance purposes.

The detail design of all the structures shall be performed in light of obtaining security, cost savings, water tightness, durability, and easy to construct.

Cement, aggregates, reinforcement steel bars, and concrete mix designs shall be in accordance with the requirements of relevant Romanian Standards or equivalent international standards.

Loads: The following loads shall be considered for the structural design, if applicable:

- Subpressure of groundwater level
- Lateral earth pressure
- Hydrostatic lateral pressure
- Seismic loads - winds
- Forces due to temperature
- Forces due to differential in humidity
- Curing
- Differential settlements
- Dead loads
- Live loads
- Movable equipment
- Stationary equipment

The area is located in a zone of seismic risk. According to the Regulation P100/1992, the area is located in a D-degree seismic area. Determination of seismic loads shall be in accordance with the Regulations, local codes or other accepted standards. Each type and size of structures shall be individually designed depending on its own conditions assigning the factors of security established by the standards.

The circumstances shall be evaluated and considered in the plant structural design. Any stationary equipment shall be taken as dead load except for the torque, impact and vibrations that might occur when rotary equipment is involved.

Design: The basic material for the construction of the plant structures will be the conventional reinforced concrete structures. Long span beams may be applied to the structures, which may be of post-tensioned with high resistance-cables.

The structure design shall follow the Romanian National Standards STAS 4273/83 or equivalent international standards and publications.

Materials: All materials to be considered for the structural and architectural designs shall be subject to the relevant in the Romanian Standards, or other equivalent international specifications.

7.4 PRINCIPAL PLANT FACILITIES

7.4.1 Storm Drainage System

The planned site elevation is 9.7 m above M.W.L. and the site is not subject to 100-year flooding. The only inundation within the site might be of stagnated stormwater. Hence, an appropriate drainage facility should be provided to handle the stormwater runoffs. Surface drainage may be of open channels or conduits installed along the edge of roads and then discharge the stormwater into nearby drains.

7.4.2 Water Supply System

The public water supply distribution system is available for the treatment plant water system. However, to secure stable clean water supply to be used for the process a supplemental new well may be dug.

7.4.3 Sanitary System

Wastewater resulting from public health water usage will be drained into the sewer located within the plant site.

7.4.4 Site Roads and Parking Areas

Roads and parking areas must be paved with the pavement consisting of granular sub-base and base course materials with an asphalt surface.

7.4.5 Grading and Landscaping

Grading will slope away from structures to the open channels or box culverts. Landscaping includes grass for the area around the roads, structures and buildings. Trees and shrubs will be all along the fence of the site limits.

Shallow rooted small shrubs should be planted at areas where pipe systems exist, to avoid possible damages. This will eliminate clogging and damaging of the pipes.

The use of small trees around roads and buildings help to give a human scale to the project because structures are usually high.

7.4.6 Site Security

The site must be closed with a chain link fence or other appropriate means. The entrances will have a gate with hardware locks to have them closed when necessary.

7.4.7 Safety

Guardrails: For walkways located in hazardous areas of the structures, guardrails must be used. Guardrails shall be painted with safety colors of yellow and black.

Lighting: There shall be exterior lighting all-over the site, along roads, near the structures and along the edge of the surrounding of fence.

Lifesavers: There shall be one lifesaver at each deep and uncovered structure such as clarifiers and anaerobic ponds.

Site Signs: A sign identifying the project and the owner should be put at the entrances of the site. A sign system for orientation within the plant, as well as a color code for elements of the buildings will be provided

7.5 BUILDING UTILITIES

7.5.1 General Requirements

Systems to be considered for the buildings are:

- Ventilation systems to ensure personnel comfort and control of odors;
- Air-conditioning systems to maintain personnel comfort and the best conditions for the electrical and electronic equipment;
- Sanitary and drainage systems;
- Potable water supply system and hot water;
- Storm drainage systems from roof areas;
- Fire protection systems; and
- Ventilation systems to maintain the best conditions of the mechanical rooms.

7.5.2 Design Basis and Criteria

The buildings shall be generally designed based on the following criteria except those that require special considerations.

Indoor design parameters

- Offices, Control and Electrical Room
  - Temperature : 20~25 ℃
  - Humidity : 50~55 %
- Machine Rooms
  - Maximum temperature : 35℃
  - Ventilation.

Air changes

- Machine rooms : 4 to 6 changes/hour
- Work shops : 5 to 10 changes/hour
- Store rooms : 4 to 6 changes/hour
- Rest rooms and blower building : 3 to 6 changes/hour

Outdoor design parameters

- Temperature
  - Maximum temperature : 39 ℃
  - Minimum temperature : - 28.6 ℃
  - Average temperature : 11 ℃
- Precipitation
  - 426 mm/year (average)

48 mm/month for summer time (July)

7.5.3 Specific Building Systems

Office building: Air conditioning may be provided through a central air handling unit. Wash room area may have exhaust fans. Plumbing systems shall include domestic water supply and sanitary systems.

Roof drainage should be connected to the surface drainage system which discharges flows into the drainage system in the plant site.

Maintenance and storage building: This building will have exhaust fans for ventilation. The maximum allowable indoor temperature may be 35℃.

Generator building: Roof and sanitary drainage systems should be provided. Forced inlet air and forced air exhaust systems should used for this building.

Pumping station: Roof and sanitary drainage systems and potable water supply system shall be provided. Portable hand extinguishers for fire protection are to be provided. Forced exhaust air shall be provided at this building.

Aerated grit chamber blower room: Roof and sanitary drainage and potable water supply systems shall be provided. Portable hand extinguishers for fire protection will be provided. Natural ventilation shall be used.

7.5.4 Environmental Conditions

Temperature: Highest, minimum and average temperatures in Galati City area are as follows:

- Highest monthly average temperature (July) : 22.6 ℃
- Lowest monthly average temperature (January) : 3.1 ℃
- Annual average temperature : 10.5 ℃

Humidity: Average humidity in Galati is 72 %, with 80 % or higher in winter and 65 % in summer.

Wind: Predominant local wind direction is northeast icy winds and the southwest winds. The wind speeds are in the range between 14 and 16 m/sec, generally higher in winter and spring. Winds of northwest-northeast directions occur at 45 % frequency, but in winter time the north winds prevail at an average occurrence frequency of 92 %.

Table AII.4.1 Lists of Equipment of Galati WWTP

(1) Screening System Equipment

No.	Equipment	Type	Size and Specifications	Q'ty	Output kW/unit	Total output(kW)	Remarks
1	Screen channel influent gates	Cast iron made, motor operated sluice gate	1200W x 1200H Design depth :7.8 m	4	—		
2	Coarse screens	Manually screened (removable type)	Clear opening 100 mm, 1.6mW x 3.3mH, 60°	4	—		
3	Fine screens	Mechanically-cleaned, (intermittently operated)	Clear opening 20 mm, 1.6mW x 3.3mH	4	0.75	3	
4	Grit chamber effluent gates	Cast iron made, manually operated sluice gate	1.2mW x 1.2mH Design depth :3.5 m	4	—		
5	Gate for pump well influent channel	Cast iron made, manually operated sluice gate	0.8mW x 0.8mH Design depth 5.0 m	1	—		
6	Screenings conveyors	Trough belt conveyor	0.5 m W x 6 mL	2	1.5	3	
7	Screenings skip hoist	Wire rope operated	$0.3m^3$ x 20mH	1	2.2	2.2	
8	Screenings hopper	Steel made, motor operated	$5m^3$	1	1.5	1.5	
9	Screening hoist	Motor operated hoist with trolley	1t x 6mH x 23mL	1	2.6	2.6	
	Total motor outputs of (1)					12.3	kW

(2) Grit Chamber, Oil Separator, Flow Measurement Equipment

No.	Equipment	Type	Size and Specifications	Q'ty	Output kW/unit	Total output (kW)	Remarks
1	Aeration channel Influent gates	Manually operated, cast ir made sluice gate	800mm W x 800mmH Design hydraulic depth; 2 m	8	—		
2	Blowers	Turbo blower	ϕ200mm x $30m^3$	5 (1)	75	300	Standby excluded
3	Grit collector	Trolley with grit lifting sand pump	3.8 kW x 380v	4	3.8	15.2	
4	Grit lifting pump	Lifting of grit from grit channel to grit hopper	2.2kW x 380v	2	2.2	4.4	
5	Aeration chamber effluent channel gates	Manually operated, cast iron made sluice gate	600mm W x 600mm H Design hydraulic depth; 2 m	8	—		
6	Flow measurement equipm	Parshall flume	7-ft. type	2	—		
	Total motor outputs of (2)					319.6	kW

(3) Pumping Equipment(Main Pumping Station)

No.	Equipment	Type	Size and Specifications	Qt'y	Output kW/unit	otal out put(kW)	Remarks
1	No.1 Pumps	Vertical centrifugal mixed pump	600mmΦ x 50m^3/min. x 16.0	4	—		
2	No.1 Pump electric motor	Vertical squirrel cage, water proof type	192kW x 4p x 400v	4	192	768	
3	Suction valves	Manually operated sluice valve	600mmΦ	4	—		
4	Check valves	Slow-closing check valve	600mmΦ	4	—		
5	Discharge valves	Motor-operated butterfly valve	600mmΦ	4	0.2	0.8	
6	No.2 Pumps	Vertical centrifugal mixed pump	900mmΦ * 100m^3/min. x 16.0m	2 (1)	—		
7	No.2 Pump electric motor	Vertical squirrel cage, water proof type	370kW x 6p x 400V	2 (1)	370	370	Standby excluded
8	Suction valves	Manually-operated sluice valve	900mmΦ	2	—		
9	Check valves	Slow-closing check valve	900mmΦ	2	—		
10	Discharge valves	Motor-operated butterfly valve	900mmΦ	2	0.2	0.4	
11	No.3 Pumps	Vertical centrifugal mixed pump	900mmΦ * 100m^3/min. x 16.0m	2 (1)	—		
12	No.3 Pump diesel engine	Diesel engine	554 ps	2	—		
13	Suction valves	Manually-operated sluice valve	900mmΦ	2	—		
14	Check valves	Slow-closing check valve	900mmΦ	2	—		
15	Discharge valves	Motor-operated butterfly valve	900mmΦ	2	0.2	0.4	
16	Crane for pumps	Manually-operated crane with chain block	3.2 t x 25mH x 7mW x 19mL	1	–		Girders by building works
17	Main pumps sealing water suply unit	Unit of water supply pump with pressure tank	40mmΦ x 0.1m^3/min. x 35m	1	2.2	2.2	With control panel
18	Pump room floor drain pumps	Submersible pump	65mmΦ x 0.3m^3/min. x 25m	2 (1)	3.7	3.7	Standby excluded
19	Floor drain pumps	Submersible pump	65mmΦ * 0.3m^3/min. x 10m	2 (1)	1.5	1.5	Standby excluded
	Total motor outputs of (3)					1,147.0	kW

(4) Primary Clarifiers

No.	Equipment	Type	Specifications	Q'ty	Output kW/uni	Total ouput	Remarks
1	Inlet gates	Sluice gate, manual operation, cast iron, circular	ϕ 1,000. Design hydraulic depth, 3m	8	—		
2	Sludge collectors	Rotating type scraper, center column supported	35mΦ x 2.4mH	8	0.75	6	
4	Sludge draw-off valves	Motor operated eccentric	200mmΦ	8	0.2	1.6	
5	Raw sludge pumps	Non-clog centrifugal pumps	100mmΦ x 1m³/min. x 10	3 (1)	3.7	7.4	Standby excluded
6	Bypass gates	Manually operated, cast iron made, circular sluice gate	ϕ 2,000mm. Design hydraulic depth, 1.5m	1	—		
7	Raw sludge flow meter	Electro-magnetic flow meter	100Φ	1	—		
8	Raw sludge densitomete	Ultra-sonic type		1	—		In electric works
	Total motor outputs of (4)					15	kW

(5) Aeration Tanks (32 tanks)

No.	Equipment	Type	Size and Specifications	Q'ty	Output kW/uni	Total output	Remarks
1	Inflow control weirs	Manually operated movable weirs	400W x 600H Design hydraulic depth 1.1 m	32	—		
2	Movable weirs for control of step inflow	Cast iron made, movable weirs	400mmW x 600mmH design depth, 1.1m	96	—		
3	Return sludge inflow control weirs	Cast iron made, movable (separate type)	600mmW x 600mmH design depth 1.1m	32	—		
4	Aeration diffusers	Ceramic made diffuser (fine bubble, 300 μ)	0,82m3/min. 8plates/holder header	670	—		SUS holder headers, & butterfly valves
5	Air control valves	Air operated butterfly valve	250mmΦ	32	—		Electro-magnetic box
6	Froth spray nozzles	Cast iron made movable type	15mmΦx8l/min. x 1kg/cm2	1440	—		1.5 m interval 67/1.5=45 p c/tank
7	Air flow meters	Oriffice	250mmΦ	32	—		Included in electric works
	Total motor output of (5)					0	kW

(6) Final Clarifiers

No.	Equipment	Type	Size and Specifications	Q'ty	Output kW/unit	Total output	Remarks
1	Inlet gates	Sluice gate, manual operation, cast iron	Circular, 1000mmΦ Design hydraulic depth 1.5m	8	—		
2	Sludge collectors	Rotating scraper, central column support	45mΦ x 3.5 m deep	8	0.75	6	
3	Sludge draw-off valves	Motor-operated eccentric valve	200mmΦ	8	0.2	1.6	
4	Return sludge pumps	Non-clog centrifugal	250mmΦx 8.2m^3/min. x 10m	10	30	300	
5	"	"	350mmΦx 15m^3/min. x 10m	6	37	222	100% sludge return
6	Excess sludge pumps	"	100mmΦx 1.1m^3/min. x 10m	6 (2)	3.7	14.8	Standby excluded
7	Return sludge flow meters	Electronic-magnetic flow meter	250mmΦ	4	—		Included in electric works
8	Excess sludge flow meters	Electronic-magnetic flow meter	100mmΦ	2	—		"
9	Return sludge densitometers	Ultra-sonic type	250mmΦ	4	—		"
	Total motor output of (6)					544.4	kW

(7) Chlorine Contact Tanks

No.	Equipment	Type	Size and Specifications	Q'ty	Output kW/unit	Total output	Remarks
1	Influent gates	Manually operated, cast iron, square type	2000mmW x 2000mmH design hydraulic depth, 2 m	1	—		
2	Bypass gates	Manually operated, cast iron, square type	600mmW x 600mmH design hydraulic depth, 1.5m	1	—		
3	Hypochlorite supply pump No.1	Diaphragm pump	Discharge 6L/min.	2	0.2	0.4	
4	Hypochlorite supply pump No.2	Diaphragm pump	Discharge 13L/min.	3 (1)	0.4	0.8	Standby excluded
5	Hypochlorite storage and supply tank	FRP made	20m^3 ϕ2.8m x 3.9m H	4	—		
	Total motor output of (7)					1.2	kW

(8) Sludge Thickeners

No.	Equipment	Type	Size and Specifications	Qt'y	Ouput kW/unit	Total output	Remarks
1	Sludge thickeners	Rotating scraper, with pickets	16mΦ x 4.0mH	4	0.4	1.6	
2	Distribution tank, movable weirs	Manually operated, cast iron weir	300mmW	4	—		
3	Sludge draw-off pump	Non-clog centrifugal pump	100mmΦx 1.2m3/min x 20m	3 (1)	15	30	Standby excluded
4	Sludge draw-off valves	Air operated eccentric valve	100mmΦ	4	0.2	0.8	
5	Sludge screen	Drum screen, self cleaning type	2m3/min.	1	0.4	0.4	
	Total of motor outputs of (8)					32.8	kW

(9) Sludge Digestion Facilities

No.	Equipment	Type	Size and Specifications	Qt'y	Output kW/unit	Total output	Remarks
1	Sludge mixer	Draft tube type	Mixing 2,300 m^3/hr or more	4	22	88	Draft tube 500mmΦ
2	Gas collectors	600mmΦ steel constructed dome, dry and wet seels		4	—		
3	Sludge feed pump valves	Motor operated eccentric valve.	150mmΦ	4	0.2	0.8	
4	Scum draw-off valves	Motor operated eccentric valve.	300mmΦ	4	0.4	1.6	
5	Digested sludge draw off telescope valves	Motor operated	200mmΦ	2	0.4	0.8	
6	Sludge circulation draw off valves	Motor operated eccentric valve.	200mmΦ	4	0.2	0.8	
7	Digested sludge draw off valves	Motor operated eccentric valve.	200mmΦ	4	0.4	1.6	
8	Thickened sludge pipe control valves	Motor operated eccentric valve.	150mmΦ	12	2.2	26.4	
9	Seed sludge pipe control valves	Non-clog sludge pump	100mmΦx $1m^3$/min x 15m	2	7.5	15	
10	Sludge circulation pumps	Non-clog sludge pump	100mmΦx $1.4m^3$/min x 15m	6	5.5	33	
11	Sludge heat exchangers	Spiral type	cntact area $25m^2$	4	—		
12	Water circulation pump	Line pump	65mmΦ x $0.6m^3$/min x 25 m	4	3.7	14.8	
13	Water heater	Vacuum type	800,000kg/hr.	3 (1)	8.3	16.6	Standby excluded
14	Gas booster fans	Turbo fan	$150m^3$/hr x 500mmq	2 (1)	1.5	1.5	Standby excluded
15	Oil service tank	Steel construction	300 L	1	—		
16	Oil pumps	Gear pump	15mmΦ x 10L/min. x 3kg/c	2 (1)	0.4	0.4	Standby excluded
17	Oil storage tank	Underground cylinder type	15,000 L	1	—		
18	Desulfide Gas scrubbers	Dry type	$500m^3$/hr.	4	—		
19	Gas holders	Dry seal (membrane), steel construction	$2,000m^3$	2	—		
20	Waste gas burners	Forced air combustion type	$200m^3$/hr.	2 1	1.5 2.2	3 2.2	Cooling fan and blower
21	Floor drain pumps	Submersible pump	65mmΦ x $0.3m^3$/min. x 10 m	2	1.5	3	
22	Chain block	Geared trolley	1ton	1	—		
23	Total motor outputs of (9)					209.5	kW

(10) Sludge Dewatering Equipment

No.	Equipment	Type	Size and Specifications	Q'ty	Output kW/unit	Total output	Remarks
1	Sludge storage tank mixers	Vertical paddle type	2,000mmΦ	4	7.5	30	
2	Sludge feed pumps	Positive displacement pump	100mmΦ x 20m^3/hr. x 20m	15 (1)	5.5	77	Standby excluded
3	Sludge dewatering	Belt filter press	3 m effective belt width, 400 kg per hour load in dry solid basis	14	3.7	51.8	
4	No.1Cake conveyor	Trough belt	600mmW x 8,500mmL	4	1.5	6	
5	No.2 Cake conveyors	Horizontal trough belt conveyor	600w * 5500L	2	1.5	3	
6	Cake hoppers	Motor operated	10m3	2	3.7	7.4	
7	Chemical containers	Cylinder type	700mmL	2	–		
8	Chemical feeders	Volumetric dry feeder	4L/min.	3	0.4	1.2	
9	Chemical dosage tank	Cylinder type	15m^3 capacity	3	7.5	22.5	
10	Chemical feed pumps	Positive displacement pump	50mmΦ x 3m^3/hr x 20m	15 (1)	1.5	21	Standby excluded
11	Chemical container hoists	Motor operated	1 ton	1 1	1.5 0.4	1.5 0.4	
12	Pumps for belt filter cleaning water	Centrifugal pump	50mmΦ x 0.3 m^3/min. x 60 m	4 (1)	7.5	22.5	Standby excluded
13	Maintenance crane	Suspension type	2 ton	1	–		
14	Chain block	Geared trolley type	2 ton	1	–		
15	Floor drain pumps	Submersible non-clog pump	65mmΦ x 0.3m^3/min. x 10 m	3	1.5	4.5	
	Total motor outputs of (10)					248.8	kW

(11) Aeration Tank Blower System

No.	Equipment	Type	Size and Specifications	Q'ty	Output kW/unit	Total output	Remarks
1	Blowers	Steel made, multi-stage turbo blower	ϕ350mm/ϕ300mm 140m^3/min.	5 (1)	–		
2	Electric motors for blowers	Horizontal squirrel cage, water proof	190 kW	5 (1)	190	760	Standby excluded
3	Blower valves	Electric-operated valve	ϕ250mm	5 (1)	0.4	1.6	Standby excluded
4	Dry type air filters	Self cleaning type	150m^3/min.	4	0.2	0.8	
5	Wet type air filters	Auto rolling type	150m^3/min.	4	0.2	0.8	
6	Maintenance crane	Geared trolley type	3 tons	1	–		
	Total motor outputs of (11)					763.2	kW

(12) Pumping Equipment (Effluent Discharge Pumping Station)

No.	Equipment	Type	Size and Specifications	Qt'y	Output kW/unit	Total output(kW)	Remarks
1	No.1 Pumps	Vertical centrifugal mixed pump	600mmΦ x 50m³/min. x 5.0	4	—		
2	No.1 Pump electric motor	Vertical squirrel cage, wate proof type	60kW x 4p x 380v	4	60	240	
3	Suction valves	Manually operated sluice valve	600mmΦ	4	—		
4	Check valves	Slow-closing check valve	600mmΦ	4	—		
5	Discharge valves	Motor-operated butterfly valve	600mmΦ	4	0.2	0.8	
6	No.2 Pumps	Vertical centrifugal mixed pump	900mmΦ * 100m³/min. x 5.0m	2 (1)	—		
7	No.2 Pump electric motor	Vertical squirrel cage, wate proof type	116kW x 6p x 380V	2 (1)	116	116	Standby excluded
8	Suction valves	Manually-operated sluice valve	900mmΦ	2	—		
9	Check valves	Slow-closing check valve	900mmΦ	2	—		
10	Discharge valves	Motor-operated butterfly valve	900mmΦ	2	0.2	0.4	
11	No.3 Pumps	Vertical centrifugal mixed pump	900mmΦ * 100m³/min. x 5.0m	2 (1)	—		
12	No.3 Pump diesel engine	Diesel engine	173ps	2	—		
13	Suction valves	Manually-operated sluice valve	900mmΦ	2	—		
14	Check valves	Slow-closing check valve	900mmΦ	2	—		
15	Discharge valves	Motor-operated butterfly valve	900mmΦ	2	0.2	0.4	
16	Crane for pumps	Manually-operated crane with chain block	3.2 t x 25mH x 7mW x 19mL	1	-		Girders by building works
17	Main pumps sealing water supply unit	Unit of water supply pump with pressure tank	40mmΦ x 0.1m³/min. x 35m	1	2.2	2.2	With control panel
18	Pump room floor drain pumps	Submersible pump	65mmΦ x 0.3m³/min. x 25m	2 (1)	3.7	3.7	Standby excluded
19	Floor drain pumps	Submersible pump	65mmΦ * 0.3m³/min. x 10m	2 (1)	1.5	1.5	Standby excluded
Total motor outputs of (12)						365.0	kW
Grand Total of Motor Output						3,659	kW

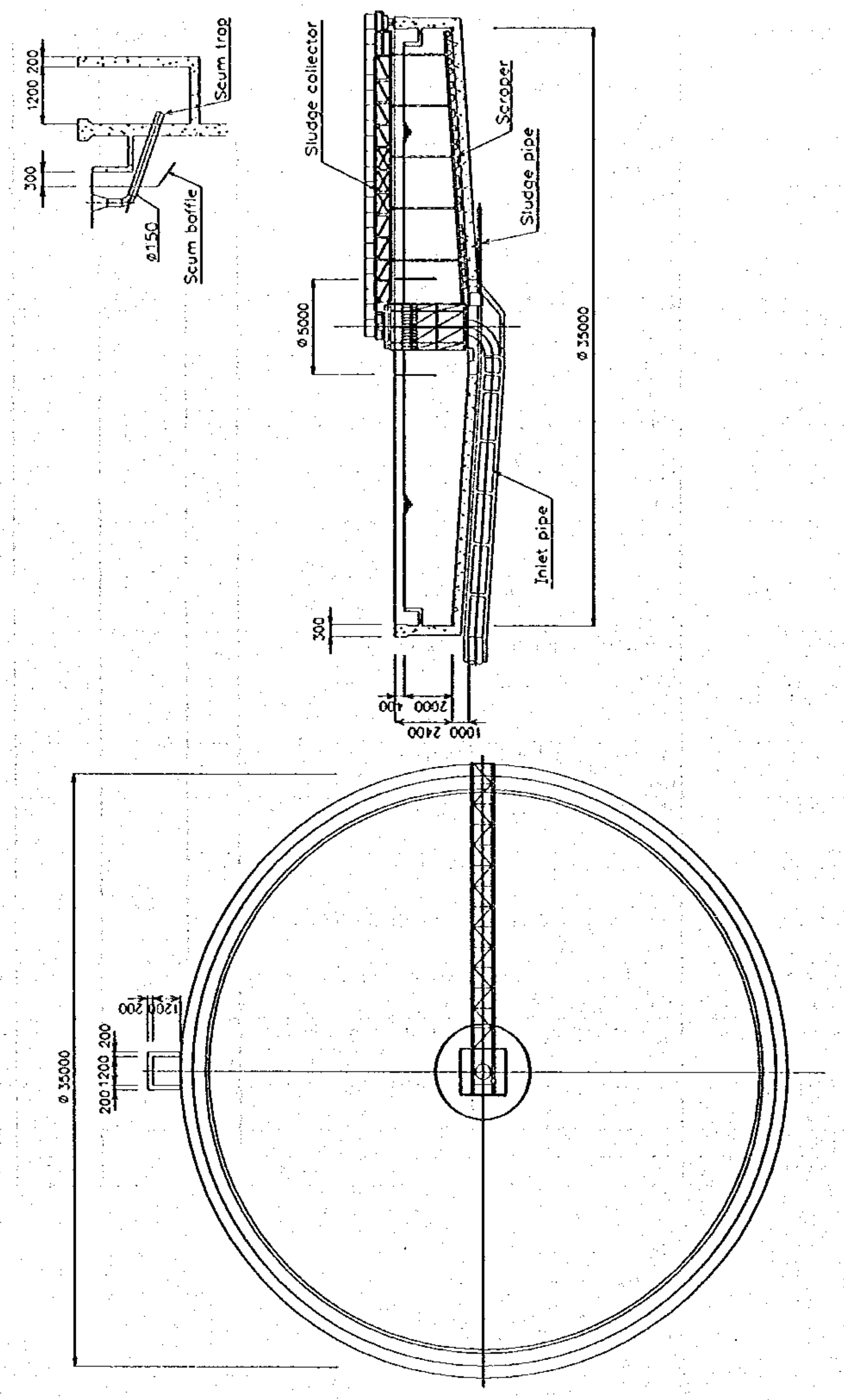


Figure AII.4.1	Primary Sedimentation Tank of Galati WWTP

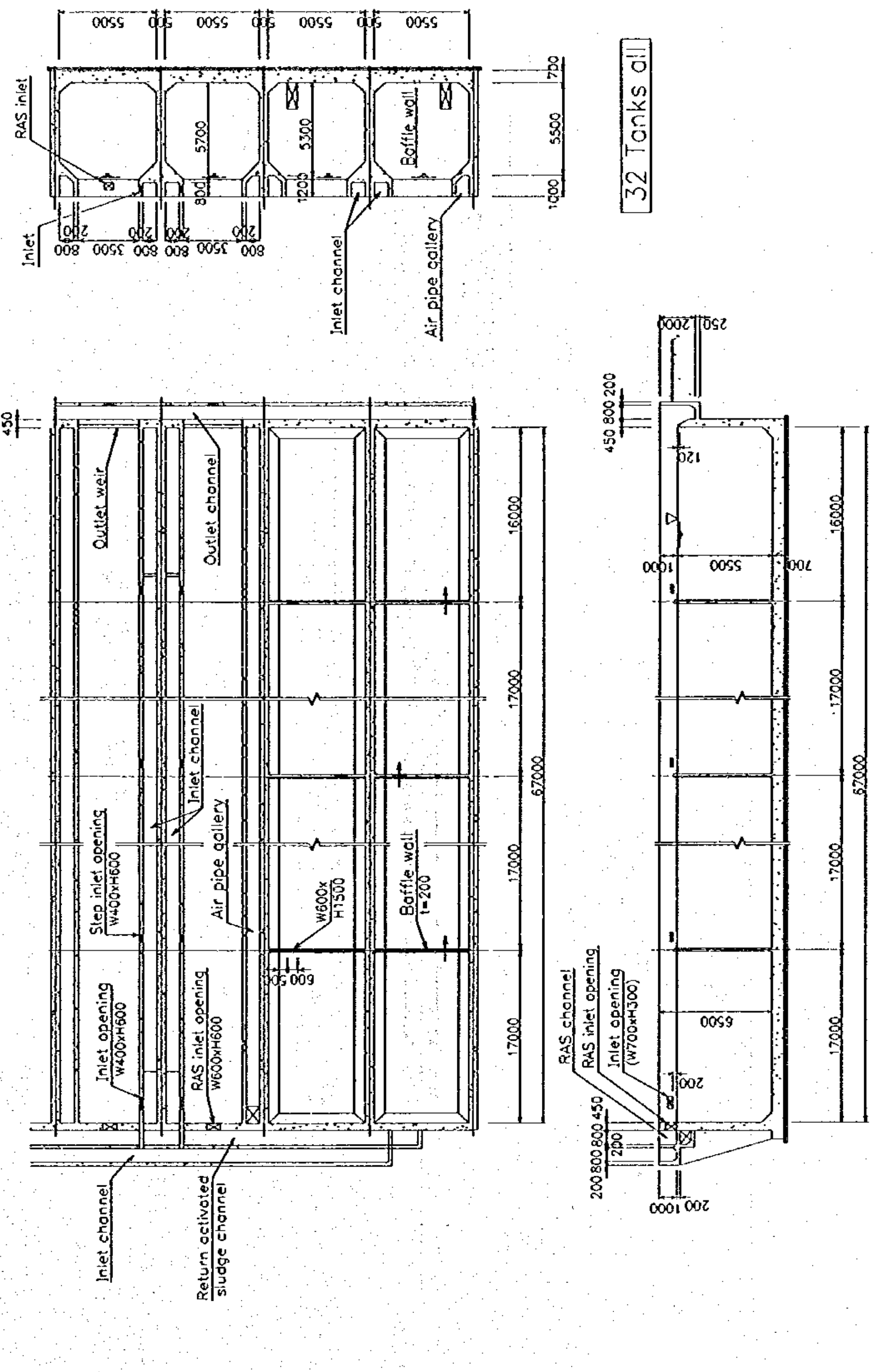


Figure AII.4.2	Aeration Tank of Galati WWTP

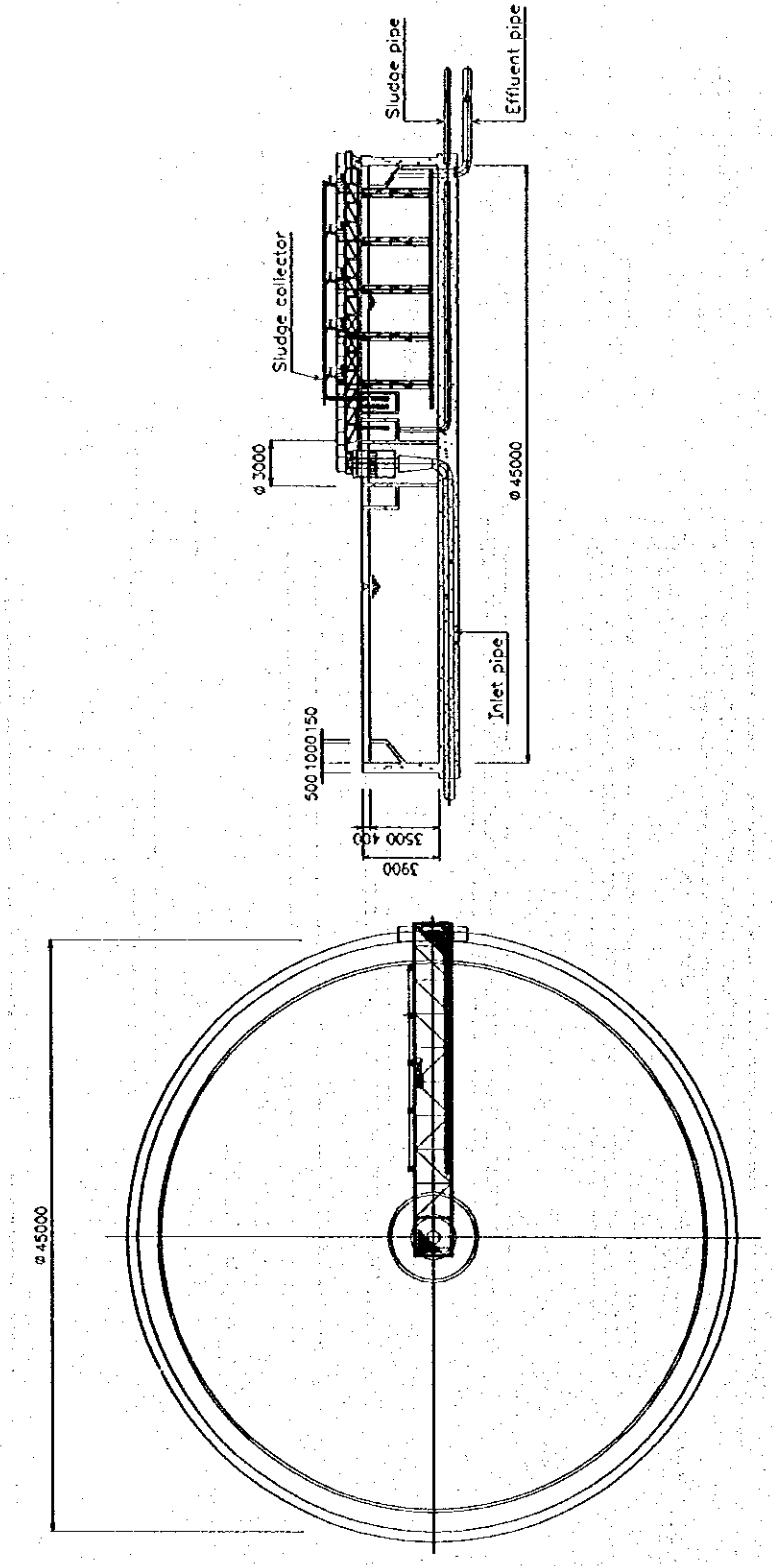


Figure AII.4.3	**Final Sedimentation Tank of Galati**

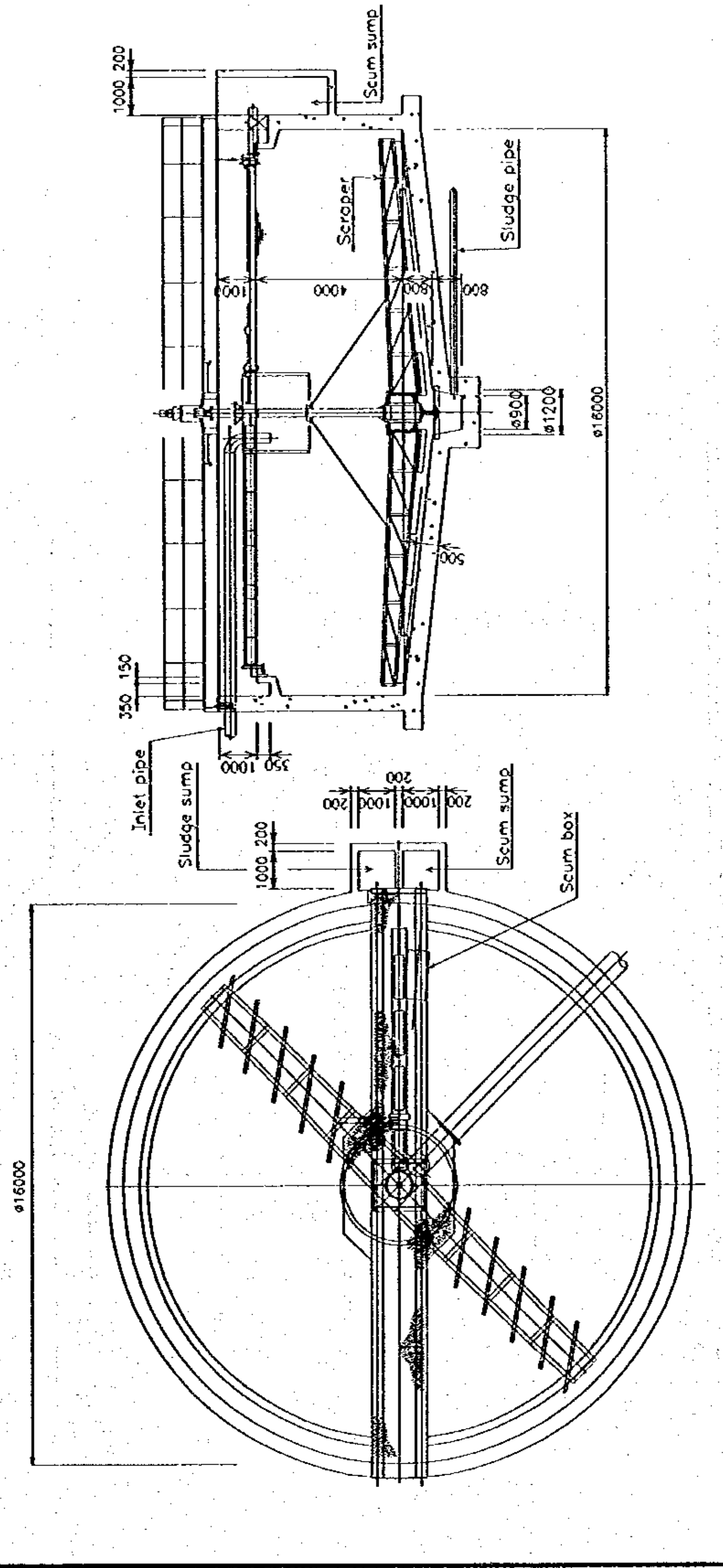


Figure AII.4.4	Sludge Thickener of Galati WWTP

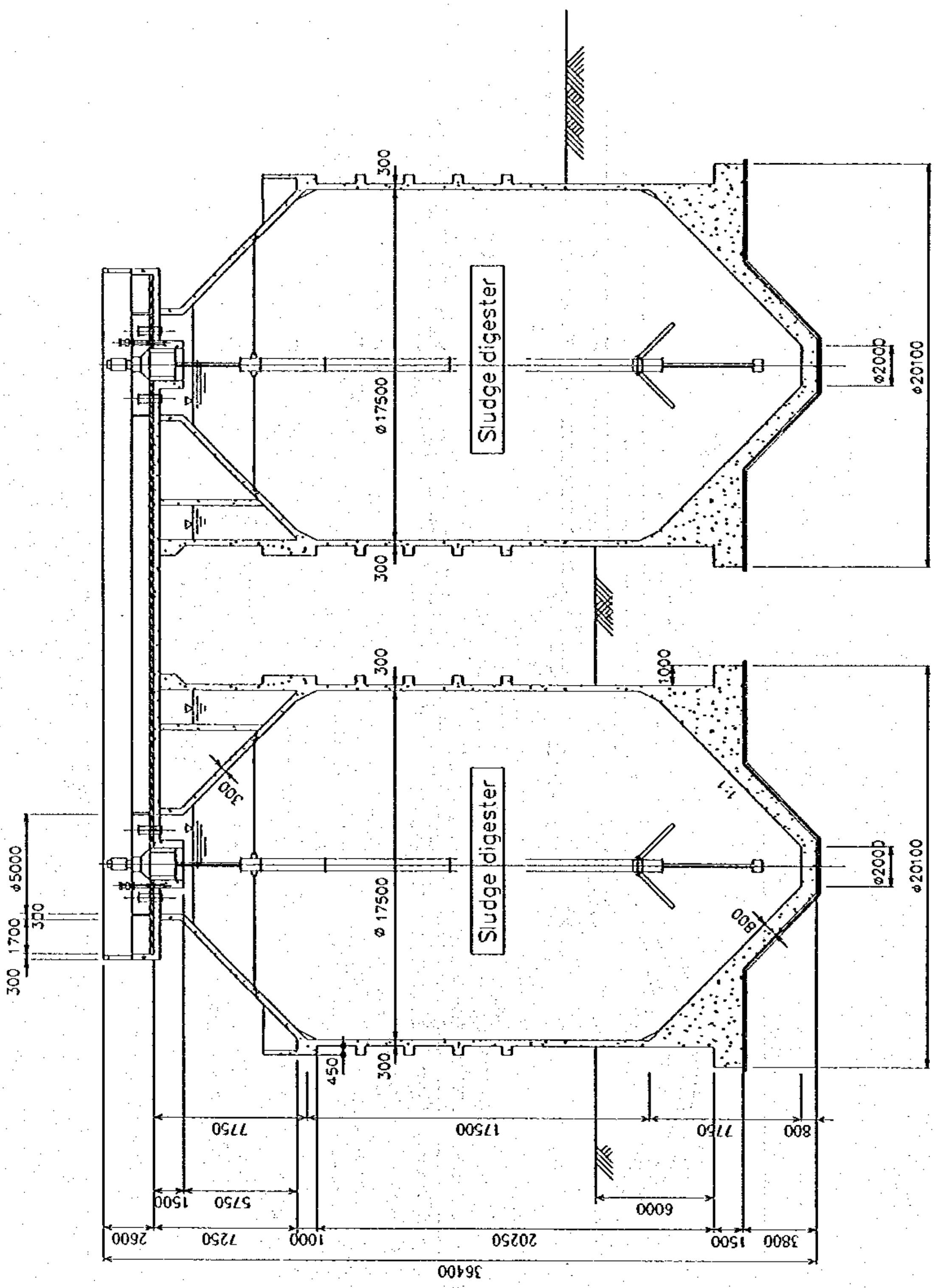


Figure AII.4.5	**Sludge Digester of Galati WWTP**

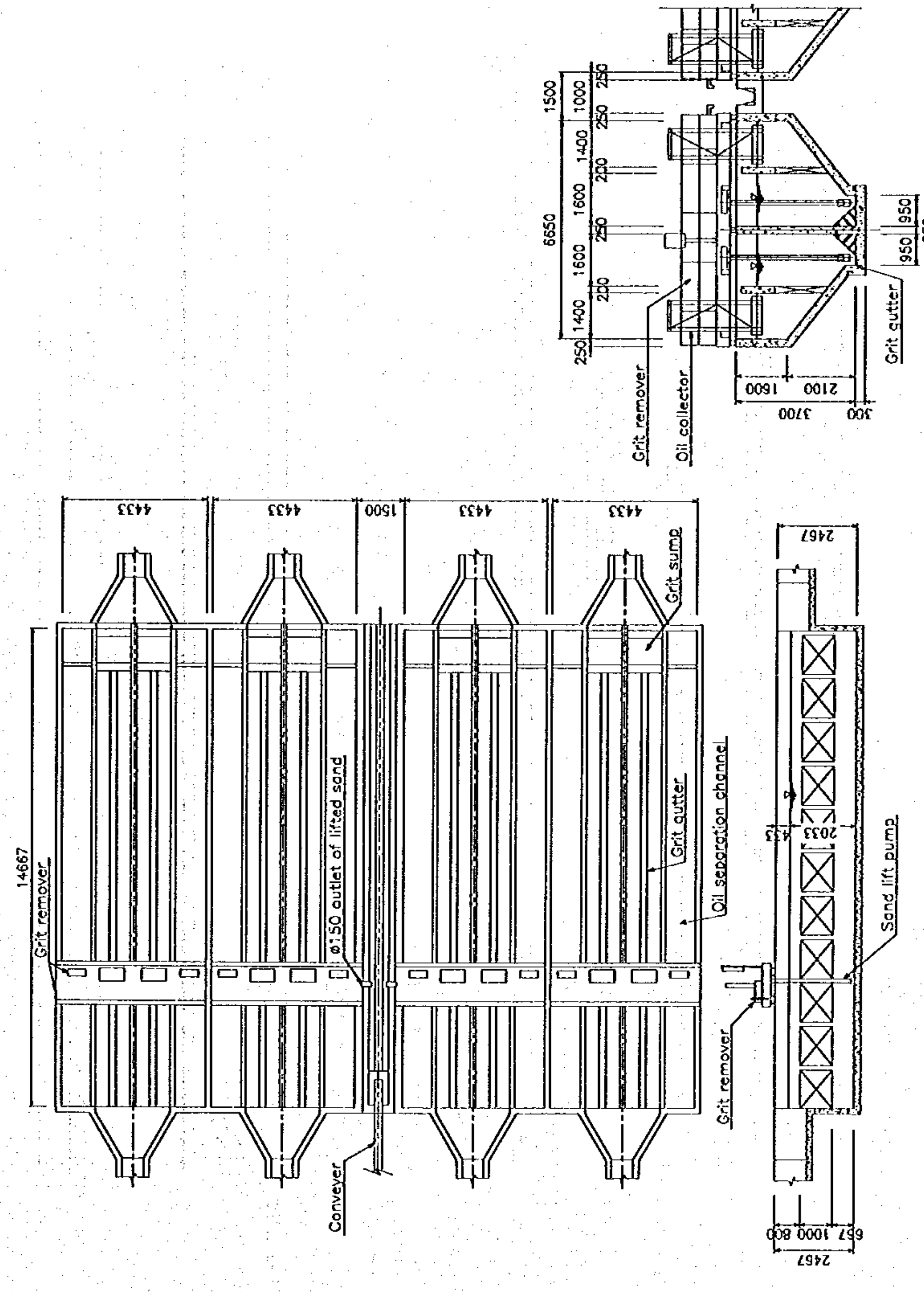


Figure AII.4.6	Grit Chamber and Oil Separator of Galati WWTP

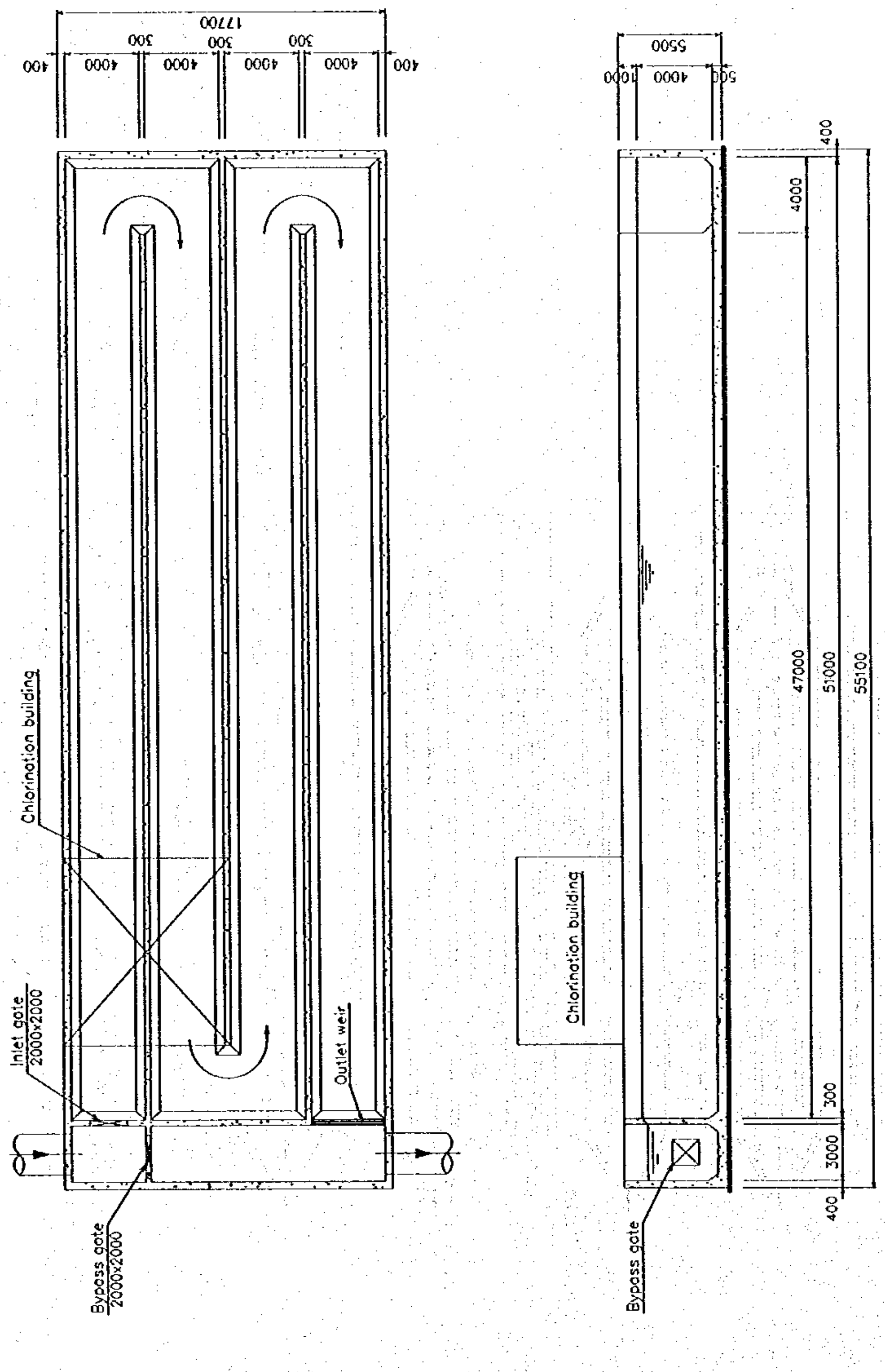


Figure AII.4.7	Chlorination Chamber of Galati WWTP

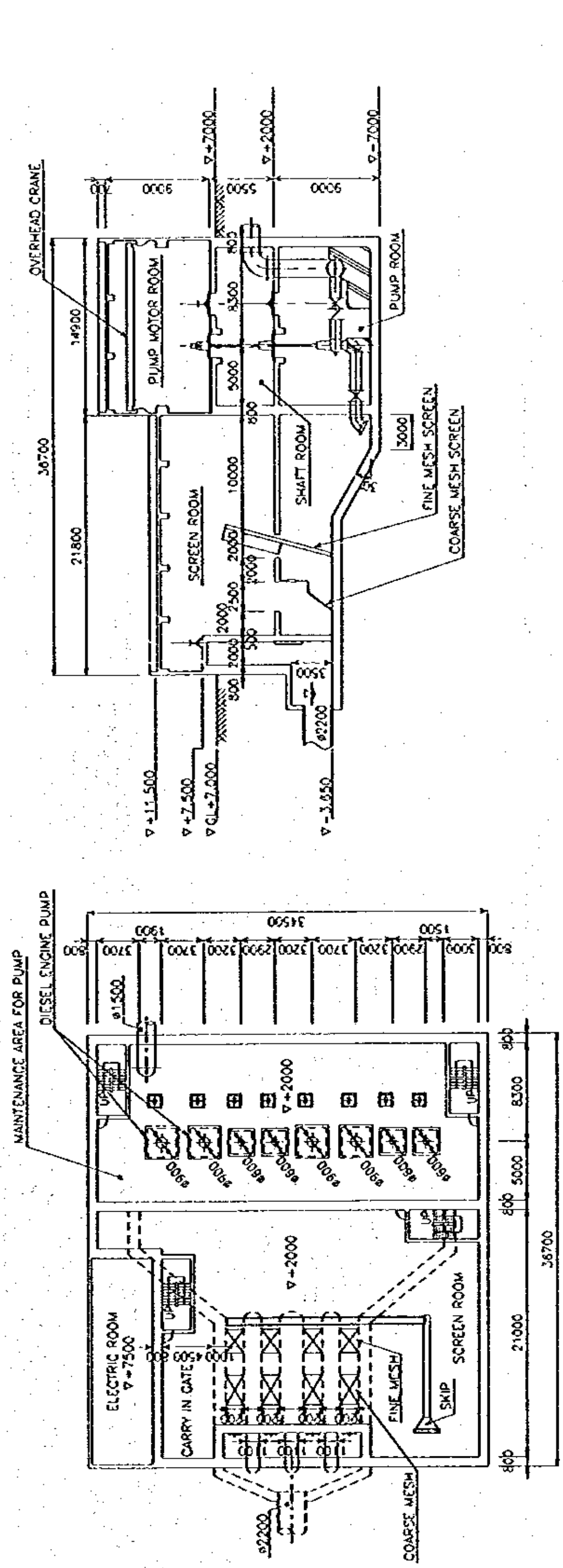


Figure AII.4.8	Screening & Pumping Station of Galati WWTP

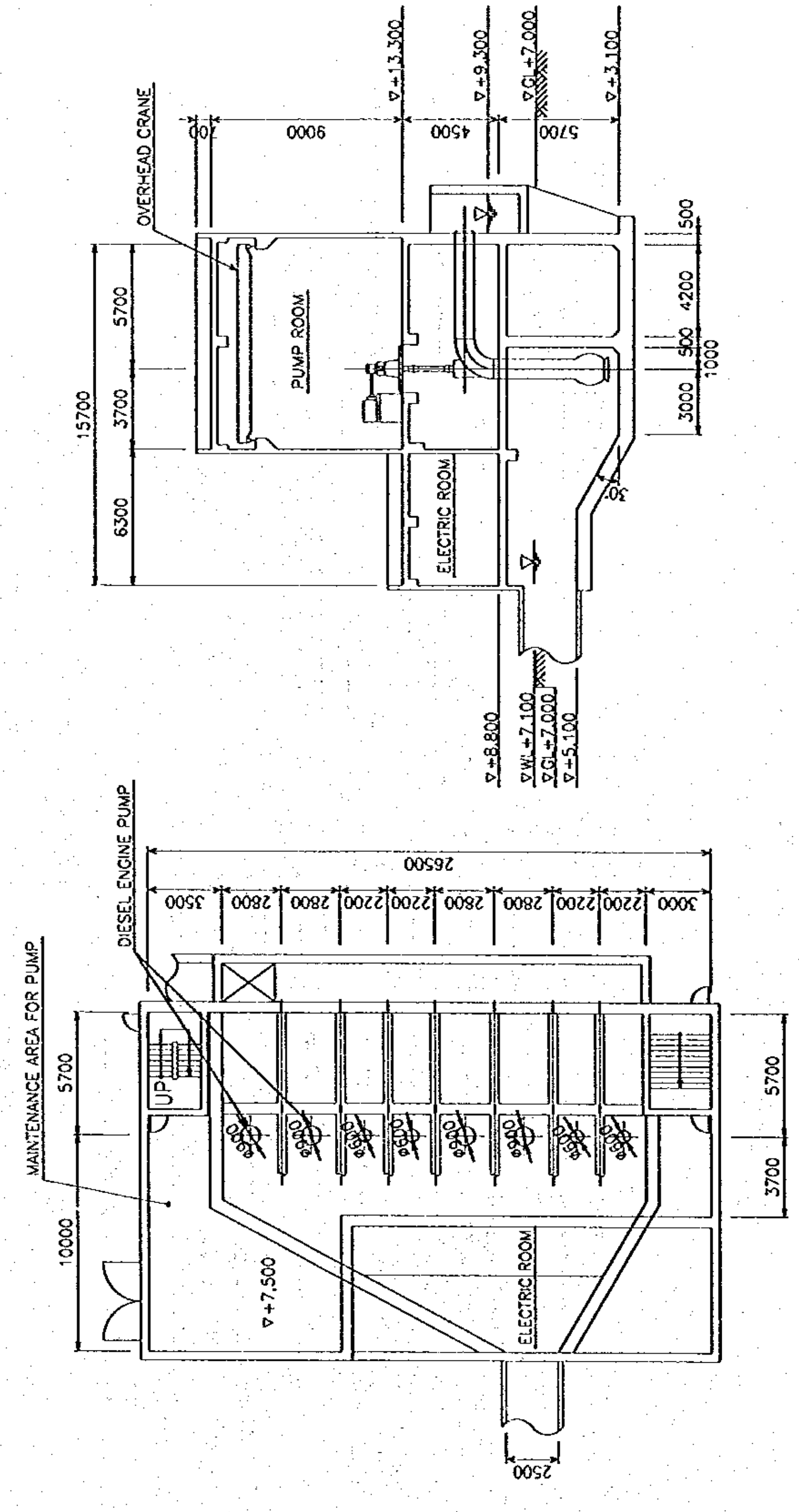


Figure AII.4.9	Effluent Pumping Station of Galati WWTP

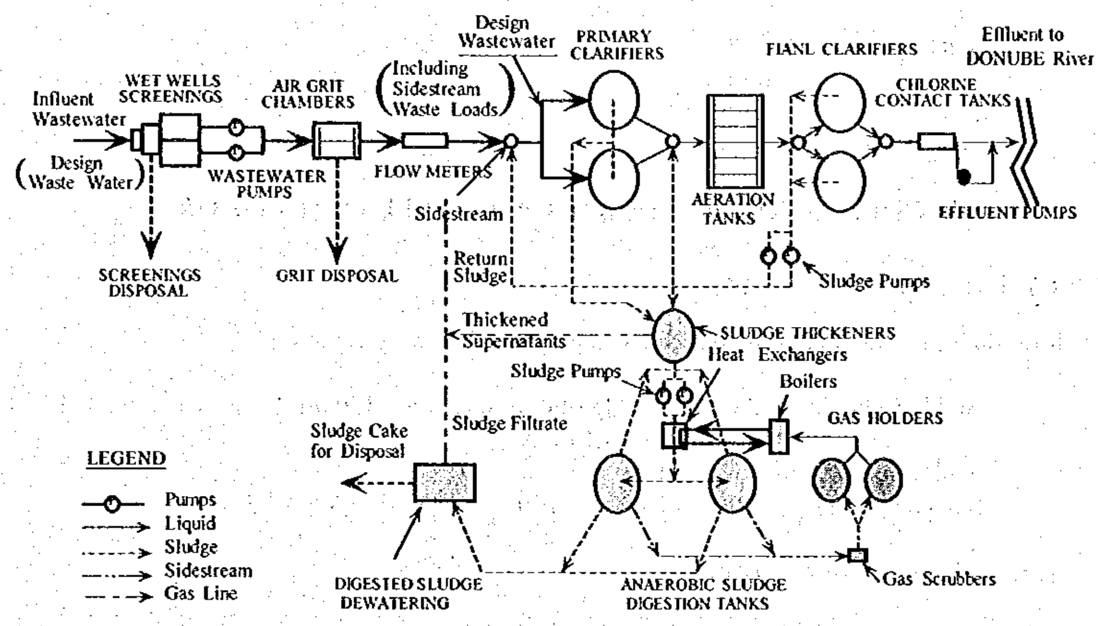
APPENDIX-5 DESIGN CALCULATIONS OF GALATI WWTP

1. CONVENTIONAL ACTIVATED SLUDGE PROCESS

1.1 DESIGN BASIS

1.1.1 SCHEMATIC OF THE CONVENTIONAL ACTIVATED SLEDGE PROCESS

Schematic of the conventional activated sludge process is shown as follows.



1.1.2 DESIGN WASTEWATER INFLOW RATES

Design wastewater inflow rates are determined as follows.

Average daily flow	Qad	200,000 m^3/day	2,315 L/s
Maximum daily flow	Qmd	235,000 m^3/day	2,720 L/s
Maximum hourly flow	Qmh	285,000 m^3/day	3,299 L/s
Wet weather flow	Qww	570,000 m^3/day	6,597 L/day

1.1.3 DESIGN WASTEWATER QUALITY

Design wastewater quality is determined as follows.

BOD = 130 mg/L
SS = 150 mg/L

1.1.4 DESIGN WASTEWATER QUALITY (INCLUDING SIDESTREAM WASTE LOADS)

Design wastewater quality (including sidestream waste loads) is calculated as follows.

BOD = 170 mg/L
SS = 180 mg/L

Parameter	Removal Efficiency(%)			Wastewater Quality (mg/L)		
	Primary treatment	Secondary treatment	Overall removal rate	Raw waste-water	Primary effluent	Secondary effluent
BOD	30	85	89.5	170	119	18
SS	40	80	88.0	180	108	22

1.1.5 POLLUTANT DISCHARGE LIMITS BY NTPA 001

Pollutant discharge limits by NTPA 001 are regulated as follows.

BOD < 20 mg/L
SS < 60 mg/L
T-N < 10 mg/L
T-P < 1.0 mg/L

1.2 CALCULATIONS OF SIDESTREAM POLLUTANT LOADS

1.2.1 RAW SLUDGE VOLUME

Raw sludge production volume is calculated by the following equation.

Solid production (t/day) = 235,000 m^3/day × 150 mg/L × 10^{-6} × 0.4
= 14.1 t/day
Sludge concentration 2.0 %
Sludge volume 14.1 × 100 ÷ 2.0 = 705 m^3/day

1.2.2 WASTE SLUDGE VOLUME

Parameter	Influent quality (mg/L)	Reaction tank influent quality (mg/L)	Primary clarifiers removal Efficiency(%)
BOD	130	91	30
SS	150	90	40

Assuming that the reactor influent S-BOD is 66.7% of the total BOD; then Scs is 60.7 mg/L
Waste sludge production volume is calculated by the following equation:

$$Qw \times Xw = (a \times Scs + b \times Sss - c \times \theta \times XA)\ Q$$

where,

Qw	Volume of waste sludge (m^3/day)		
Xw	Average SS concentration of waste sludge (mg/L)		
Q	Influent volume to reactors (m^3/day)		235,000
XA	MLSS concentration in reactors (mg/L)		1,660
Scs	Influent soluble-BOD concentration to reactors (mg/L)		60.7
Sss	Influent SS concentration to reactors (mg/L)		90
a	Sludge yield coefficient of S-BOD(mg MLSS/mgSS)	0.4~0.6	0.5
b	Sludge yield coefficient of SS(mg MLSS/mgSS)	0.9~1.00.	0.95
c	Coefficient of SS reduction due to indigeneous respiration of activated sludge micro-organisms (L/day)	0.03~0.05	0.04

0 HRT in reactor basins (day) 6.3/24 =0.26

therefore,

$Qw \times Xw = (0.5 \times 60.7 + 0.95 \times 90 - 0.04 \times 0.26 \times 1660) \times Q \times 10^{-6}$

$= 98.42 \times Q \times 10^{-6} = 23.13$ t/day

Solid production = 23.13 t/day

Sludge concentration = 0.5 %

Sludge production = 23.13 × 100 ÷ 0.5 = 4,626 m^3/day

1.2.3 Thickened Sludge

Thickened sludge production volume is calculated by the following equation.

Sludge solids = 14.1 + 23.13 = 37.23 t/day

Primary sludge Excess sludge

Sludge volume = 705 + 4,626 = 5,331 m^3/day

(2.0%) (0.5%)

Solids = 37.23 × 0.85 = 31.64 t/day

Assuming sludge concentration is 3.5 %

Sludge volume = 31.64 × 100 ÷ 3.5 = 904 m^3/day

1.2.4 Sludge Supernatant of Thickeners

Sludge supernatant of thickeners are calculated by the following equation.

Liquor volume = 5,331 − 904 = 4,427 m^3/day

Solids weight = 37.23 × 0.15 = 5.58 t/day

BOD = 4,427 × 2000 × 10^{-6} = 8.85 t/day

BOD is assumed to be of 2,000 mg/L

1.2.5 Digested Sludge

Digested sludge production volume is calculated by the following equation.

Digested sludge solids = 31.64 × (1 − 0.7 × 0.5) = 20.57 t/day

Digested sludge volume 3.0 %

= 20.57 × 100 / 3.0 = 686 m^3/day

1.2.6 Dewatered Sludge(sludge cake)

Dewatered sludge production volume is calculated by the following equation.

Solids = 20.57 × 100 / 0.9 = 18.51 t/day

(Assuming 20.0 % solids concentration)

Cake volume = 18.51 × 100 / 20.0 = 93 m^3/day

1.2.7 Digested Sludge Filtrate

Digested sludge filtrate weight is calculated by the following equation.

Filtrate volume = 904 − 93 = 812 m^3/day

Dry solids weight = 20.57 × 0.10 = 2.06 t/day

BOD = 812 × 1,500 × 10^{-6} = 1.22 t/day

(Assumed BOD concentration = 1,500 mg/L)

1.2.8 Sidestream Volume and Waste Load

Sidestream volume and waste load is calculated by the following equation.

		Thickener supernatants		Sludge filtrate		
Liquor volume	=	4,427	+	812	=	5,238 m^3/day
Dry solids	=	5.58	+	2.06	=	7.64 t/day
BOD	=	8.85	+	1.22	=	10.07 t/day

1.2.9 Wastewater Quality (Including All Sidestreams)

Wastewater quality (including all sidestreams) is calculated by the following equation.

Overall wastewater flow = Influent + Sidestreams
Maximum daily flow = 235,000 + 5,238 = 240,238 m^3/day
Then, the design wastewater flow characteristics are;

BOD = (235,000 × 130 × 10^{-6} + 10.07) / 240,238
= 0.0001691 × 10^6 = 169 → 170 mg/L

SS = (235,000 × 150 × 10^{-6} + 7.64) / 240,238
= 0.0001785 × 10^6 = 179 → 180 mg/L

1.3 SLUDGE PRODUCTIONS

1.3.1 Raw Sludge

Raw sludge production volume is calculated by the following equation.

Solid production (t/day) = 235,000 × 180 × 10^{-6} × 0.4
= 16.92 t/day

Sludge concentration 2.0 %

Sludge volume 16.92 × 100 ÷ 2.0 = 846 m^3/day

1.3.2 Waste Sludge Volume

Parameter	Influent quality (mg/L)	Reaction tank influent quality (mg/L)	Primary clarifiers removal Efficiency(%)
BOD	170	119	30
SS	180	108	40

Assuming that influent S-BOD to reactor basins is 66.7% of the raw wastewater BOD,S-BOD concentration is estimated to be; 79.4 mg/L

Waste sludge production volume is calculated by the following equation.

$$Qw \times Xw = (a \times Scs + b \times Sss - c \times \theta \times XA)\ Q$$

where,

Qw	Volume of waste sludge (m^3/day)	
Xw	Average SS concentration of waste sludge (mg/L)	
Q	Influent volume to reactors (m^3/day)	235,000
XA	MLSS concentration in reactors (mg/L)	1,660
Scs	Influent soluble-BOD concentration to reactors (mg/L)	79.4
Sss	Influent SS concentration to reactors (mg/L)	108

a	Sludge yield coefficient of S-BOD(mg MLSS/mgSS)	0.4~0.6	0.5
b	Sludge yield coefficient of SS(mg MLSS/mgSS)	0.9~1.00	0.95
c	Coefficient of SS reduction due to indigeneous respiration of activated sludge micro-organisms (L/day)	0.03~0.05	0.04
θ	HRT in reactor basins (day)	6.0/24 =	0.25

therefore,

$Qw \times Xw = (0.5 \times 79.4 + 0.95 \times 108 - 0.04 \times 0.25 \times 1667) \times Q \times 10^{-6}$

$= 125.62 \times Q \times 10^{-6} = 29.52$ t/day

Solid production = 29.52 t/day

Sludge concentration = 0.5 %

Sludge production = 29.52 × 100 ÷ 0.5 = 5,904 m^3/day

= 4.1 m^3/min.

1.3.3 RETURN SLUDGE

Return sludge volume is calculated by the following equation.

Sludge return ratio 50 %

Return sludge volume = 235,000 × 0.5 = 117,500 m^3/day

= 81.6 m^3/min.

1.3.4 GRAVITY SLUDGE THICKENERS

Gravity thickened sludge production volume is calculated by the following equation.

Solids inflow = 16.92 (Primary sludge) + 29.52 (Excess sludge) = 46.44 t/day

Sludge inflow = 846 + 5,904 = 6,750 m^3/day

Thickened sludge solids = 46.44 × 0.8 = 37.15 t/day

Assume solids content to be 3.5 %

Thickened sludge volume = 37.15 × 100 / 3.5 = 1,061 m^3/day

1.3.5 ANAEROBIC SLUDGE DIGESTERS

Anaerobic digested sludge production volume is calculated by the following equation.

Input solids = 37.15 t/day

Input sludge volume = 1,061 m^3/day

Volatile solids content of sludge 70 %

Solids destruction rate 50 %

Digested sludge solids = 37.15 × (1 – 0.7 × 0.5) = 24.15 t/day

Assume solids concentration is 3.0 %

Digested sludge volume = 24.15 × 100 / 3.0 = 805 m^3/day

1.3.6 SLUDGE DEWATERING

Dewatered sludge production volume is calculated by the following equation.

Input solids = 24.15 t/day

Recovered solids (90%) = 24.15 × 0.9 = 21.73 t/day

Assuming solids concentration as 20.0 %

Sludge cake volume = 21.73 × 100 / 20.0 = 109 m^3/day