6.2.18 Gas Compressor Station (Facility No. 14)

(1) Process

Efficient sludge mixing requires that digester gas be injected at a rate of $1m^3/hrs./m^2$ of surface area of the structure. With a surface area of 607 m^2 for each digester a volume of approximately 600 m^3/hrs of gas must be injected into each digester at a pressure of 2 bars.

Three gas compressors (2 duty + 1 standby) are required for the purpose of digester mixing. Additional compressors are required to feed the engine generators. A process schematic showing gas collection and utilisation is presented on **Drawing G5**.

(2) Civil Works

The existing structure will be demolished and reconstructed to suit new equipment requirements. Foundation requirements and soil conditions will need to be confirmed at the design stage. It may be possible to re-utilise the same foundation if the new building can be designed with the same foot print as the old one.

6.2.19 Gas Storage Tank (Facility No. 15)

(1) Process

The existing gas storage tank has 5,000 m^3 of capacity that will provide retention times for excess bio-gas of 11.7 hours in the year 2000 and 7.7 hours in the 2015.

(2) Civil

Although there were no major leaks observed during the site investigation, the tank should be thoroughly inspected from the inside and all cracks and joints sealed. The tank is a hermetically sealed container that must be kept full of water to ensure that gas is collected under the floating steel roof. Rehabilitation related to civil works for the digesters is discussed in the following sections:

a) Removing the roof for inspection

Prior to doing any rehabilitation work the roof will need to be lifted using several cranes. Once lifted the roof will need to be supported on scaffolding erected inside the tank. With the roof lifted it will then be possible to inspect and repair the interior of the concrete walls and the exterior walls of the steel roof.

b) Anti-corrosion protection

Contact to biogas can lead to considerable and rapid deterioration of the steel on the inside of the dome. The risk of corrosion can be avoided by coating the dome with an

anti-corrosion lining that is impervious to gas. It is likely that a protective coating was applied to the dome of the roof during the construction. This lining should be inspected for signs of distress. The lining and the gas-tightness of the dome can be verified by spraying water containing a surfactant liquid soap on the exterior. The tank can then be pressure tested for imperviousness to gas. Soap bubbles will appear if there is any air leaks.

c) Required testing

After sealing leaks and applying protective coatings to the inside surfaces the tank should be hydraulically tested. Leaks through cracks in the concrete and embedded sleeves should be identified and sealed from the inside face.

6.2.20 Homogenised Sludge Holding Tank (Facility No. 16)

(1) Process

Using forecast design flows this provides 6.00 days of storage in the year 2000 and 3.71 days of storage in the year 2015. The tank's capacity makes it possible to stop the de-watering process for maintenance or weekend periods.

(2) Civil

As recommended in the assessment report a new inside wall 150 mm thick is required to protect reinforcement and repair leaking expansion joints. A new floor slab is not needed since the length of expansion joints along the floor is small and leakage is probably insignificant. The new wall thickness is required to permit proper placement and compaction of concrete inside the formwork. These repairs will require removal and re-adjustment of the scrappers to fit new internal dimensions. The volume of the tank will be reduced only slightly and will not have an impact on treatment performance.

6.2.21 Sludge Pumping Station (Facility No.17)

(1) Process

Sludge is withdrawn from the holding tank at the rate of 60 m^3/hrs.(total of 800 m^3/day). One pump is required for each filter press. The unit capacity of the pumps should be adjustable from 6 to 25 m^3/hrs.to provide operating flexibility. Equipment details are discussed in mechanical sections of the report.

(2) Civil

The wet well structure is in good condition and shows no signs of leakage. Therefore no civil structural repairs are required.

6.2.22 Sludge De-Watering (Facility No. 18)

(1) Process

The filter belt presses and polymer feed equipment were damaged during the war and need to be replaced. Based on estimated design parameters the operating characteristics of the dewatering process will be as following **Table 6.14**.

Table 6.14 OPERATING CHARACTERISTICS OF DEWATERING PROCESS

	YEAR 2000	YEAR 2015
Working days per week	5	5
Sludge weight per calendar day	20, 214 kg SS/day	3,3 958 kg SS/day
Sludge to be dewatered per working day	28, 300 kg SS/day	47, 541 kg SS/day
Number of filter presses	4 duty, 1 standby	6 duty, 1 standby
Cake volume to be disposed	107 m^3/day	180 m^3/day
Dewatered cake concentration	24%	24%
Cake weight to be disposed	118 tons wet sludge/day	198 tons weight sludge/day

Estimated polymer dosing and consumption are shown in **Table 9.15**.

Table 6.14A ESTIMATED POLYMER DOSING AND CONSUMPTION

	YEAR 2000	YEAR 2015
Polymer dosing	4 kg/Ton DS	4 kg/Ton DS
Daily average consumption	113 kg/day	190 kg/day
Hourly average consumption	15.6 kg/hrs.	24.2 kg/hrs.

6.2.23 Service Water Pumping Station

(1) Process

A service water network using treated effluent was installed to reduce the amount of potable water used for process equipment:

1) unblocking the sludge extraction pipes
2) cleaning the rooms, pumps houses and filtration units
3) watering

This service water is supplied from a booster unit that recovers water at the inlet to the Parshall flume and pumps it a pressure of 4 bars to the dewatering building.

The design and arrangement of the pumps caused many problems in the past. The pumps lose their prime when they stop operating and priming them again is difficult and time consuming. The effluent water contains suspended solids that lead to clogging in the pipes and difficulties in downstream processes.

To improve operations, pumps will be changed to submersible units installed in the wet well. A filter unit will be installed to remove suspended solids. The proposed layout and modifications to

the pumping station are shown on **Drawing M5**. Equipment and details are discussed in mechanical sections of the report.

(2) Civil

There are no civil structural repairs or modifications required.

Table 6.4 (1/9) SCOPE OF REHABILITATION FOR CIVIL WORKS

Facility Name	Structure	Condition Assessment	Recommended rehabilitation
1. Raw water pumping station	Inflow Gate Chamber	The concrete panels covering the chamber are damaged and difficult to remove for maintenance access.	Replace concrete cover with removable steel grating.
	Inflow gate	Plant operators confirm that the gate never operated properly since the day it was first installed. The guides appear to be damaged near the bottom and the gate cannot be fully closed.	The gate cannot be repaired. It will not be required after the new pre-treatment facility is constructed, therefore the gate should be removed.
	General	Steel railings around wet well are missing	Provide railings around perimeter.
		Concrete stairs leading up to the pump station control room are badly damaged by weathering. The cross sectional dimensions are inadequate and reinforcing steel is exposed and corroded.	Remove concrete stairs and replace with open grate galvanized steel stairs and landings, and railings.
	Wet well for screw pumps	Concrete pillars were constructed in front of screw pumps to prevent damage from large objects. These pillars trapped too many rags and debris and quickly became clogged resulting in a serious operating and maintenance problem.	Remove the concrete pillars and wire cage.
		There is provision for maintaining the lower bearing of each screw pump individually by inserting stop boards to isolate the flow. The stop boards are missing.	New stop boards are required (8)
2. Screening Station	Inlet structure	Sluice gates are in good condition but need maintenance	Replace packing and grease spindle
		The wide cross section causes low velocities which results in excessive deposit of sediments. These sediments block screens and create operating difficulties.	Reduce the cross sectional area by forming new channels. Improve hydraulic conditions by extending wing walls to direct flow towards screens.
3. Aerated Grit Chamber	General	Handrails and ladders are rusted.	Provide new handrails. Replace ladders with steel stairs.
		Access to the travelling bridge along the outside walls is inadequate	Provide open grate walkways and railings on both sides of the grit chamber.
		The travelling bridge cannot operate properly in the winter because the running surface on top of the wall is susceptible to freezing an snow accumulation.	Provide 100 mm air entrained concrete topping to accommodate heat tracing cable.

Table 6.4 (2/9) SCOPE OF REHABILITATION FOR CIVIL WORKS

Facility Name	Structure	Condition Assessment	Recommended rehabilitation
3. Aerated Grit Chamber	General	Concrete slab surfaces are damaged by frost. Reinforcing steel is exposed.	Remove all concrete walkways and replace with open steel gratings. Extend gratings over inlet and outlet wells.
	Silting basin walls	Exterior walls are exposed to weathering which leads to rapid deterioration of concrete surfaces.	Seal exposed concrete surfaces
		Sluice gates at outlet are in good condition but need maintenance	Replace packing and grease spindle
		The hydraulic leakage test confirms that leakage through cracks and joints is excessive. Most of the leakage occurs at horizontal and vertical construction joints in the outlet structure. Expansion joints appear to be water tight.	Seal all cracks and construction joints. Provide new seal in expansion joints.
4. Primary Sedimentation tanks	General	Steel ladders and rails are rusted. There is no access to the peripheral end drive of travelling bridge.	Provide steel stairs. Provide open grating walkway and railings beside overflow launder.
	Inlet structure	Wood stop boards at inlet are rotted	Provide new stop boards (2)
		The concrete slab supporting the gate actuators has failed and there is insufficient space for operating the sluice gate.	Replace with stronger slab and cover open wells with open grating to improve access space for operation of valve.
	Tank walls	The hydraulic leakage test confirmed that leakage through cracks and expansion joints in the wall and overflow launder is excessive. Several of the cracks that were previously repaired are leaking.	Seal all cracks and construction joints including any that were previously repaired. Repair expansion joints.
		Inside walls of tank have inadequate cover over reinforcement. Steel is corroded and exposed over most of the surface area.	Expose and treat all corroded reinforcing steel. Provide new concrete wall 150mm thick on inside face to increase cover and facilitate repair of expansion joints. Provide protective coating for high and low water levels.

Table 6.4 (3/9) SCOPE OF REHABILITATION FOR CIVIL WORKS

Facility Name	Structure	Condition Assessment	Recommended rehabilitation
4. Primary Sedimentation tanks	Tank walls	Footings are only 0.5 meters deep and are susceptible to frost heaving.	Damproof concrete and backfill around tanks 1m deep.
	Tank floors	The floor finish appears to be in good condition. The screed finish is cracked along the movement joint (normal) but is not delaminated. Leakage in floor joints is probable.	Remove existing screed mortar. Provide new expansion joint and 100 mm concrete floor over existing.
	Slab supporting the peripheral drive unit for scrapper bridge	The top surface of slab is rough. Supporting columns located next to expansion joints have shear failure.	Reconstruct columns and reinforce with additional shear steel.
	Overflow Channel	Leakage was observed at all vertical & horizontal expansion joints and several deep cracks	Seal all cracks and construction joints. Repair expansion joints.
	Outlet Structure	Leakage was observed at horizontal construction joints.	Seal all construction joints.
5. Aeration Tank	General	Steel ladders and rails are rusted. There is no direct access from one row of aerators to the next making operation and maintenance difficult.	Provide steel stairs and railings at inlet and outlet side along East and West elevation (4 total). Provide steel catwalk to interconnect aerators.
	Inlet structure	Concrete slab surfaces are damaged by frost	Remove loose concrete and finish with air entrained epoxy mortar
		Inadequate surface area for operations and maintenance	Cover intake structure wells with open steel grating
		The inflow weir is damaged	Install new weir plate
		The wood stop boards used to isolate the flow of primary influent are rotted.	Provide new stop boards (5)
	Tank walls	The hydraulic leakage test confirms that leakage through cracks and expansion joints is excessive.	Seal all cracks and construction joints. Repair expansion joints.
		Inside walls of tank have inadequate cover over reinforcement. Steel is corroded and exposed over 40% of the surface area.	Expose and treat all corroded reinforcing steel. Provide new concrete wall 150mm thick on inside face to increase cover and facilitate repair of expansion joints. Provide protective coating 1 m either side of high and low water levels.
		The rigid connection of the walkway slab to the wall creates positive bending moments in outside face of exterior walls. There is insufficient reinforcement to resist tension resulting in deep cracks (45^0).	Remove rigid connection between walkway slabs and exterior wall.

Table 6.4 (4/9) SCOPE OF REHABILITATION FOR CIVIL WORKS

Facility Name	Structure	Condition Assessment	Recommended rehabilitation
5. Aeration Tank	Tank walls	Exterior walls have insufficient reinforcement to prevent temperature cracks caused by temperature differentials.	Provide new exterior wall 150mm thick. Seal exposed concrete surfaces.
	Tank floors	The floor finish appears to be in good condition. The screed finish is cracked along the movement joint (normal) but is not delaminated. Leakage in floor joints is probable.	Provide new expansion joint and 100 mm concrete floor over existing.
	Aerator slab	Frost damage caused by inadequate surface drainage and spray from aerator. Reinforcing steel is exposed and corroded. The 150mm slab does not have sufficient mass to dampen vibrations.	Remove existing slab and beams and reconstruct to larger dimensions. Coat underside of slab with epoxy resin finish.
		Inadequate floor pad for support of surface aerator.	Provide concrete base with vibration isolating pads.
	Aerator columns	Inadequate concrete cover over reinforcement	Remove loose concrete and expose reinforcing steel. Remove rust and coat with rust inhibitor. Reform columns with additional 100mm concrete cover on all sides
		frost damage at water line.	Repair and coat with epoxy resin
	Outlet Structure	Access to sluice gates is difficult especially during winter. Steel ladders are corroded	Provide open grate catwalk and railings
		wooden stop boards are rotted	Provide new (3)
		Leakage was observed at horizontal construction joints.	Seal all construction joints.
6. Final Sedimentation tanks	General	Steel ladders, walkways and railings are rusted.	Remove corrosion and coat with rust inhibitor. Finish with weather resistant paint.
	Inlet structure	Inlet sluice gates located at aeration tank are leaking.	Replace packing and grease spindle
	Tank walls	The hydraulic leakage test confirmed that leakage through cracks and expansion joints is excessive. Several of the cracks that were previously repaired are leaking.	Seal all cracks and construction joints. Repair expansion joints.

Table 6.4 (5/9) SCOPE OF REHABILITATION FOR CIVIL WORKS

Facility Name	Structure	Condition Assessment	Recommended rehabilitation
6. Final Sedimentation tanks	Tank walls	Inside walls of tank have inadequate cover over reinforcement. Steel is corroded and exposed over most of the surface area.	Expose and treat all corroded reinforcing steel. Provide new concrete wall 150mm thick on inside face to increase cover and facilitate repair of expansion joints. Provide protective coating for high and low water levels.
	Tank floors	The floor finish appears to be in good condition. The screed finish is cracked along the movement joint (normal) but is not delaminated. Leakage in floor joints is probable.	Remove existing screed mortar. Provide new expansion joint and 100 mm concrete floor over existing.
	Overflow Channel	Leakage was observed at all vertical & horizontal expansion joints and several deep cracks	Seal all cracks and construction joints. Repair expansion joints.
7. Flow metering	Parshall flume	No civil structural repairs or modifications	
8. Recycle sludge pumping station	General	Concrete stairs leading up to pump station control room are badly damaged by weathering. Reinforcing steel is exposed and corroded. Hand rails are corroded.	Remove concrete stairs and replace with open grate steel stairs, landings and railings.
		Insufficient surface area at outlet channel for operation and maintenance.	Cover intake structure wells with open steel grating
		The wood stop boards used for isolating flow of recycled sludge to the aeration basin are rotted.	Provide new stop boards
	Walls & floor of recirculation channel	Leakage was observed at horizontal construction joints between wall and floors	Seal all cracks and construction joints. Repair expansion joints.
9. Primary sludge pumping station	General	Inadequate operating space around valve operators and no access to wet well for maintenance.	Provide open steel grating platform over wet well with aluminum access ladder into wet well..
	Pump room	Pumping room is prone to flooding because the floor elevation is lower than ground level.	Remove door and seal opening. Provide new access stairwell to below grade entrance. Water proof exterior of structure and backfill around pump station and sedimentation tanks.
	Wet well	Wet well structure is in good condition but is showing signs of aging (many small cracks)	Provide waterproof coating on the exterior of the wet well and provide a liner on the interior to improve liquid retention.

Table 6.4 (6/9) SCOPE OF REHABILITATION FOR CIVIL WORKS

Facility Name	Structure	Condition Assessment	Recommended rehabilitation
10. Sludge Thickener	General	Access via the roof of the pumping station is difficult in the winter. Steel ladders, walkways and railings are rusted.	Provide open grate steel stairs along side of one sludge thickener. Remove rust on existing walkways and railings and coat with protective paint.
	Tank walls	The tanks were not tested hydraulically. Visual inspection revealed many deep cracks in the walls on overflow launder. Leakage through cracks and expansion joints appears to have been a problem in the past and several of the cracks were previously repaired.	Seal all cracks and construction joints. Repair expansion joints.
		Inside walls of tank have inadequate cover over reinforcement. Steel is corroded and exposed over most of the surface area.	Expose and treat all corroded reinforcing steel. Provide new concrete wall 150mm thick on inside face to increase cover and facilitate repair of expansion joints. Provide protective coating at high and low water levels.
	Tank floors	The floor finish appears to be in good condition. Crack opening along bottom movement joints is less than 5 mm and there is no evidence of leakage through the joint. The bottom screed is cracked along the movement joint (normal) but is not delaminated.	No action required
11. Thickened Sludge pumping Station	General	There is no access to the wet well for maintenance	Cover top of wet well with open grating. Provide aluminum access ladder into wet well.
	Wet well	There is visible evidence of past leakage in the walls of the wet well.	Provide a waterproof liner on the inside of the wet well
12. Sludge Digester	General	Steel access ladders and platforms are damaged and corroded	Replace with new platforms and handrails.
		The digesters are approximately 2/3 full of sludge which has been dormant since April 1992.	Remove liquids and solids. Clean digesters.
	Thermal Insulation	Insulation on walls and roof is damaged.	Remove existing insulation and replace with 400mm rigid polystyrene covered with protective metal cladding.

Table 6.4 (7/9) SCOPE OF REHABILITATION FOR CIVIL WORKS

Facility Name	Structure	Condition Assessment	Recommended rehabilitation
12. Sludge Digester	Concrete	The digesters are approximately 2/3 full of liquid sludge. There is no apparent leakage. Some small surface areas have been damaged by projectiles but there is no structural damage.	Patch all damaged areas with epoxy mortar. Perform hydraulic test with insulation removed to ascertain water tightness. Repair leaks with epoxy injection if necessary.
	Anti-corrosion protection	Contact with bio-gas can lead to considerable deterioration of the concrete on internal walls and dome. A protective coating was applied during construction however a visual inspection to ascertain conditions inside the digester was not possible.	Inspect dome and side-walls between high and low sludge levels. Replace coating if required.
	Valves	The gate valves at the base of the digester have been damaged by freezing. The valve casings have split and sludge is leaking out onto the ground.	Replace all valves and provide heat tracing to prevent freezing
13. Boiler House	Building	Existing building will be reconstructed	No action required
14. Gas Compressor Station	Building	Existing building will be reconstructed	No action required
15. Gas Storage Tank	Concrete	The tank is usually filled with water to provide a seal between the roof and the wall of the tank. Visual inspection of the tank walls reveals many cracks and construction joints with visible signs of previous leakage. Hydraulic test indicates that leakage is small.	Seal all cracks and joints with epoxy injection from the inside. Provide epoxy resin coating to inside surface.
	Roof	The gas holding tank is fitted with a floating steel roof. The roof appears to be in good condition but needs anti-corrosion coating on both sides	Temporarily raise roof and support on scaffolding. Sandblast corrosion and old finish. Apply epoxy paint to all exterior steel surfaces. Apply epoxy tar coating on interior surfaces to protect from gas corrosion.

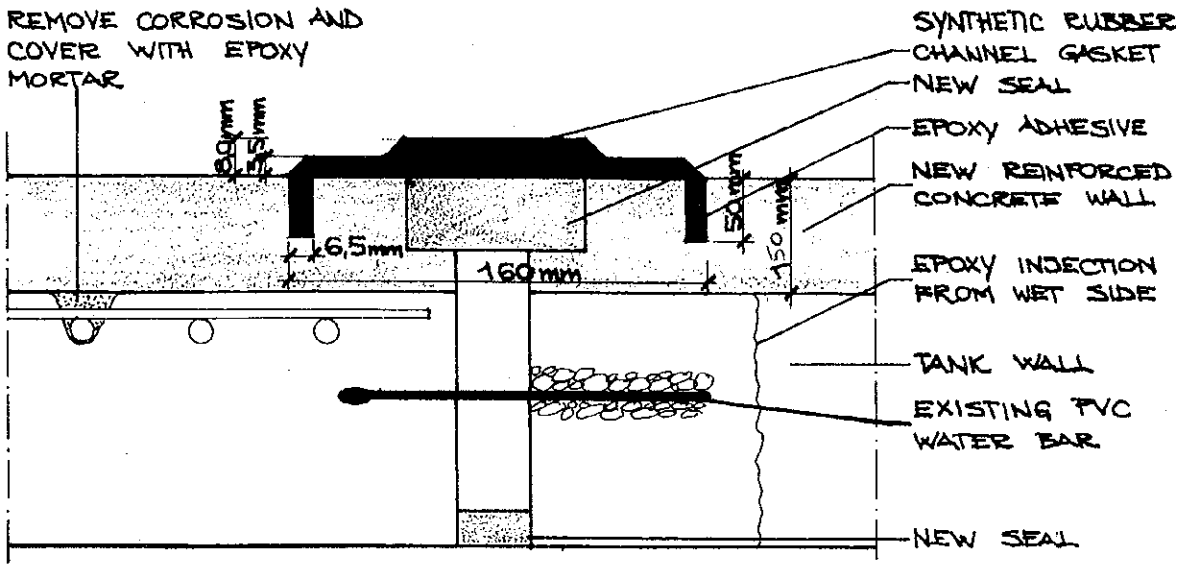
Table 6.4 (8/9) SCOPE OF REHABILITATION FOR CIVIL WORKS

Facility Name	Structure	Condition Assessment	Recommended rehabilitation
16. Homogenized Sludge Holding Tank	General	Steel ladders, walkways and railings are rusted.	Provide open grate steel stairs along side of one sludge thickener. Remove rust on existing walkways and railings and coat with protective paint.
	Tank walls	The tanks were not tested hydraulically. Visual inspection revealed many deep cracks in the walls. Leakage through cracks and expansion joints appears to have been a problem in the past and several of the cracks were previously repaired.	Seal all cracks and construction joints. Repair expansion joints.
		Inside walls of tank have inadequate cover over reinforcement. Steel is corroded and exposed over most of the surface area.	Expose and treat all corroded reinforcing steel. Provide new concrete wall 150mm thick on inside face to increase cover and facilitate repair of expansion joints. Provide protective coating at high and low water levels.
	Tank floors	The floor finish appears to be in good condition. Crack opening along bottom movement joints is less than 5 mm and there is no evidence of leakage through the joint. The bottom screed is cracked along the movement joint (normal) but is not delaminated.	No action required
17. Sludge pumping station	General	There is no access to the wet well for maintenance	Cover the wet well with a steel grating and provide an aluminum access ladder into the wet well.
	Walls & floor of recirculation channel	Walls appear to be liquid tight however the structure was not hydraulically tested.	No action required

Table 6.4 (9/9) SCOPE OF REHABILITATION FOR CIVIL WORKS

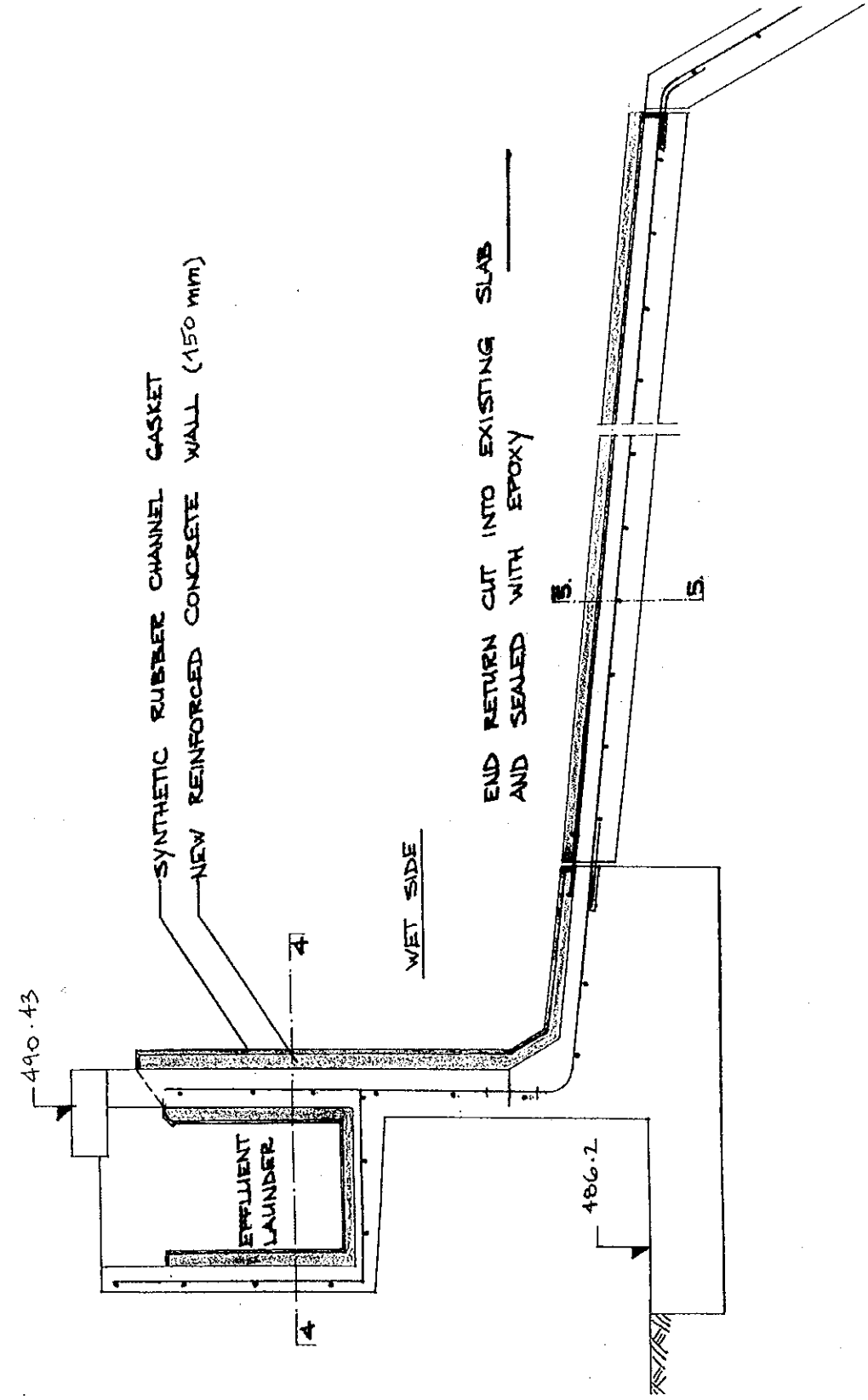
Facility Name	Structure	Condition Assessment	Recommended rehabilitation
18. Sludge Dehydration	No civil structural repairs or modifications		
19. Air blower room	No civil structural repairs or modifications		
20. Power station	No civil structural repairs or modifications		
21. Sub-station	No civil structural repairs or modifications		
22. Reception	No civil structural repairs or modifications		
23. Administration	No civil structural repairs or modifications		
24. Service Water Pumping Station	No civil structural repairs or modifications		
25. Main laboratory	No civil structural repairs or modifications		

WET SIDE

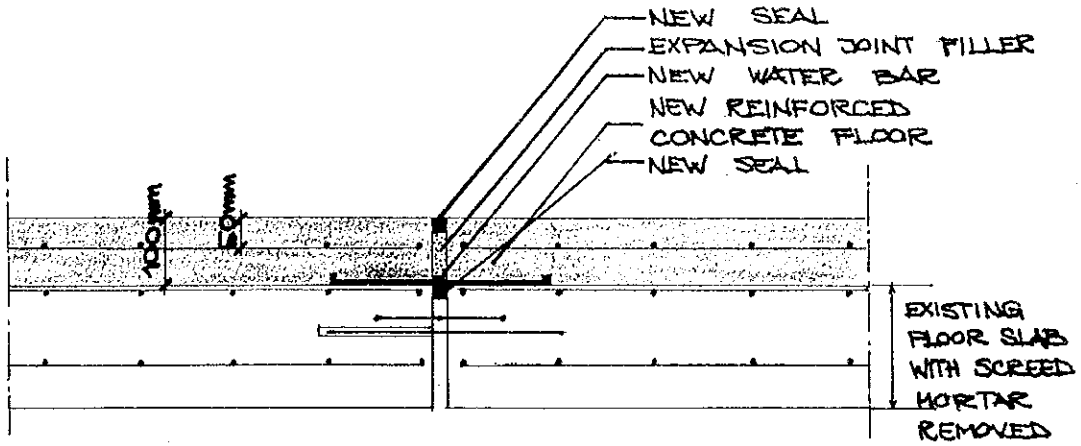


DRY SIDE

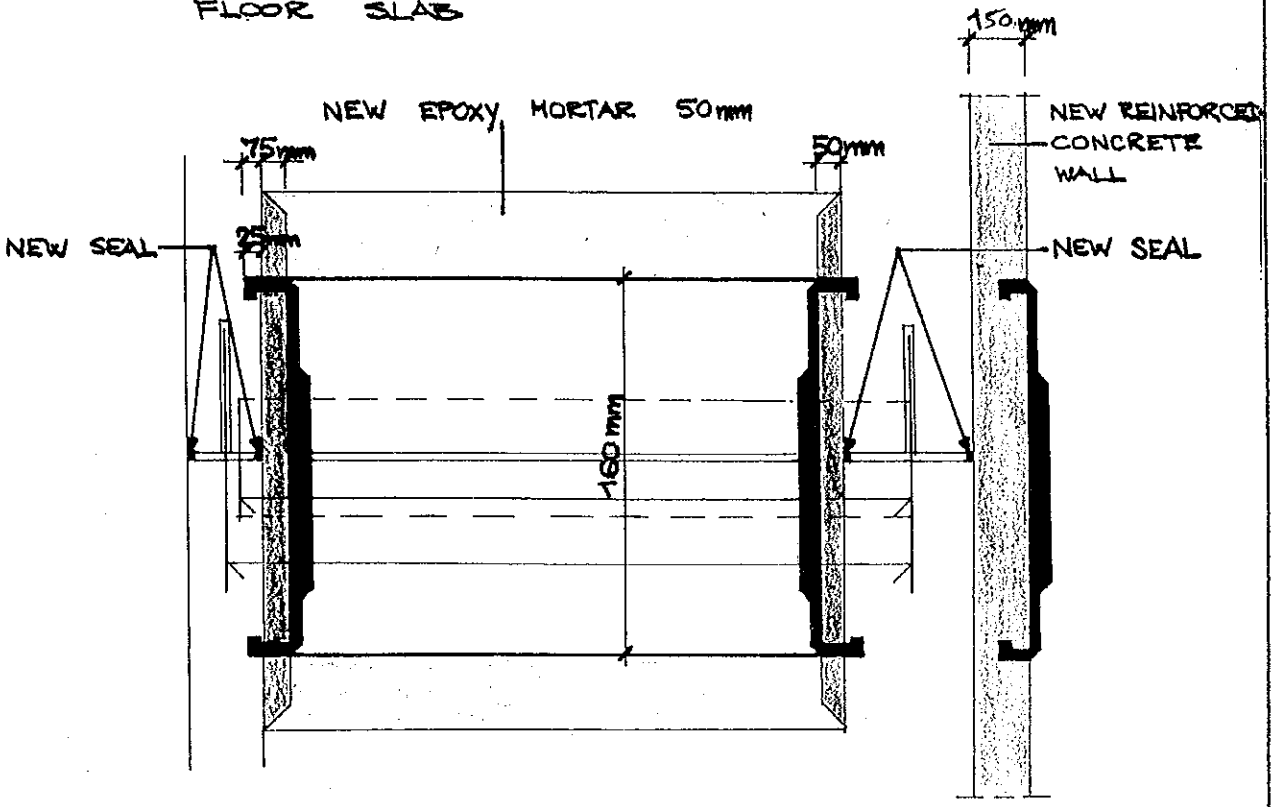
Date: Jul/99	FEASIBILITY STUDY ON THE WASTEWATER TREATMENT PLANT OF SARAJEVO	Design Ref. No.
Scale: NTS	Proposed Wall Repair - Typical Detail	Figure 6.1



Date: Jul/99	FEASIBILITY STUDY ON THE WASTEWATER TREATMENT PLANT OF SARAJEVO	Design Ref. No.
Scale: NTS	Proposed Expansion Joint Repair- Typical Wall & Floor Section	Figure 6.2

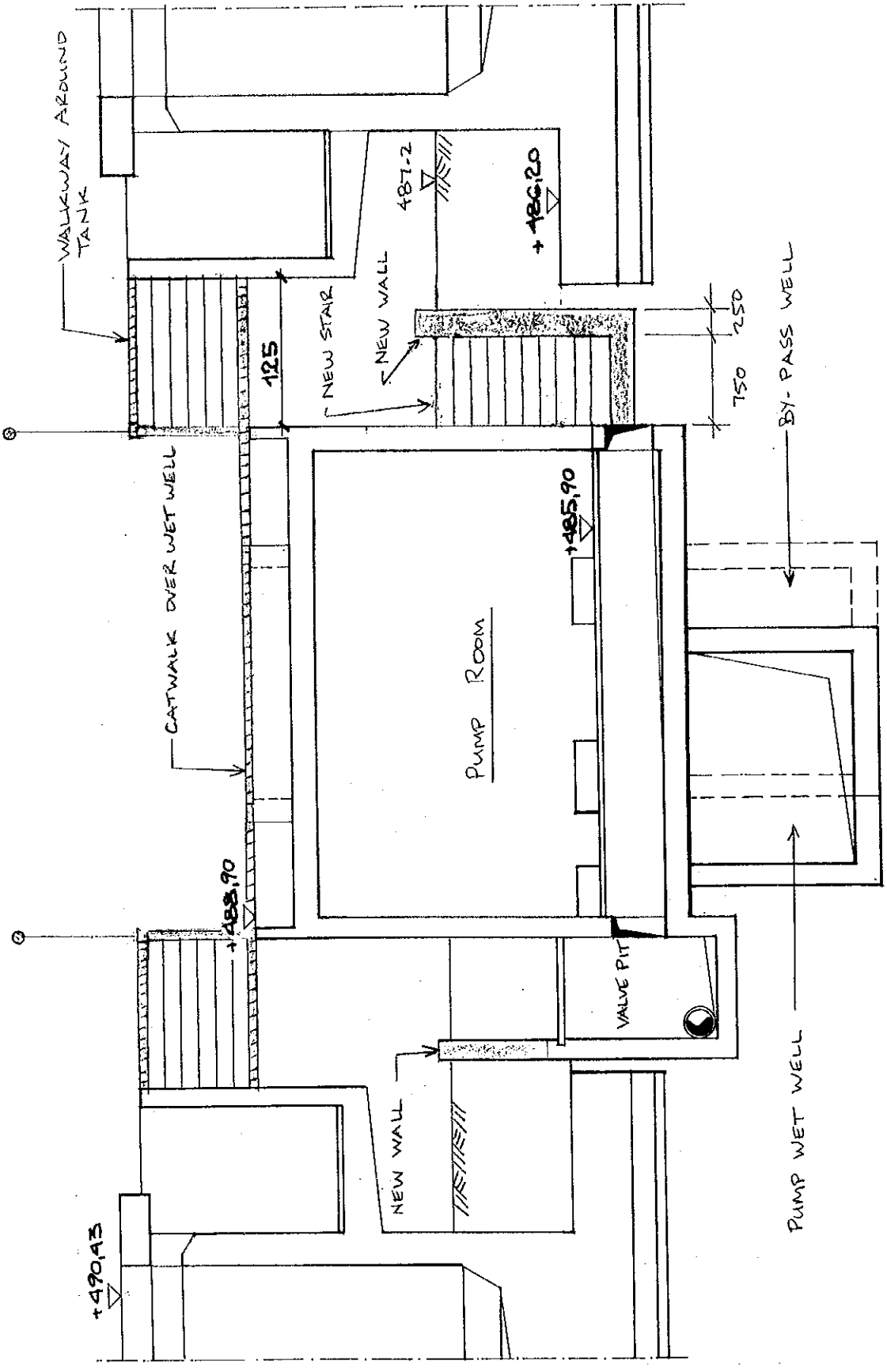


SECTION 5
FLOOR SLAB

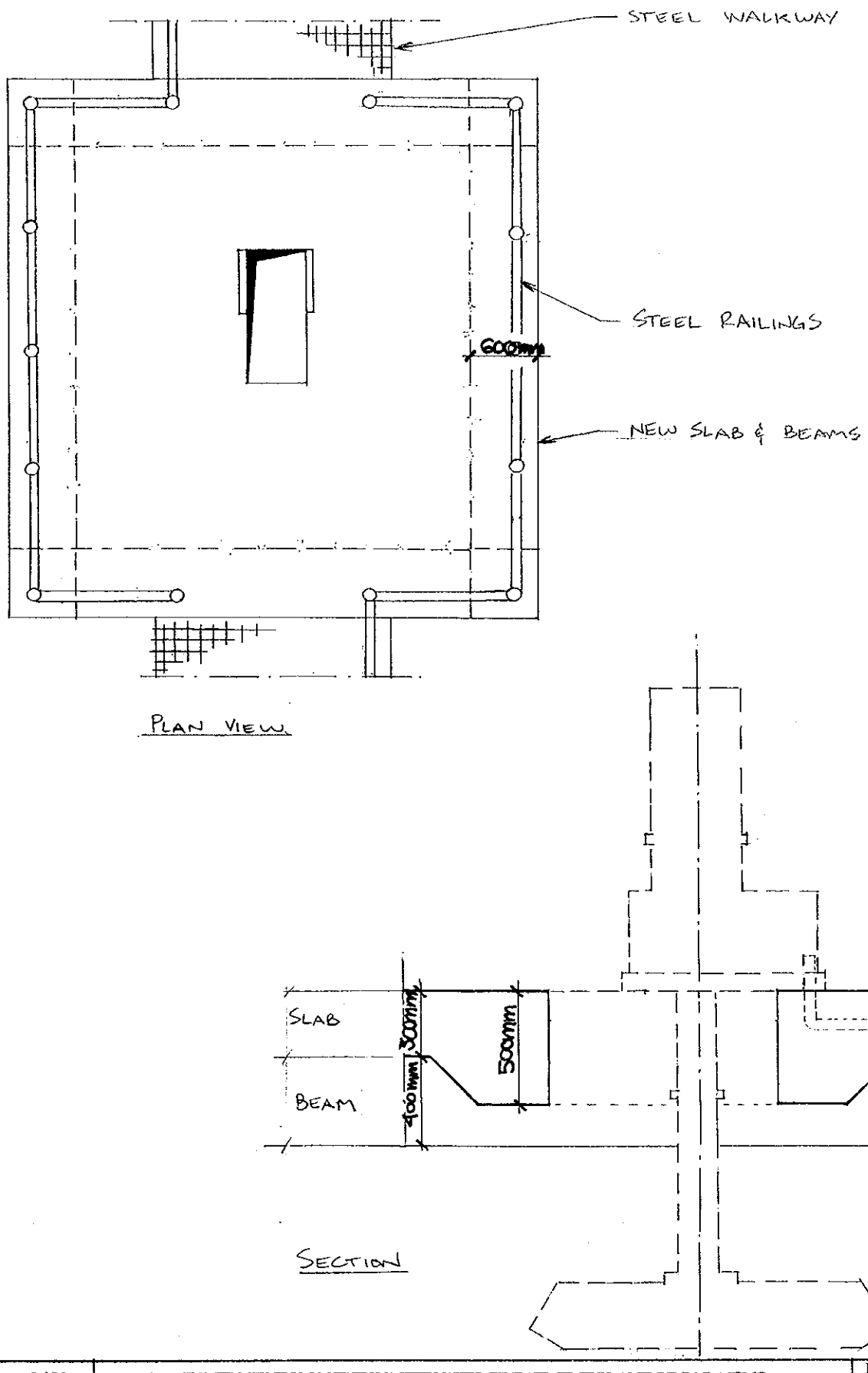


SECTION 4
EFFLUENT LAUNDER

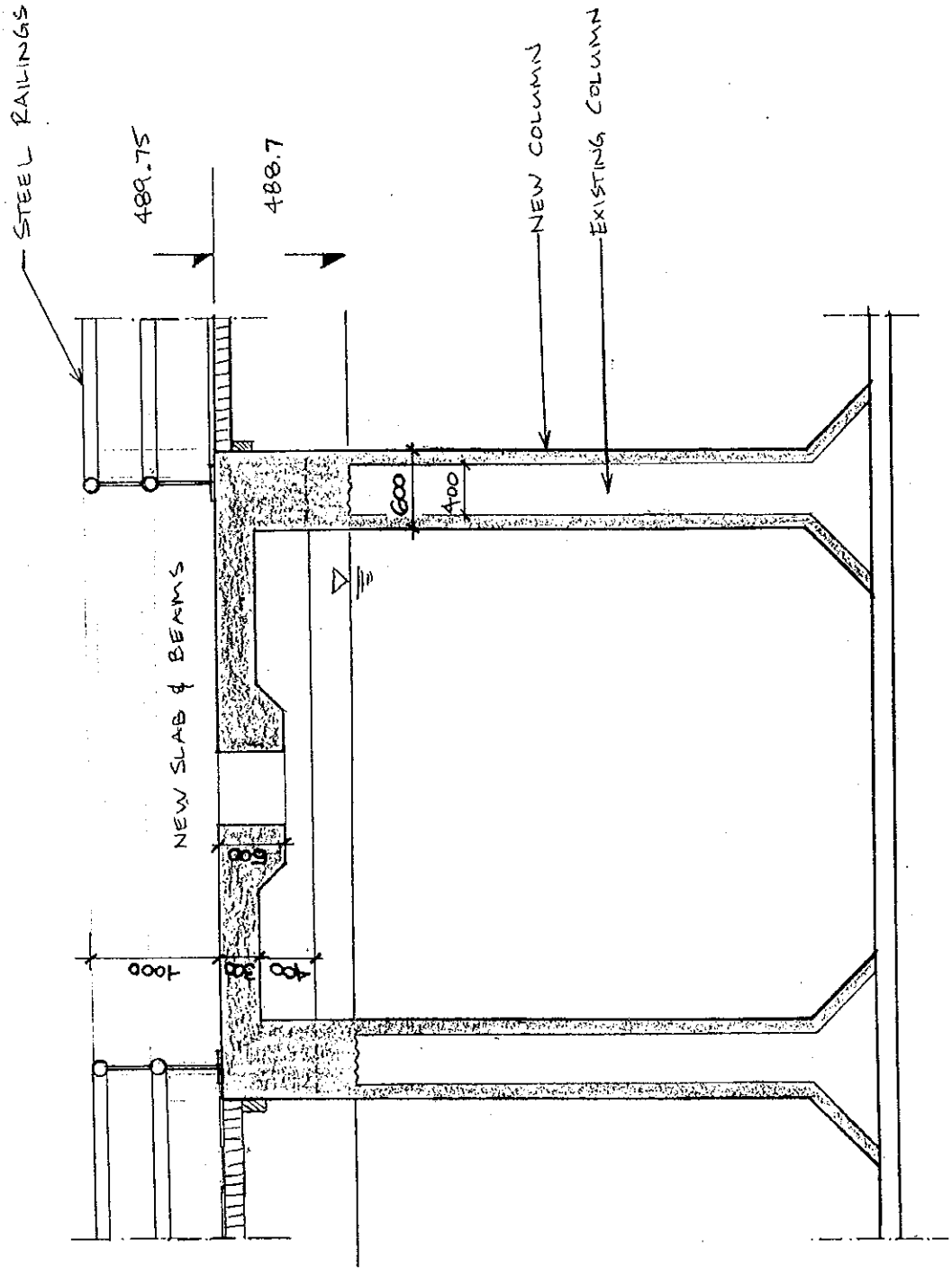
Date: Jul/99	FEASIBILITY STUDY ON THE WASTEWATER TREATMENT PLANT OF SARAJEVO	Design Ref. No.
Scale: NTS	Proposed Expansion Joint Repair- Typical Details	Figure 6.3



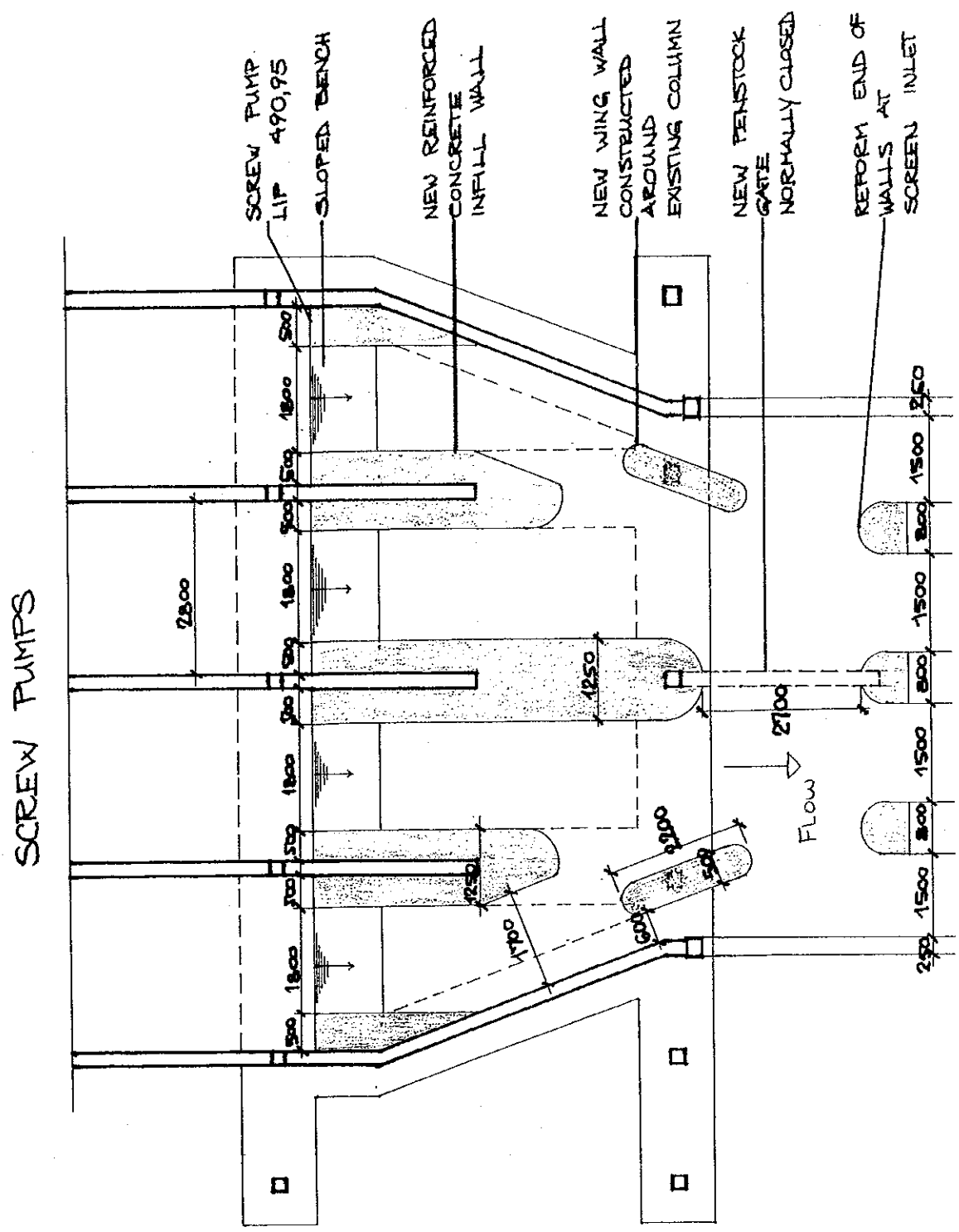
Date: Jul/99	FEASIBILITY STUDY ON THE WASTEWATER TREATMENT PLANT OF SARAJEVO	Design Ref. No.
Scale: NTS	Primary Sedimentation Tank- Proposed Backfill (Sectional View)	Figure 6.4



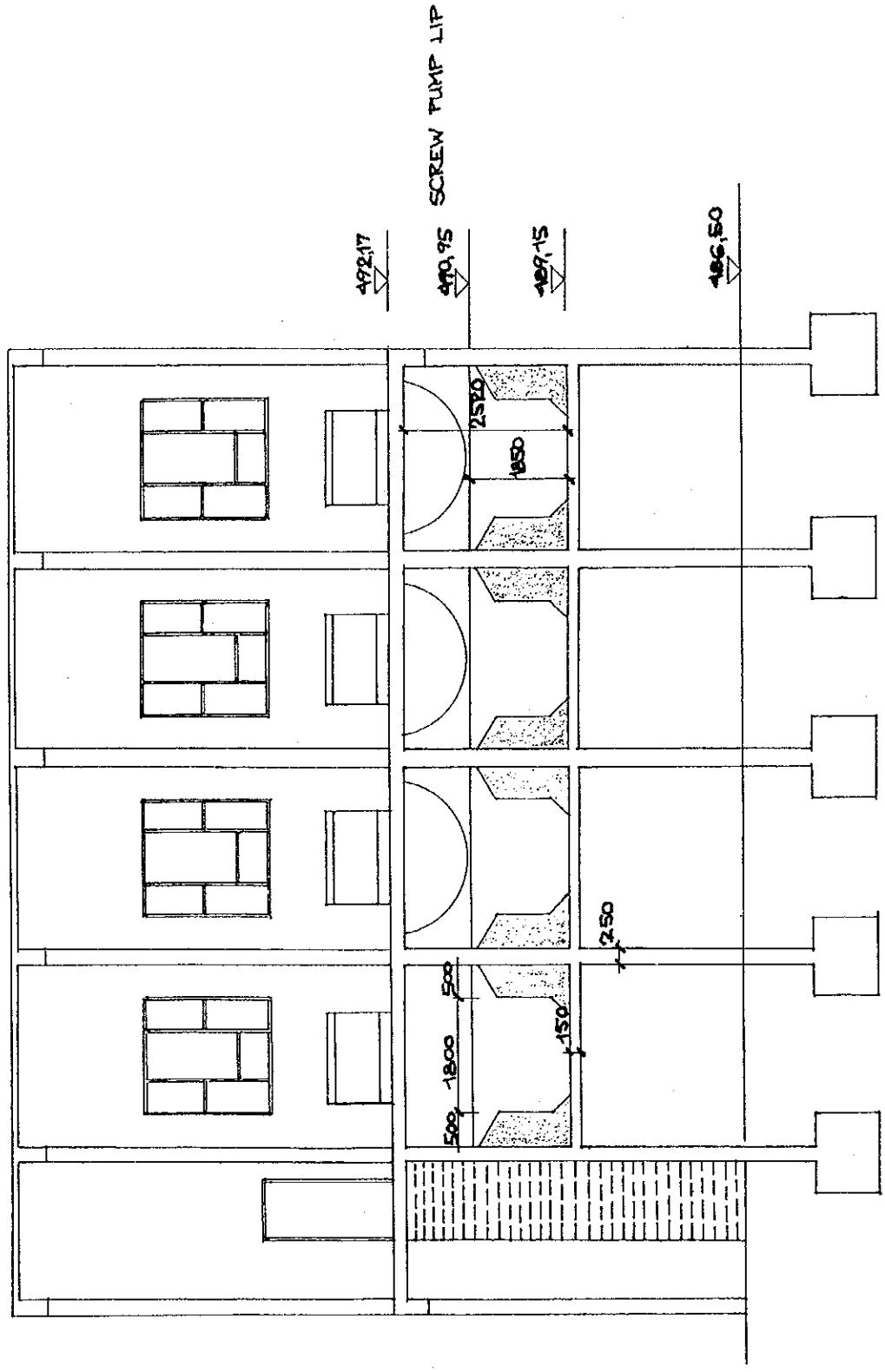
Date: Jul/99	FEASIBILITY STUDY ON THE WASTEWATER TREATMENT PLANT OF SARAJEVO	Design Ref. No.
Scale: NTS	Surface Aerators - Proposed Slab Re-construction Plan & Detail	Figure 6.5



Date: Jul/99	FEASIBILITY STUDY ON THE WASTEWATER TREATMENT PLANT OF SARAJEVO	Design Ref. No.
Scale: NTS	Surface Aerators - Proposed Slab Re-construction Section	Figure 6.6



Date: Jul/99	FEASIBILITY STUDY ON THE WASTEWATER TREATMENT PLANT OF SARAJEVO	Design Ref. No.
Scale: NTS	Screening Room- Proposed Modifications to Inlet (Plan View)	Figure 6.7(1)



Date: Jul/99	FEASIBILITY STUDY ON THE WASTEWATER TREATMENT PLANT OF SARAJEVO	Design Ref. No.
Scale: NTS	Screening Room- Proposed Modifications to Inlet (Sectional View)	Figure 6.7(2)

6.3 PRELIMINARY DESIGN FOR ARCHITECTURAL WORK

6.3.1 Outline of Construction for the New Facility Structure

(1) Pre-treatment and Pre-screening (OA&OB)

Building Area:	434.90 m^3
Structure:	reinforced concrete columns, iron frame beams
Walls:	brick
Roof:	metal
Other:	heavy-duty ceiling crane

(2) Boiler and Generator House (B)

Building Area:	874.08 m^2
Structure:	reinforced concrete columns and beams, iron frame beam for generator room
Roof:	asphalt waterproof and metal roof for generator room
Others:	ceiling crane

6.3.2 Condition on Architectural Standard

(1) Law/Regulation on Architectural Standard

Presently, there is no law/regulation on Architectural Standard enforce for Bosnia and Hazegovina. However, the German Standard is being applied particularly in Sarajevo. The Japanese Standard may also be applied for this project.

(2) Structure

Other Structural design criteria are as follows:

Snowfall:	120cm; Snowfall weight: 75kg/cm^2
Wind velocity:	60kg/cm^2 (material 2)
Soil Capacity:	11t/m^2 approximate (borehole work is required for detailed design process)
Type of subsoil:	clay

(3) Natural Condition

Temperature:	37.4℃ - absolute maximum
	Minus 17℃ - absolute minimum
Frost data:	80 cm
Ground water level:	+ 485.80 m

Earthquake may also occur in this region. The principle of structural design in Sarajevo is the same as the Japanese Standard such as the Foundation coefficient, coefficient for civil of importance, except for the seismic coefficient, K = 0.03 which is very low.

6.3.3 RAW WATER PUMPING STATION(Facility No1)

ITEM	ASSESSMENT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHMIDT HAMMER TEST SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	RECONSTRUCTION IS NOT NECESSARY.
EXTERIOR FINISH	PEELED MORTAR CAN BE SEEN AT THE ENTIRE EXTERIOR WALL, THE BRICK ITSELF IS STRONG. BUT FINISHING IS PEELING OFF, AND THE STAIN IS AWFUL.	BROKEN PART OF THE WALL MUST BE REPAIRED WITH MORTARING,AND FINISHING MUST BE DONE FOR THE ENTIRE WALL.
WATERPROOF ON ROOF	TRACES OF LEAKAGE IS VISIBLE INSIDE THE BUILDING.CORROSION OF THE COPING IS SERIOUS.	ENTIRE WATERPROOFING AND COPING ARE NECESSARY.
FITTINGS	OVERALL CORROSION IS SEVERE, PART OF THE FITTINGS ARE MISSING.	GENERAL REPLACEMENT IS REQUIRED.
INTERIOR FINISH	THE STAIN IS ENTIRELY AWFUL. MORTAR IS FLOATED PARTLY.	REPAIR WITH MORTAR AND ENTIRE FINISHING MUST REDONE.
LIGHTING EQUIPMENT	SOME OF EQUIPMENT ARE MISSING. AND REST OF EQUIPMENT ARE CORRODED..	ALL LIGHTING EQUIPMENTTO BE REPLACED.RE-WIRING IS NECESSARY BY EXPOSED PIPING.
VENTILATION EQUIPMENT	BROKEN.	GENERAL REPLACEMENT IS REQUIRED.
HEATING EQUIPMENT	NOT EXISTING.	NEW EQUIPMENT NECESSARY.
SANITARY EQUIPMENT	-	-
FIRE EXTINGUISHER	NOT USEFUL,DUE TO SEVERE CORROSION.	APRROPRIATE FIRE DISTINGUISER IS NECESSARY SINCE IT IS DENGEROUS TO USE WATER EXTINGUISER TO ELECTRIC CAUSED FIRE IN PUMP ROOM,EXTINGUISHER FOR ELECTRIC CAUSED FIRE MUST BE EQUIPED.
OTHERS	CONCRETE OF THE EXTERIOR STAIRS HAS DETERIORATES,AND THE REINFORCEMENT MATERIALS ARE EXPOSED.	RECONSTRUCTION IS NECESSARY.

6.3.4 SCREENING STATION(Facility No2)

ITEM	ASSESSMENT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHMIDT HAMMER TEST SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	RECONSTRUCTION IS NOT NECESSARY.
EXTERIOR FINISH	PEELED MORTAR CAN BE SEEN AT THE ENTIRE EXTERIOR WALL, THE BRICK ITSELF IS STRONG. BUT FINISHING IS PEELING OFF, AND THE STAIN IS AWFUL.	BROKEN PART OF THE WALL MUST BE REPAIRED WITH MORTARING,AND FINISHING MUST BE DONE FOR THE ENTIRE WALL.
WATERPROOF ON ROOF	TRACES OF LEAKAGE IS VISIBLE INSIDE THE BUILDING.CORROSION OF THE COPING IS SERIOUS.	ENTIRE WATERPROOFING AND COPING ARE NECESSARY.
FITTINGS	OVERALL CORROSION IS SEVERE, PART OF THE FITTINGS ARE MISSING.	GENERAL REPLACEMENT IS REQUIRED.
INTERIOR FINISH	THE STAIN IS ENTIRELY AWFUL. MORTAR IS FLOATED PARTLY.	REPAIR WITH MORTAR AND ENTIRE FINISHING MUST REDONE.
LIGHTING EQUIPMENT	SOME OF EQUIPMENT ARE MISSING. AND REST OF EQUIPMENT ARE CORRODED..	ALL LIGHTING EQUIPMENTTO BE REPLACED.RE-WIRING IS NECESSARY BY EXPOSED PIPING.
VENTILATION EQUIPMENT	BROKEN.	GENERAL REPLACEMENT IS REQUIRED.
HEATING EQUIPMENT	NOT EXISTING.	NEW EQUIPMENT NECESSARY.
SANITARY EQUIPMENT	-	-
FIRE EXTINGUISHER	NOT USEFUL,DUE TO SEVERE CORROSION.	APRROPRIATE FIRE DISTINGUISER IS NECESSARY SINCE IT IS DENGEROUS TO USE WATER EXTINGUISER TO ELECTRIC CAUSED FIRE IN PUMP ROOM,EXTINGUISHER FOR ELECTRIC CAUSED FIRE MUST BE EQUIPED.
OTHERS	CONCRETE OF THE EXTERIOR STAIRS HAS DETERIORATES,AND THE REINFORCEMENT MATERIALS ARE EXPOSED.	RECONSTRUCTION IS NECESSARY.

6.3.5 RECYCLED SLUDGE PUMPING STATION(Facility No8)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHMIDT HAMMER TEST SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	RECONSTRUCTION IS NOT NECESSARY.
EXTERIOR FINISH	PEELED MORTAR CAN BE SEEN AT THE ENTIRE EXTERIOR WALL. THE BRICK ITSELF IS STRONG. BUT FINISHING IS PEELING OFF,AND THE STAIN IS AWFUL.	BROKEN PART OF THE WALL MUST BE REPAIRED WITH MORTARING,AND FINISHING MUST BE DONE FOR THE ENTIRE WALL.
WATERPROOF ON ROOF	NO TRACE OF LEAKAGE CAN BE SEEN FROM INSIDE OF THE BUILDING,BUT ITS DURABILITY LIFE(10 YEARS) HAS LAPSED. COPING IS HEAVILY CORRODED.	OVERALL REPLACEMENT OF COPING AND WATERPROOFING IS REQUIRED.
FITTINGS	OVERALL CORROSION IS SEVERE, PART OF THE FITTINGS ARE MISSING.	GENERAL REPLACEMENT IS NECESSARY.
INTERIOR FINISH	THE STAIN IS ENTIRELY AWFUL.WE CAN SEE PART OF MORTAR IS FLOATED.	REPAIR IN MORTAR AND ENTIRE FINISHING MUST BE REDONE.
LIGHTING EQUIPMENT	SOME OF EQUIPMENT ARE MISSING. REST OF EQUIPMENTS ARE CORRODED..	AL LIGHTING EQUIMENTS TO REPLACED AND RE-WIRING IS NECESSARY BY EXPOSING PIPING.
VENTILATION EQUIPMENT	-	-
HEATING EQUIPMENT	NO EXISTING.	NEW EQUIPMENTS NECESSARY.
SANITARY EQUIPMENT	-	-
FIRE EXTINGUISHER	-	APPROPRIATE FIRE EXTINGUISHER IS NECESSARY.
OTHERS	CONCRETE OF THE EXTERIOR STAIRS HAS DETERIORATES.AND THE REINFORCEMENT MATERIALS ARE EXPOSED.	RECONSTRUCTION IS NECESSARY.

6.3.6 PRIMARY SLUDGE PUMPING STATION(Facility No9)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHMIDT HAMMER TEST SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	RECONSTRUCTION IS NOT NECESSARY.
EXTERIOR FINISH	FINISHING ARE PEELING OFF, AND STAIN IS AWFUL.	BROKEN PART OF THE WALL MUST BE REPAIRED WITH MORTARING,AND FINISHING MUST BE DONE FOR THE ENTIRE WALL.
WATERPROOF ON ROOF	TRACES OF LEAKAGE IS VISIBLE INSIDE THE BUILDING.CORROSION OF THE COPING IS SERIOUS.	ENTIRE WATERPROOFING AND COPING ARE NECESSARY.
FITTINGS	OVERALL CORROSION IS SEVERE, PART OF THE FITTINGS ARE MISSING.	GENERAL REPLACEMENT IS REQUIRED.
INTERIOR FINISH	THE STAIN IS ENTIRELY AWFUL. MORTAR IS FLOATED PARTLY.	REPAIR IN MORTAR AND ENTIRE FINISHING MUST BE REDONE.
LIGHTING EQUIPMENT	EQUIPMENTS ARE MISSING.	ALL LIGHTING EQUIPMENT TO BE REPLACED. RE-WIRING IS NECESSARY BY EXPOSED PIPING.
VENTILATION EQUIPMENT	-	-
HEATING EQUIPMENT	NOT EXISTING.	NEW EQUIPMENT NECESSARY.
SANITARY EQUIPMENT	-	-
FIRE EXTINGUISHER	-	APROPRIATE FIRE EXTINGUISHER IS NECESSARY.
OTHERS	THERE ARE TRACES OF FLOOD ON WALLS	THE PILE OF SOIL FROM THE CIVIL WORK ON THE PRIMARY SEDIMENTATION TANK MAY HAD CAUSED FLOODING IN THIS BUILDING. SUMP PUMP IS NECESSARY TO AVOID FLOODING.

6.3.7 THICKENED SLUDGE PUMPING STATION(Facility No11)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHMIDT HAMMER TEST OF THE OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	RECONSTRUCTION IS NOT NECESSARY.
EXTERIOR FINISH	CONCRETE FINISH HAS CAUSED AWFUL STAIN ON WALLS.	MORTAR SPRAY FINISH IS REQUIRED THE SAME AS OTHER.
WATERPROOF ON ROOF	TRACES OF LEAKAGE IS VISIBLE INSIDE THE BUILDING.CORROSION OF THE COPING IS SERIOUS.	ENTIRE WATERPROOFING AND COPING ARE NECESSARY.
FITTINGS	OVERAL CORROSION IS SEVERE, PART OF THE FITTINGS ARE MISSING.	GENERAL REPLACEMENT IS REQUIRED.
INTERIOR FINISH	STAIN IS ENTIRELY AWFUL. MORTAR IS FLOATED PARTLY.	OVERALL RE-FINISHING WORK IS NECESSARY.
LIGHTING EQUIPMENT	NOT EXISTING.	ALL LIGHTING EQUIPMENT TO BE REPLACED. RE-WIRING IS NECESSARY BY EXPOSED PIPING.
VENTILATION EQUIPMENT	-	-
HEATING EQUIPMENT	NOT EXISTING.	NEW EQUIPMNT NECESSARY.
SANITARY EQUIPMENT	-	-
FIRE EXTINGUISHER	HEAVILY CORRODED.	APPROPRIATE FIRE EXTINGUISHER IS NECESSARY.
OTHERS	THERE ARE TRACES OF FLOOD ON WALLS.	PUMP STAND MUST BE ELEVATED(+486.80) TO PREVENT FROM FLOODING.

6.3.8 BOILER HOUSE(Facility No13)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHMIDT HAMMER TEST OF THE OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	
EXTERIOR FINISH	DAMAGE CAN BE SEEN PARTRY ON THE WALL. FINISHING IS PEELING OFF AND HAS STAINS.	
WATERPROOF ON ROOF	NO TRACE OF LEAKAGE CAN BE SEEN FROM INSIDE OF THE BUILDING,BUT ITS DURABILITY LIFE(10 YEARS) HAS LAPSED. COPING IS HEAVILY CORRODED.	
FITTINGS	OVERALL CORROSION IS SEVERE. PART OF THE FITTINGS ARE MISSING.	
INTERIOR FINISH	STAIN IS ENTIRELY AWFUL. MORTAR IS PEELING OFF PARTLY.	ELEVATION OF THE BOILER HOUSE IS LOW.(IT IS IMPOSSIBLE FOR PIPING).AND IT IS IMPOSSIBLE TO ELEVATE THE STAND FOR AVOIDING FLOOD. IT MUST BE NEWLY CONSTRUCTED AS BOILER STATION AT PRESENT LOCATION WITH GENERETOR HOUSE.
LIGHTING EQUIPMENT	BROKEN	
VENTILATION EQUIPMENT	-	
HEETING EQUIPMENT	NOT EXISTING.	
SANITARY EQUIPMENT	-	
FIRE EXTINGUISHER	CORROSION IS SEVERE, IT IS NOT AVAILABLE.	
OTHERS	THERE ARE TRACES OF FLOOD ON WALLS.	

6.3.9 GAS COMPRESSOR STATION(Facility No14)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHMIDT HAMMER TEST OF THE OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	RECONSTRUCTION IS NOT NECESSARY.
EXTERIOR FINISH	DAMAGE CAN BE SEEN PARTRY ON THE WALL. FINISHING IS PEELING OFF AND HAS STAINS.	WALL MUST BE REPAIRED AND OVERALL FINISHING IS NECESSARY.
WATERPROOF ON ROOF	NO TRACE OF LEAKAGE CAN BE SEEN FROM INSIDE OF THE BUILDING,BUT ITS DURABILITY LIFE(10 YEARS) HAS LAPSED. COPING IS HEAVILY CORRODED.	OVERALL REPLACEMENT OF COPING AND WATERPROOFING IS REQUIRED.
FITTINGS	OVERALL CORROSION IS SEVERE, PART OF THE FITTINGS ARE MISSING.	GENERAL REPAIRMENT IS REQUIRED.
INTERIOR FINISH	STAIN IS ENTIRELY AWFUL. PART OF MORTAR IS PEELING OFF.	REPAIR WITH MORTAR AND ENTIRE FINISHING MUST REDONE.
LIGHTING EQUIPMENT	BROKEN	ALL LIGHTING EQUIPMENTTO BE REPLACED.RE-WIRING IS NECESSARY BY EXPOSED PIPING.
VENTILATION EQUIPMENT	BROKEN	NEW VENTILATION EQUIPMENT IS REQUIRED.
HEATING EQUIPMENT	NO EQUIPMENT IS EXISTED.	NEW EQUIPMENT NECESSARY.
SANITARY EQUIPMENT	-	-
FIRE EXTINGUISHER	NOT USEFUL DUE TO SEVERE CORROSION.	APPROPRIATE FIRE EXTINGUISHER IS NECESSARY.
OTHERS	THERE ARE TRACES OF FLOODING ON WALLS	FLATFORM FOR GAS COMPRESSOR AND PUMP MUST BE ELEVATED(+486.80), TO PREVENT FROM FLOOD.

6.3.10 SLUDGE PUMPING STATION(Facility No17)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHMIDT HAMMER TEST OF THE OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.COLUMN REINFORCEMENT IS PARTLY EXPOSED.	AFFECTED COLUMN NEEDS REPAIR.
EXTERIOR FINISH	DAMEGE CAN BE SEEN PARTLY ON WALLS. FINISHINGS ARE FLOATED, AND IT HAS STAINS.	IT MUST BE REPAIRED ON WALLS,AND FINISHING HAS TO BE DONE ENTIRELY.
WATERPROOF ON ROOF	ONLY PART OF THE LEAKING PORTION HAS BEEN REPAIRED AS CAN BE SEEN FROM INSIDE OF THE BUILDING.THE DURABLE YEARS OF THE WATERPROOFING MATERIAL HAS LASPED.COPING IS SEVERELY CORRODED.	WATERPROOF AND COPING MUST BE ENTIRELY REPLACED.
FITTINGS	WINDOWS HAD BEEN REPAIRED.	DOOR MUST BE NEWLY REPLACED.
INTERIOR FINISH	STAINS IS AWFUL OVERALL.IT CAN BE SEEN MORTAR WHICH IS FLOATED PARTLY.	IT MUST BE REPAIRED ON MORTAR,AND FINISHING MUST BE DONE OVERALL.
LIGHTING EQUIPMENT	SOME EQUIPMENTS ARE MISSING,AND EXISTING EQUIPMENTS ARE BROKEN.	IT MUST BE NEWLY EQUIPPED OVERAL.WIRING MUST BE DONE BY EXPOSED PIPING.
VENTILATION EQUIPMENT	BROKEN	NEW EQUIPMENT NECESSARY.
HEATING EQUIPMENT	NO EQUIPMENT EXIST.	IT MUST BE NEWLY EQUIPPED ENTIRELY.
SANITARY EQUIPMENT	NO EQUIPMENT EXIST.	IT MUST BE NEWLY EQUIPPED.
FIRE EXTINGUISHER	CORROSIONS ARE AWFUL AND NOT AVAILABLE.	IT MUST BE REPAIRED.
OTHERS	THERE ARE TRACES OF FLOOD ON WALLS.	IT IS NEEDED TO HAVE A PLAN TO PREVENT FLOODING.

6.3.11 SLUDGE DEHYDRATION(Facility No18)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHMIDT HAMMER TEST OF THE OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.COLUMN REINFORCEMENT IS PARTLY EXPOSED.	AFFECTED COLUMN NEEDS REPAIR.
EXTERIOR FINISH	DAMEGE CAN BE SEEN PARTLY ON WALLS. FINISHINGS ARE FLOATED, AND IT HAS STAINS.	IT MUST BE REPAIRED ON WALLS,AND FINISHING HAS TO BE DONE ENTIRELY.
WATERPROOF ON ROOF	ONLY PART OF THE LEAKING PORTION HAS BEEN REPAIRED AS CAN BE SEEN FROM INSIDE OF THE BUILDING.THE DURABLE YEARS OF THE WATERPROOFING MATERIAL HAS LASPED.COPING IS SEVERELY CORRODED.	WATERPROOF AND COPING MUST BE ENTIRELY REPLACED.
FITTINGS	WINDOWS HAD BEEN REPAIRED.	DOOR MUST BE NEWLY REPLACED.
INTERIOR FINISH	STAINS IS AWFUL OVERALL.IT CAN BE SEEN MORTAR WHICH IS FLOATED PARTLY.	IT MUST BE REPAIRED ON MORTAR,AND FINISHING MUST BE DONE OVERALL.
LIGHTING EQUIPMENT	SOME EQUIPMENTS ARE MISSING,AND EXISTING EQUIPMENTS ARE BROKEN.	IT MUST BE NEWLY EQUIPPED OVERAL.WIRING MUST BE DONE BY EXPOSED PIPING.
VENTILATION EQUIPMENT	BROKEN	NEW EQUIPMENT NECESSARY.
HEATING EQUIPMENT	NO EQUIPMENT EXIST.	IT MUST BE NEWLY EQUIPPED ENTIRELY.
SANITARY EQUIPMENT	NO EQUIPMENT EXIST.	IT MUST BE NEWLY EQUIPPED.
FIRE EXTINGUISHER	CORROSIONS ARE AWFUL AND NOT AVAILABLE.	IT MUST BE REPAIRED.
OTHERS	THERE ARE TRACES OF FLOOD ON WALLS.	IT IS NEEDED TO HAVE A PLAN TO PREVENT FLOODING.

6.3.12 AIR BLOWER ROOM(Facility No19)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHMIDT HAMMER TEST FOR OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	RECONSTRUCTION IS NOT NECESSARY.
EXTERIOR FINISH	SOME STAINS ARE VISIBLE.	CONSIDERING THE COMTRAST AMONG OTHER BUILDINGS,FINISHING MUST BE DONE ENTIRELY.
WATERPROOF ON ROOF	THERE ARE SOME TRACES OF LEAKING WATER INSIDE THE BUILDING.	REPLACEMENT FOR WATERPROOFING AND COPING IS REQUIRED.
FITTINGS	CORROSIONS ARE SEVERE ENTIRELY.	REPLACEMENT IS REQUIRED ENTIRELY.
INTERIOR FINISH	STAINS ARE ENTIRELY AWFUL.	FINISHING MUST BE DONE ENTIRELY.
LIGHTING EQUIPMENT	BROKEN	REPLACEMENT IS REQUIRED ENTIRELY.RE-WIRING IS NECESSARY BY EXPOSED PIPING.
VENTILATION EQUIPMENT	BROKEN	NEW EQUIPMENT NECESSARY.
HEATING EQUIPMENT	NO EQUIPMENT EXIST.	NEW EQUIPMENT NECESSARY.
SANITARY EQUIPMENT	-	-
FIRE EXTINGUISHER	-	-
OTHERS	THERE ARE TRACES OF FLOOD ON WALLS	BLOWER STAND AND PUMP STAND MUST BE ELEVATED(+468.80) TO PREVENT FLOODING.

6.3.13 POWER STATION(Facility No20)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHMIDT HAMMER TEST FOR OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED. REINFORCING STEEL IS PARTLY EXPOSED.	AFFECTED COLUMN NEEDS REPAIRMENT.
EXTERIOR FINISH	DAMEGE CAN BE SEEN PARTLY ON WALLS. FINISHINGS ARE FLOATED, AND HAS STAINS.	REPAIRMENT IS REQUIRED ON WALLS AND FINISHING MUST BE REDONE ENTIRELY.
WATERPROOF ON ROOF	THERE ARE NO TRACES OF LEAKING INSIDE OF BUILDING. ALTHOUGH MATERIALS FOR WATERPROOF HAD PASSED ITS GENERAL DURABLE YAERS(10 YEARS).CORROSION ON COPING IS AWFUL.	ROOF ON THE GENERETOR ROOM HAD BEEN REPAIED YET. OTHER ROOF AND COPING MUST BE ENTIRELY REPLACED.
FITTINGS	CORROSIONS ARE SEVERE, AND SOME FITTINGS ARE MISSING.	IT MUST BE ENTIRELY REPLACED.
INTERIOR FINISH	AWFUL STAINS AND FLOATED MORTARS ARE VISIBLE.	IT MUST BE REPAIRED BY MORTARING. ENTIRE FINISHING MUST BE REDONE.
LIGHTING EQUIPMENT	SOME EQUIPMENTS ARE MISSING,SOME ARE BROKEN.	IT MUST BE NEWLY EQUIPPED OVERALL.RE-WIRING IS NECESSARY BY EXPOSED PIPING.
VENTILATION EQUIPMENT	BROKEN.	NEW EQUIPMENT NECESSARY.
HEETING EQUIPMENT	NOT EXISTING.	NEW EQUIPMENT NECESSARY.
SANITARY EQUIPMENT	NOT EXISTING.	NEW EQUIPMENT NECESSARY.
FIRE EXTINGUISHER	IT IS NOT USEFUL DUE TO ITS AWFUL CORROSION.	APROPRIATE FIRE EXTINGUISHER IS NECESSARY.
OTHERS	THERE ARE TRACES OF FLOOD ON WALLS OF THE ELECRICAL ROOM.	FLOOR OF ELECTRICAL ROOM MUST BE ELEVATED(+468.80) TO PREVENT.AND GENERATOR ROOM MUST BE MOVED AND NEWLY CONSTRUCTED RIGHT NEXT TO BOILER HOUSE FOR SAME REASON AND SEEKING THE EFFICIENCY.

6.3.14 SUBSTATION(Facility No21)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHDMIT HAMMER TEST FOR OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	REPAIRMENT IS NOT NECESSARY.
EXTERIOR FINISH	THERE ARE SOME FLOATINGS AND STAINS ON FINISHING.	ENTIRE FINISING MUST BE DONE.
WATERPROOF ON ROOF	THERE ARE TRACES OF LEAKING WATER INSIDE THE BUILDING.	ENTIRE WATERPROOFING AND COPING MUST BE REPLACED.
FITTINGS	CORROSIONS IS ENTIRELY SEVERE. SOME FITTINGS ARE MISSING.	GENERAL REPLACEMENT IS REQUIRED.
INTERIOR FINISH	AWFUL STAINS ARE VISIBLE ENTIRELY.	ENTIRE FINISING MUST BE DONE.
LIGHTING EQUIPMENT	BROKEN.	ENTIRE EQUIPMENTS MUST BE NEWLY EQUIPPED.RE-WIRING IS NECESSARY BY EXPOSED PIPING.
VENTILATION EQUIPMENT	-	-
HEATING EQUIPMENT	-	-
SANITARY EQUIPMENT	-	-
FIRE EXTINGUISHER	-	-
OTHERS	THERE ARE TRACES OF FLOOD ON WALLS	FLOOR MUST BE ELEVATED(+486.80) TO PREVENT FLOOD.

6.3.15 RECEPTION(Facility No22)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHDMIT HAMMER TEST FOR OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	REPAIRMENT IS NOT NECESSARY.
EXTERIOR FINISH	IT HAS BEEN REPAIRED.	REPAIRMENT IS NOT NECESSARY.
WATERPROOF ON ROOF	IT HAS BEEN REPAIRED.	REPAIRMENT IS NOT NECESSARY.
FITTINGS	IT HAS BEEN REPAIRED.	REPAIRMENT IS NOT NECESSARY.
INTERIOR FINISH	IT HAS BEEN REPAIRED.	REPAIRMENT IS NOT NECESSARY.
LIGHTING EQUIPMENT	IT HAS BEEN REPAIRED.	REPAIRMENT IS NOT NECESSARY.
VENTILATION EQUIPMENT	-	-
HEATING EQUIPMENT	NOT EXISTING.	NEW EQUIPMENT NECESSARY.
SANITARY EQUIPMENT	IT HAS BEEN REPAIRED.	REPAIRMENT IS NOT NECESSARY.
FIRE EXTINGUISHER	IT HAS BEEN REPAIRED.	REPAIRMENT IS NOT NECESSARY.
OTHERS	-	-

6.3.16 ADMINISTRATION BUILDING A-BLOCK(Facility No23A)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHDMIT HAMMER TEST FOR OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	REPAIRMENT IS NOT NECESSARY.
EXTERIOR FINISH	FLOATED MORTARS ARE VISIBLE AT ENTIRE WALLS,BUT BRICK ITSELF IS HEALTHY.FLOATING AND STAINS ON FINISHIG ARE VISIBLE.	FLOATING PART MUST BE REPAIRED,AND FINSHNG MUST BE DONE COMPLETELY.
WATERPROOF ON ROOF	IT HAD BEEN REPAIRED ALREADY.	REPAIRMENT IS NOT NECESSARY.
FITTINGS	IT HAD BEEN REPAIRED ALMOST.	IT IS ALMOST NOT NEEDED TO BE REPAIRED.
INTERIOR FINISH	IT HAD BEEN REPAIRED ALMOST.	THERE ARE SLIGHT NEEDS FOR REPAIRING. Ex CENTRAL CONTROL ROOM.
LIGHTING EQUIPMENT	IT HAD BEEN REPAIRED ALMOST.	THERE ARE SLIGHT NEEDS FOR REPAIRING. Ex CENTRAL CONTROL ROOM.
VENTILATION EQUIPMENT	THERE IS NO VENTILATION FAN FOR EXAMINING WATER.	IT MUST BE EQUIPPED.
HEATING EQUIPMENT	NO EQUIPMENT EXISTS.	NEW EQUIPMENT NECESSARY.
SANITARY EQUIPMENT	SOME OF EQUIPMENTS ARE NOT REPAIRED.	IT IS REQUIRED TO REPAIR ALL THE EQUIPMENT.
FIRE EXTINGUISHER	SOME ARE REPAIRED,BUT MOST OF THOSE HAD NOT BEEN REPAIRED.	IT IS REQUIRED TO REPAIR ALL.
OTHERS	-	-

6.3.17 ADMINISTRATION BUILDING B-BLOCK(Facility N023B)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHDMIT HAMMER TEST FOR OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	REPAIRMENT IS NOT NECESSARY.
EXTERIOR FINISH	FLOATED MORTARS ARE VISIBLE AT ENTIRE WALLS. BRICK ITSELF IS HEALTHY.FLOATING AND STAINS ON FINISHIG ARE VISIBLE.	FLOATING PART MUT BE REPAIRED,AND ENTIRE FINSHNG MUST BE REDONE.
WATERPROOF ON ROOF	IT HAD BEEN REPAIRED ALREADY.	REPAIRMENT IS NOT NECESSARY.
FITTINGS	IT HAD BEEN REPAIRED ALMOST.	IT IS ALMOST NOT NEEDED TO BE REPAIRED.
INTERIOR FINISH	SOME ROOMS ARE NOT REPAIRED.	IT IS NEEDED TO BE REPARED.
LIGHTING EQUIPMENT	SOME ROOMS ARE NOT REPAIRED.	IT IS NEEDED TO BE REPARED.
VENTILATION EQUIPMENT	-	-
HEATING EQUIPMENT	NOT EXISTING.	NEW EQUIPMENT NECESSARY.
SANITARY EQUIPMENT	SOME OF EQUIPENTS ARE NOT REPAIRED.	IT IS NEEDED UNREPAIRED EQUIPMENTS TO BE REPAIRED.
FIRE EXTINGUISHER	SOME ARE REPAIRED,BUT MOST OF THOSE ARE NOT REPAIRED.	IT IS NEEDED TO BE REPARED.
OTHERS	-	-

6.3.18 ADMINISTRATION BUILDING C-BLOCK(Facility N023C)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHDMIT HAMMER TEST FOR OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	REPAIRMENT IS NOT NECESSARY.
EXTERIOR FINISH	FLOATED MORTARS ARE VISIBLE AT ENTIRE WALLS. BRICK ITSELF IS HEALTHY.FLOATING AND STAINS ON FINISHIG ARE VISIBLE.	FLOATING PART MUST BE REPAIRED.ENTIRE FINSHNG MUST BE REDONE.
WATERPROOF ON ROOF	IT HAD BEEN REPAIRED ALREADY.	IT IS NOT NEEDED TO BE REPAIRED.
FITTINGS	LARGE DOOR AT THE ENTRANCE IS NOT REPAIRED.	LARGE DOOR IS NEEDED TO BE REPAIRED
INTERIOR FINISH	IT IS NOT REPAIRED.	IT IS NOT NEEDED TO BE REPAIRED.
LIGHTING EQUIPMENT	IT IS NOT REPAIRED.	IT IS NOT NEEDED TO BE REPAIRED.
VENTILATION EQUIPMENT	-	-
HEATING EQUIPMENT	NOT EXISTING.	NEW EQUIPMENT NECESSARY.
SANITARY EQUIPMENT	-	-
FIRE EXTINGUISHER	SOME ARE REPAIRED,BUT MOST OF THOSE ARE NOT REPAIRED.	IT IS NEEDED TO BE ENTIRELY REPARED.
OTHERS	-	-

6.3.19 SERVICE WATER PUMPING STATION(Facility No24)

ITEM	ASSESSMENT RESULT	RECONSTRUCTION PLAN
STRUCTURE	THE BUILDING IS STRUCTURALLY SAFE SINCE THE RESULT OF THE SCHDMIT HAMMER TEST FOR OTHER BUILDING SHOWED ACTUAL CONCRETE STRENGTH HIGHER THAN THE DESIGNED.	REPAIRMENT IS NOT NECESSARY.
EXTERIOR FINISH	FLOATINGS AND STAINS ON FINISHING ARE VISIBLE.	ENTIRE FINISHING MUST BE REDONE.
WATERPROOF ON ROOF	THERE ARE NO TRACES OF LEAKING INSIDE OF BUILDING. ALTHOUGH MATERIALS FOR WATERPROOF HAD ALREADY PASSED ITS GENERAL DURABLE YAERS(10YEARS).CORROSION ON COPING IS AWFUL.	OVERALL WATERPROOFING AND COPING MUST BE REPLACED.
FITTINGS	CORROSIONS ARE ENTIRELY SEVERE.IT IS NOT USEFUL.	IT MUST BE ENTIRELY REPLACED.
INTERIOR FINISH	STAINS ARE ENTIRELY AWFUL.SOME MORTARS ARE FLOATING.	REPAIR WITH MORTAR AND ENTIRE FINISHING MUST BE REDONE.
LIGHTING EQUIPMENT	BROKEN.	IT MUST BE NEWLY EQUIPPED OVERALL.RE-WIRING IS REQUIRED BY EXPOSED PIPING.
VENTILATION EQUIPMENT	-	-
HEATING EQUIPMENT	NOT EXISTING.	SINCE THE LOCATION IS ISOLATED, IT NEEDS TO USE INDEPENDENT HEETING EQUIPMENTS(ex:ELECTRIC).
SANITARY EQUIPMENT	-	-
FIRE EXTINGUISHER	-	-
OTHERS	-	-

6.4 PRELIMINARY DESIGN FOR MECHANICAL WORK

6.4.1 Proposed Pre-Treatment (Facility No.0)

Proposed Pre-Treatment Facilities consist of 3 horizontal flow grit channels equipped with grab bucket having a capacity of 0.3 m^3, and followed by 3 sets of 50 mm automatic coarse screens, and 25 mm automatic medium screens of 2 m width each. The Pre-Treatment facility is planned to be installed upstream of Raw Water Pumping Station for the purpose of strengthening the grit discharging capacity of the existing screening station and the aerated grit chamber.

6.4.2 Pumping Station : Screw Pumps-Archimedean Spiral (Facility No.1)

Drive motors can be used, however reducers suffered many damages during operation before wartime. The grease lubrication systems to lower foot bearings are all broken or damaged severely. Only main shafts and screws are in good condition with anti corroded protection painting except minor scratch on top of the screws. Therefore drive units including necessary auxiliaries for lubrication need to be replaced. The screws and shafts require complete anti rust protection painting and readjustment.

Specification:

$78m^3$ / min × 8.91m × 160 kW screw pump	4 sets

6.4.3 Screening Station : Fine Screens (Facility No.2)

Existing 4 sets each of coarse screen and fine screen should be removed. And new 4 sets of fine screens with 6 mm opening are planed to install. The screen should be alternately arranged for easier maintenance and for an increase screening efficiency.

Specification:

6 mm opening × 1.5 m width automatic screen	4 sets

6.4.4 Aerated Grit Chamber : Sand Bridge Trap & Aerator System (Facility No.3)

Metal bridge construction is attacked severely by corrosion, the bridge drive motor is rusted and flexible electric cable is missing. The aeration system, made of galvanized pipe with nozzles for production of air bubbles is damaged heavily. At the bridge, there are mammoth pumps and pipe lines for sludge evacuation which are almost of no use. As a conclusion, the sand trap bridge with mammoth pumps including every necessary auxiliaries need to be renewed. As an anti-frozen countermeasure along the concrete rails of the sand trap bridge during wintertime, installation of electric heater sheets on top of the concrete rails covered with 50 mm concrete is recommended. This countermeasure is for the purpose of melting down the accumulated snow along the concrete rails. New sand trap bridge equipped with mammoth pumps having "jet mix suction" enable to suck much more grit than existing sand trap bridge.

Specification:

12 m width mobile sand trap bridge × 1.5 kW	1 set

6.4.5 Primary Sedimentation Tank: (Facility No.4)

The primary settling tanks are traction type driven on peripheral concrete rails. Drive motors of these unit are missing. Some diagonal members of mechanisms are rusted severely. Almost all bolts and nuts are corroded heavily. As a conclusion, drive units need to be changed with new one. The structures mechanism needs to be cleaned and applied with anti rust protection painting and readjustment. All bolts and nuts needs to be replaced with stainless steel.

Specification:

52 m diameter × 2.8 m depth × 1.5 kW traction type thickener 2 sets

6.4.6 Aeration Tank: Surface Aeration Turbines (Facility No.5)

Out of the 36 existing aerator turbine, 19 sets are concluded as usable after 2 hours of continuous load testing. These kind of machines should be installed on channel beam structure with at least three (3) flat liner sheets between aeration turbine base and the basement channels, leveled accurately and tightened by anchor bolts and liners welded to each other to avoid excessive vibration. Existing 36 turbines are installed on structure's reinforced steel bar, to which anchor bolts are welded on concrete slab and no liners exist. This installation method produces excessive vibration, although the test result shows the vibrations are within the allowable range. However, if these turbines are installed in the recommended method, the vibration would be much smaller resulting to a longer life of the turbines with reducer and rubber couplings. As to the rubber couplings with buckle steel, several quantities were found to be broken due to fatigue from repetitive tension. Therefore reasonable number of rubber expansion couplings with buckle steel are necessary to be stored as spare parts.

And we strongly recommend reinstallation of all 36 turbines by above mentioned proper method. Otherwise may cause unexpected danger in future.

Specification:

2 m diameter × 37 kW surface aeration turbine 36 sets

6.4.7 Final Sedimentation Tank: (Facility No. 6)

The drive motors of all 4 final sedimentation tanks are found missing and all drive heads are incomplete. The structure's mechanisms are partly attacked by rust and almost all bolts and nuts are corroded heavily. The structure's mechanisms need to be cleaning, anti protection of corroded parts, replacement of all the bolts and nuts with stainless steel and replacement of central sliding sleeves. The whole structure's mechanisms need anti rust protection painting. The drive units need to be replaced with new ones.

Specification:

52 m diameter × 3.0 m depth × 0.75 kW center drive thickener 4 sets

6.4.8 Flow Metering : (Facility No.7)

The flow metering facility exist almost nothing. The flow metering facility needs to be renewed. Therefore flow meter with transducer as well as all necessary auxiliaries need to be replaced with new one.

Specification:

Weir type flow meter with level meter and transducer 1 set

6.4.9 Recycled Sludge Pumping Station: Screw Pumps (Facility No.8)

Grease lubrication system for lower foot bearings are damaged severely. Drive motors could be utilized with minor repair work, however reducers seem damaged considerably. Therefore the drive units and foot bearings including all auxiliaries for oil and grease lubrication need to be replaced. The screws and shafts require anti rust protection painting and readjustment.

Specification:

200 m^3/hrs. × 8 m × 100 kW screw pump 2 sets

6.4.10 Primary Sludge Pumping Station: Torque Flow Type Pumps (Facility No. 9)

Three pumps are damaged severely and no drive motors exist. All pumps including necessary auxiliaries as well as drive motors need to be replaced with new ones.

Specification:

5.0 m^3/min × 11 m × 15 kW sludge pump with induce screw 2 sets

6.4.11 Sludge Thickener : (Facility No.10)

The drive motors of the 2 sludge thickeners are found missing, and drive head are incomplete. The structure's mechanisms are partly attacked by rust and almost all bolts and nuts are corroded. The structure's mechanisms need cleaning, protection of corroded parts, replacement of all the bolts and nuts with stainless steel as well as replacement of drive units.

Specification:

30 m diameter × 3.5 m depth × 1.5 kW center drive thickener with picket 2 sets

6.4.12 Thickened Sludge Pumping Station: Torque Flow Type Pumps (Facility No.11)

These pumps are damaged severely and no drive motors exist. All pumps including auxiliaries with drive motors need to be replaced with new ones.

Specification:

1.0 m^3/min × 49 m × 22 kW sludge pump with induce screw 2 sets

6.4.13 Sludge Digester : Gas Mixing (Facility No.12)

Almost all the auxiliary equipment are damaged very severely. Therefore all the gas mixing facilities and auxiliaries need to be replaced with new one.

Specification:

3.75 m^3/min × 9 m × 11 kW sludge pump with induce screw	3 sets

6.4.14 Boiler House: Boilers and Auxiliaries (Facility No.13)

Two sets of boilers with total capacity of 1,300,000 kcal/hrs with auxiliary equipment exist. These facilities are damaged heavily. The two sets of boilers of the same capacity with the existing to include sludge recirculation pumps, heat exchangers and all necessary auxiliaries need to be replaced with new ones.

650,000 kcal /hr × 110 ° C × 6 bars digested gas boiler	2 sets

6.4.15 Gas Compressor Station: Digested Gas Compressors (Facility No.14)

There are six gas compressors that were found severely damaged. Because of the complexity of these compressors transporting a very explosive gas, replacement with new compressors and auxiliaries is necessary.

Specification:

582 N m^3 / hrs. × 2 bars × 37 kW digested gas blower for mixing	3 sets
400 N m^3 /hrs. × 2.2 bars × 30 kW digested gas blower for transporting	3 sets

6.4.16 Gas Storage Tank : Service Piping (Facility No.15)

The Gas Storage Tank is floating roof type with water sealed system. Floating roof of the tank is made of steel plate, welded with anti corrosive protection painting, and installed at the concrete ground-slab. The gas tank is provided with necessary servicing pipes and reinforcement for pressure keeping and equipped with device for separation of water from digested gas. The roof and floating guide mechanisms need to be repaired, and applied with anti protection painting. Service pipes including necessary auxiliaries need to be renewed.

Specification:

5,000 Nm^3 /hrs. capacity gas holder with water sealed	1 set

6.4.17 Homogenized Sludge Holding Tank : Drive Motor (Facility No.16)

The drive motor of the thickener was found missing, and drive head incomplete. The structure's mechanisms are partly attacked by rust and most of bolts and nuts are corroded heavily. The structure's mechanism needs to be cleaned, protection of corroded parts, and replacement of the bolts and nuts with stainless steel. The drive head needs to be replaced with new one.

Specification:

30 m diameter × 3.5 m depth × 1.5 kW center drive thickener with picket 1 set

6.4.18 Sludge Pumping Station: Moineau Pumps (Facility No.17)

These pumps have the eccentric rotors, driven by electrical motor through reducer, so that the numbers of turns can be regulated.
The drive motors were found missing together with part of transmission mechanism and reducers. Almost all parts of the pumps and casings are missing. All 5 sets of new pumps need to be replaced with new ones.

Specification:

6 ~ 28 m^3 /hrs. × 15 m × 1.5 kW Moineau pump 5 sets

6.4.19 Sludge Dehydration : Belt Filter Press (Facility No.18)

All five presses are devastated, the electrical motors, transmission mechanisms, and part of automatics are destroyed, the filter clothes are dismounted, pipe lines of the air automatics are cut. Therefore all the five presses and auxiliaries need to be replaced.

Specification:

3 m width × 140 kg/m-hrs. filter capacity × 1.5 kW belt filter press 5 sets

6.4.20 Air Blower Room : Blowers for Aerated Sand Trap (Facility No.19)

No drive motors exist, with part of flexible coupling placed on motor is missing. The blowers are damaged severely, therefore all three blowers need to be replaced with new ones including necessary auxiliaries.

Specification:

13 Nm^3 / min × 1 bar × 10 kW 3 sets

6.4.21 Power Station : Diesel Engine for Power Generation (Facility No.20)

These diesel engines were manufactured 19 years ago in 1980. During that period the operation time was extremely cut sort due to:

1) the test period for commissioning.
2) suffered many operational interruption due to lack of gas production
3) the whole plant stopped operation in April 1992 and never started again since then

Due to long stand-still condition and disastrous conservation since April 1992, these machines were found to have suffered extensive damages which make their replacement with new units safer and most cost effective than refurbishment.

Specification:

640 kW capacity diesel engine 2 sets

6.4.22 Service Water Pumping Station : Centrifugal Pumps (Facility No.24)

There are four pumps in Service Water Pumping Station; two of them are 37 kW and other two are 22 kW. The bigger pumps are with motors and small pumps are without motors. These four pumps including auxiliaries are damaged severely. Therefore all four pumps including auxiliaries need to be renewed. The small pumps need new motors and bigger pumps' motors can be used with small repairs such as replacement of bearings and rewindings.

Specification:

2.1 m^3 / min × 7.1 m × 37 kW centrifugal pump	2 sets
0.84 m^3 / min × 6.85 m × 22 kW centrifugal pump	2 sets

The list of mechanical equipment related to the above-mentioned rehabilitation plan is described in **Appendix M.**

6.5 DESIGN FOR ELECTRICAL WORK

6.5.1 Electric Power Supply

(1) Electric Power Generation by Digester Gas

By the year 2015, the volume of wastewater flowing into the WWTP is forecasted at 196,200 m^3/day (Average Dry Water Flow) with BOD and TSS load of 37,970 kg/day and 48,100 kg/day, respectively. Using the above condition, it is estimated that the digester gas production available for power generation will be the following **Table 6.15.**

Table 6.15 DIGESTER GAS PRODUCTION

	Daily Net Production	Daily Total Consumption	Excess Gas
In Summer	15,610 Nm^3/day	3,000 Nm^3/day	12,600 Nm^3/day
In Winter		5,100 Nm^3/day	10,500 Nm^3/day

In summer season, the electric power generation is capable of following capacity consuming as permissibly the excess digester gas.

Generating capacity = Volume of excess gas per day × Calorie of gas × (1 kW-hrs. / 760 kcal) × Efficiency of power generating × 1 day/ 24hrs.
= 12,600 Nm^3 / day × 5,500 kcal / Nm^3 × 1 kW-hrs. / 760 kcal × (30 % / 100) × 1 day / 24 hrs.
= 27,360 kW-hrs. / day × 1 day / 24 hrs.
= 1,140 kW

On the other hand, the capacity of the Engine Generators existing in Power Station is
640 kW × 2 pcs. = 1,280 kW
Taking into account the excess gas available for electric power generation, the capacity of the existing engine generators is reasonable.

Therefore, it is recommended for the rehabilitation of the Electric Power Supply Plan the capacity of the engine generators shall be 2×640 kW, the same capacity as the existing generators.

(1) Electric Energy Ratio Supplied by the Digester Gas

As mentioned above, the estimated electric power supply produced by the digester gas is 27,360 kW-hrs. / day in summer season.

On the other hand, the estimated electric energy consumed by the WWTP is 55,000 kW-hrs./day in summer season (Refer to **Appendix M**).

Therefore, the electric energy ratio supplied by the digester gas is estimated as follows:

$$\frac{27{,}360 \text{ kW-hrs./day}}{55{,}000 \text{ kW-hrs./day}} \times 100\ \% = 50\ \%$$

(2) Recommended Mode for Electric Power Supply

1) On Normal Time
The electric power demand by WWTP is estimated as about 2,000 kW. (Refer to **Appendix M**) Therefore, the recommended mode for electric power supply shall be the following:

a) The electric power generated by the digester gas shall be permissibly used to the maximum of 1,280 kW.
b) The deficiency shall be supplied by the commercial electric power enterprise, Electric Distribution, Sarajevo (EDS). The power distribution line has the capacity to supply a maximum of 3,200 kW to the WWTP.

2) Power Outages from the EDS

a) The electric power generated by the digester gas shall be used as permissibly as possible.
b) The deficiency shall be supplied by the engine generator using fuel oil.

Figure 6.8 and **6.9** show the power supply situation from the engine generators during power outages from the EDS.

6.5.2 Electric Facilities for the Rehabilitation Plan

The electric facilities can be rehabilitated in accordance with following ideas.

(1) Electric Power Supply System

In the Rehabilitation Plan, the power demand is almost the same as during the operational period of the WWTP. Therefore, the previous design idea for electric power supply system including the generator, the HT switchgear and the transformer will be followed. However, it is recommended that engine generators and accessories shall be located near Gas Storage Tank, due to following reasons.

1) The existing Power Station is built on the low level location within the WWTP. For flood control measure, it is more convenient to build a new engine generator room than raising up the existing base level of the Power Station.
2) The generator should be as close as possible to the gas supply in order to minimize loss.

(2) L T Power Distribution/Motor Control Panel

The L T power distribution/motor control panels follows the previous design idea.

(3) Central Control Equipment

The central control equipment consists of main control panel with mimic graphic and operator console. The main control panel will be usefull to view the general condition of whole plant. There is no problem in the Central Control Room to install these panels. Therefore, these panels follow the previous design idea.

The Data Logging System is not contained in the previous central control equipment. It is considered that the Data Logging System is useful in the control of the overall operation of the WWTP. Therefore, it is recommended that the Data Logging System shall be furnished in the Rehabilitation Plan.

(4) Local Control Panel

The Local Control Panels follow the previous design idea.

However, the Local Control Panels for Pre-Screening Station and Chlorination Building shall be added in the Rehabilitation Plan.

(5) Measuring Equipment

The measuring equipments follow the previous design idea but adding few new points.

Main electrical equipments for the Rehabilitation Plan are shown in **Appendix M.**

(6) Prevention from the Submerging

The electric facilities previous have an experience that they have been submerged due to the flood. In the Rehabilitation Plan, all electric facilities should be taken into account to prevent from the submerging in the flood.

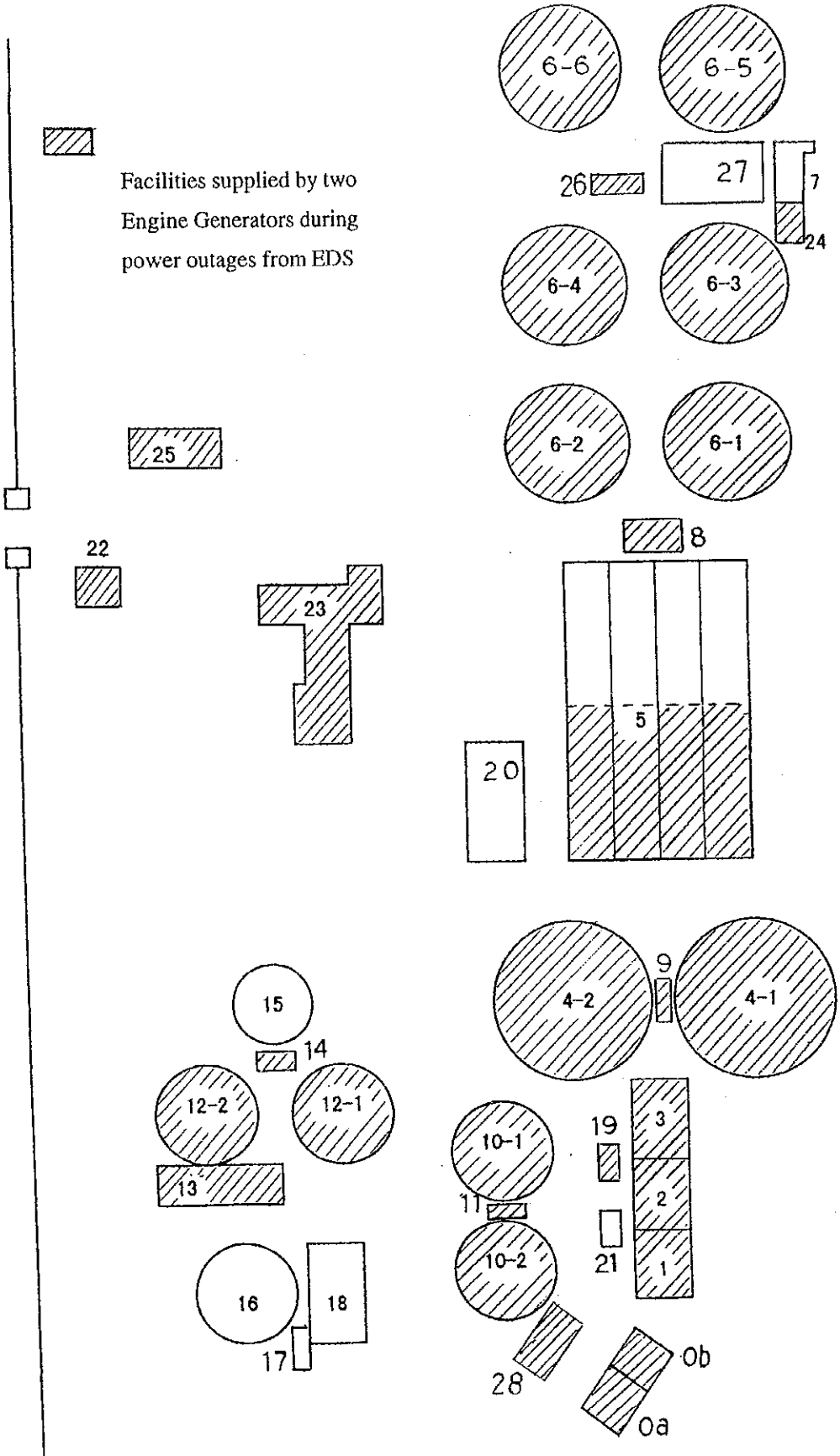


Figure 6 .8 WWTP SITUATION FOR ELECTRIC POWER SUPPLY BY TWO (2) ENGINE GENERATORS

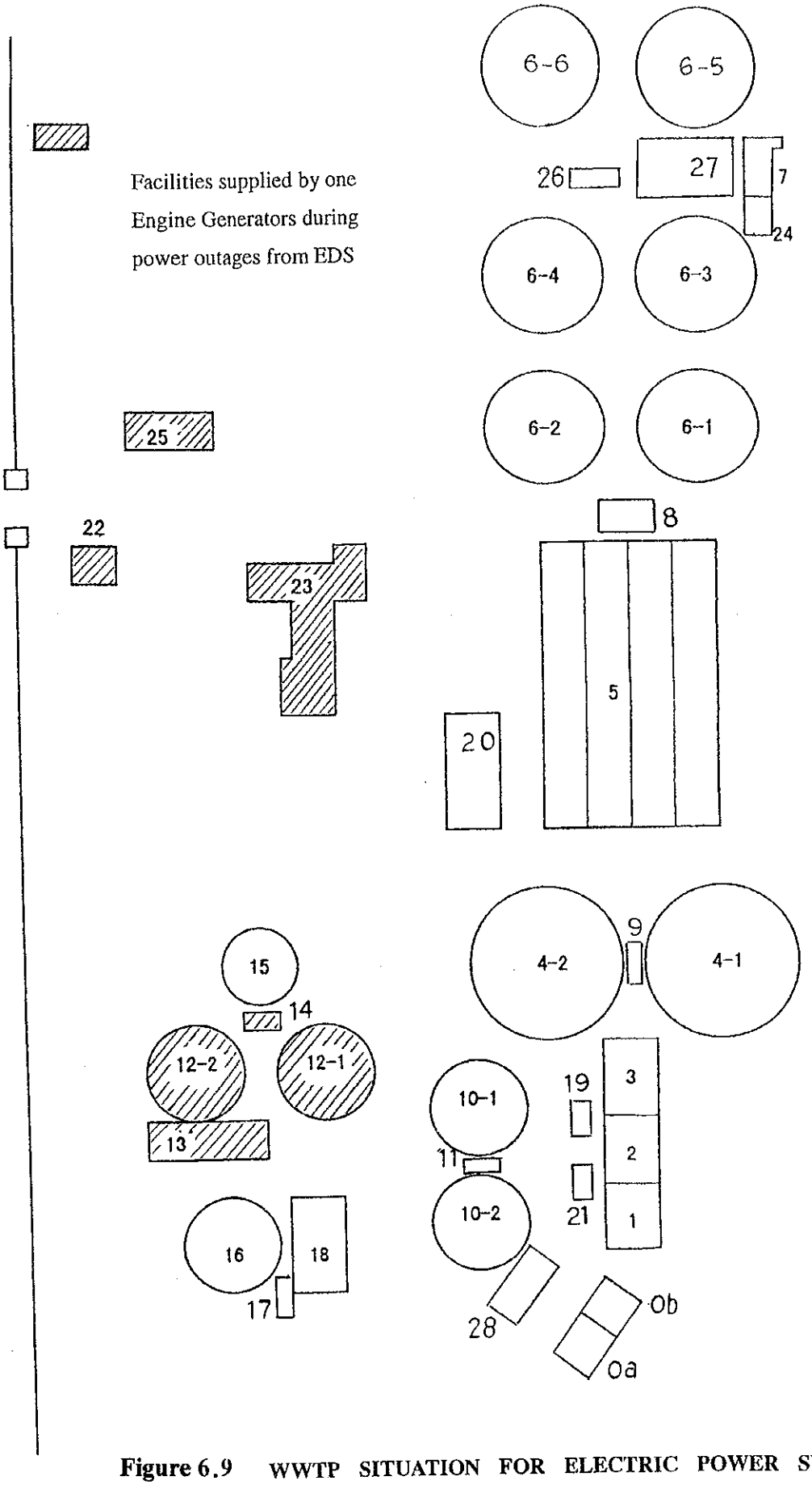


Figure 6.9 WWTP SITUATION FOR ELECTRIC POWER SUPPLY BY ONE (1) ENGINE GENERATOR

6.6 IMPLEMENTATION PLAN

6.6.1 General

The Reconstruction Program has been authorized by Ministry of Foreign Affairs. The implementation program shall commence from early 2000 through 2001, being inclusive to act in concert with other reconstruction project as well as other sewerage project. JICA Study Team will strongly recommend necessary action for budget – making this project implemented.

6.6.2 Implementation plan

Stating the conclusion of this Feasibility Study, it will take a total of thirty months to re-start operation of the WWTP. It will also take one year for the detail design and other engineering services to finalize plus another 1 1/2 years for the construction works to complete. **Table 6.16** and **6.17** shows the implementation schedule for the Detail Design, engineering services and construction towards the commissioning and inauguration of WWTP.

6.6.3 Purchasing Plan of the equipment

The procurement and purchasing plan of mechanical and electrical equipment will require the general contractor suffiient time to purchase such equipment in order to meet the desired construction schedule for each facility.

Since the manufactured treatment plant equipment will take almost half year to be shipped, the general constructor shall order these equipment as scheduled complying with the purchasing plan and implementation plan.

Table 6.16 IMPLEMENTATION SCHEDULE

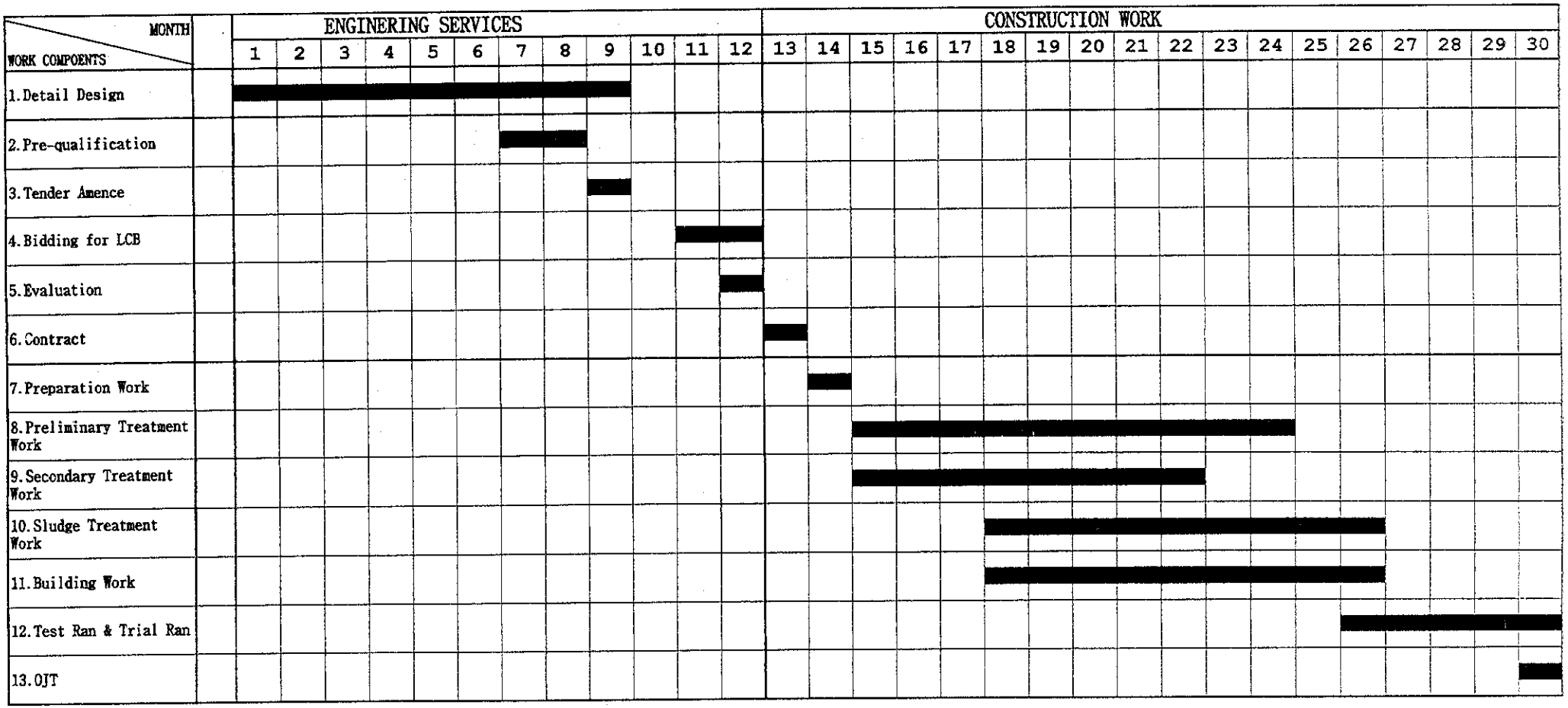
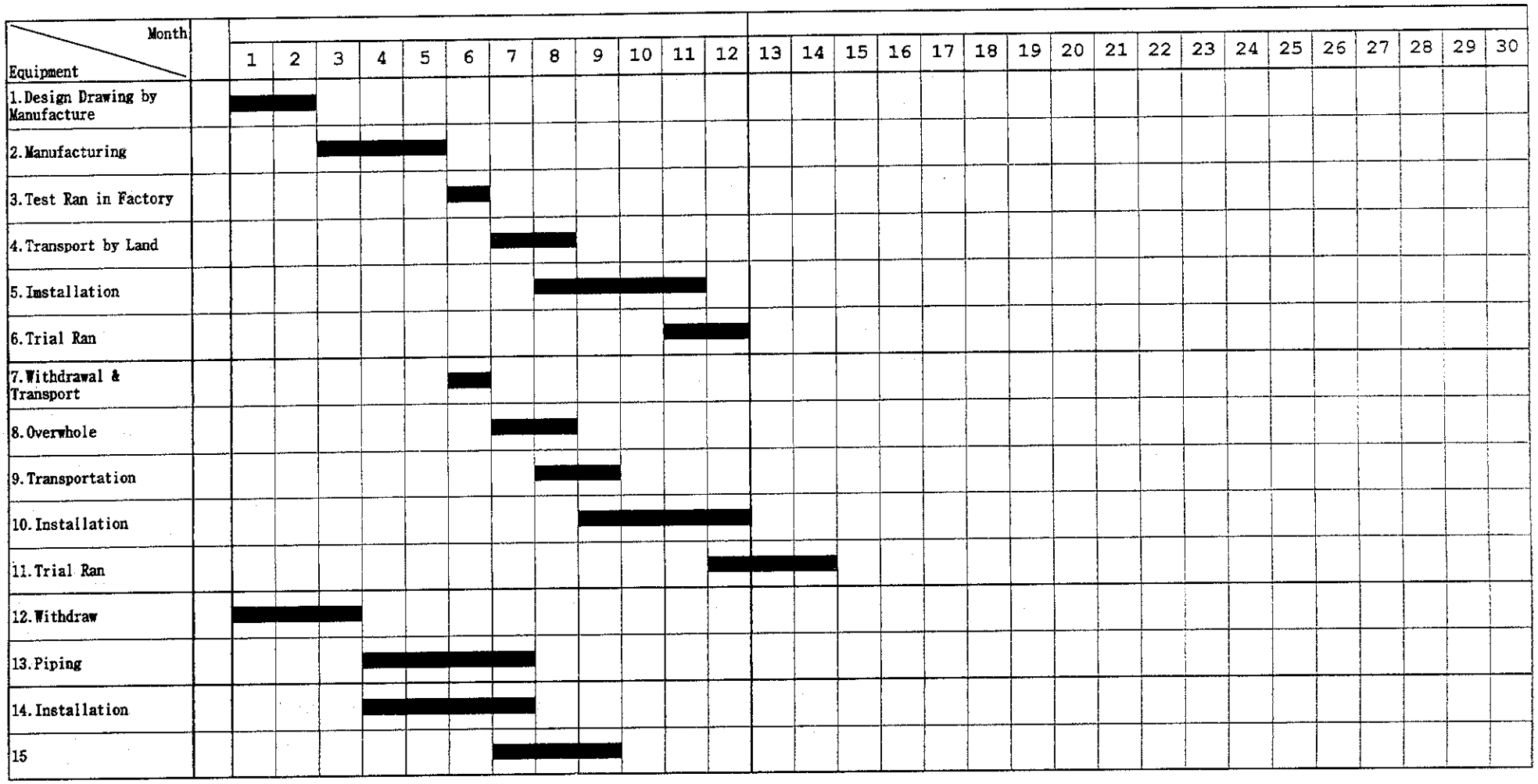


Table 6.17 PURCHASING PLAN



6.7 OPERATION AND MAINTENANCE (O & M)

6.7.1 General

During the more or less 7 years of operation, 5 of the many factors that remarkably created serious operational and maintenance problems to the Sarajevo WWTP are the following:

(1) enormous amount of grit and large objects damaging the raw water screw pumps, thus causing plant shutdowns,
(2) weaker strength of wastewater resulting in diluted sludge, poor digestion and low gas production,
(3) cold weather problems on travelling bridge of the Aerated Grit Chamber
(4) poor access to most process control points, and
(5) flooding of the power station and pump rooms

The above-mentioned factors, which are attributable to the type of sewer collection system and the economically designed facilities, will be rectified with the provision of the following:

(1) new pre-treatment and screening facilities upstream of the Raw Water Pumping Station,
(2) design with provision to improve operational flexibility,
(3) electrical heat tracing installed along the top of the walls,
(4) appropriate stairs and catwalks built on all important O & M points, and
(5) raising of the existing floor elevations for the power station and sludge pumping stations

Aside from the above-mentioned measures appropriate operational and maintenance practices are necessary to (a) increase treatment efficiency, (b) reduce wear in the downstream equipment (c) reduce operational and maintenance problems, and (d) produce highly acceptable effluent quality.

Trained licensed operators on a 7-day-per-week basis should operate the Sarajevo Wastewater Treatment Plant facilities. Mechanics, electricians and other support staff should provide support on a 24-hr basis. Quality control of wastewater and sludge processing should be performed in the laboratory facility to be managed and operated by qualified technicians. Equipment maintenance shops with qualified workforce should be provided in the plant.

As much as possible, chlorine solution should be readily available in each treatment unit for washing the walls, weirs and to remove the scum. Particular operation and maintenance requirement for each treatment facility are discussed below.

6.7.2 Pre-Treatment Facility

The pre-treatment facility is designed to allow one unit to be taken out of service for routine maintenance without impairing the process. The grit removal facility should be handled properly to avoid serious odour problems. Daily disposal of grits collected from the channels and regular washing of the facility with chlorine or hydrogen peroxide solution will reduce odour and insect problems. **Table 6.18** below describes the routine maintenance steps of the pre-treatment facility.

Table 6.18 ROUTINE MAINTENANCE STEPS FOR PRE-TREATMENT FACILITY

Frequency of Operation		
Every Shift	**Case-to-case**	**Annually**
Inspect distribution boxes and clean baffles, weirs, and gates to remove solids.	Hose down and remove wastewater spills.	Drain each basin to inspect underwater portions of the concrete structure, pipings and the like.
Remove accumulations of debris from inlet channels, gates and outlet weir.	Prepare lubrication chart for mechanical equipment.	Replace or repair all defective parts.
Clean all vertical walls and channels		Patch defective concrete, and repaint all clean metal surfaces as required.
Inspect gratings and exposed metal for signs of corrosion and deterioration of paint		

6.7.3 Raw Water Pumping Station

The designed pumping station has a stand-by unit in order to maintain continuous operation. The operation of each screw pump is automatic, and is controlled by float contractors installed in the wet well at the bottom of the screws. **Table 6.19** and **6.20** below describes the routine maintenance steps and troubleshooting guide for Raw Water Pumping Station.

Table 6.19 ROUTINE MAINTENANCE STEPS FOR RAW WATER PUMPING STATION

Frequency of Operation				
Every Shift	**Weekly**	**Monthly**	**Quarterly**	**Case-to-Case**
Observe pump Operations & keep log of inspection.	Inspect stuffing boxes for free movement of glands and examine for leaks.	Lubricate yokes & slip joints of flexible shafting.	Lubricate thrust bearings of the pump.	Completely overhaul pumps in accordance with manufacturer's instructions.
Check temperature of pump casing and investigate further for possible problems	Lubricate the motors			Standby unit should be exercised on a regular basis for uniform wears.

Table 6.20 COMMON OPERATIONAL PROBLEMS AND SUGGESTED SOLUTIONS FOR RAW WATER PUMPINT STATION

Symptom	Problem	Solution
Surging of the plant influent indicated by flooded weirs, and drop in treatment plant efficiency	Surging during dry weather flow may be due to pump controls malfunction, and insufficient hydraulic capacity of the plant. Surging during wet weather indicate excessive infiltration and inflow.	Check and repair pump controls seal manhole covers, and repair broken sewer lines.
Improper liquid levels in wet well	Coating of liquid level probes, hang-ups in the level indicators, leaks in the floats and fouling of bubbler control	Clean and repair probes, level indicators, floats and bubbler.
Accumulation of solids and scums in the wet well	Scum blanket in the wet well and improper operation of the level-sensing equipment	The scum should be broken down by high-pressure water. Start the pump manually and lower the liquid level to the lowest possible.
Presence of obnoxious odor in the wet well, emission of hydrogen	Long storage in the wet well	Proper operation of the pumping station, addition of chlorine or hydrogen peroxide solution in the

sulfide, corrosion of metal works and concrete, and black color observe in liquid or solids		wet well, installation of air diffusers in the wet well, or installation of blower & gas scrubber for oxidation of gases exhausting to the atmosphere.
Pump does not start	Blown fuses, defective control, or defective motor	Check, repair or replace (a) fuses and their ratings, (b) corroded or shorted contact switches, (c) loose or broken terminal switches, (d) automatic control mechanism, (e) switches not properly set, (f) dirty or arching contacts of the controls, (g) short circuited wiring, (h) burnt out or shorted motor.
Pump not running or circuit breaker not resetting	Clogged pump suction, discharge pipes, or closed valve	Check, clean pump suction, discharge pipes, & open valve
Pump running but with reduced discharge	(a) pump not primed or pump is air-bound, (b) clogged impeller, (c) low speed of motor due to improper wiring or defects, (d) discharge head too high, (e) suction lift too high, (f) discharge or suction lines clogged, (g) air leaks in suction line or in packing box, (h) valve partially closed, (i) damaged or incorrect impeller adjustment, (j) worn-out or defective packing, couplings, or wearing rings	Check for the probable fault and repair or replace accordingly
Unrealistic power consumption	(a) Clogged pump, (b) mis-aligned belt drive, (c) speed of rotation too high (d) operating head lower than designed rating, (e) check valve open or force main draining back into the wet well, (f) pump shaft bent, (g) rotating elements binding (h) packing boxes too tight (i) worn-out or binding wearing rings, (j) impeller rubbing	Check for the probable fault and repair or replace accordingly
Excessive wear or damage to the pump	Accumulation of grit or grease in the wet well	Clean wet well from grit or grease
Pump noisy	(a) Cavitation, (b) pump not completely primed, (c) inlet clogged, (d) inlet not submerged, (e) improper pump lubrication, (f) bearing or impellers worn out, (g) insecure foundation, (h) pump defects	Check for probable cause and take appropriate action

6.7.4 Screening Station

Debris present in wastewater has to be removed for the smooth operation of the treatment processes and to minimise damage to the equipment. High repair cost is normally attributed to the poor performance of the screens. It is therefore imperative to know and rectify common operational problems as summarised in **Table 6.21** below.

Table 6.21 COMMON OPERATIONAL PROBLEMS AND SUGGESTED SOLUTION FOR SCREENING STATION

Symptom	Problem	Solution
Presence of flies, other insects & obnoxious odor	Prolonged storage of screened debris	Increase frequency of disposal
Unusual amount of debris in	Excessive screen clogging	Identify the source and stopping

wastewater		it at the source as possible
Low velocity through the rack	Excessive screen clogging	Provide a coarser rack
Mechanical rake inoperable	Jammed raking mechanism	Remove the obstruction immediately
Mechanical rake inoperable, but motor running	Broken chain or cable, or broken limit switch	Inspect chain and switches and replace them as necessary
Mechanical rake inoperable, but problem is not visible	Defective remote control circuit or motor	Check remote control circuit and motor and replace them as necessary

The screenings removed from the WWTP should be stored in covered containers and disposed of daily in order to minimise odour and flies. The area should be regularly cleaned and washed with chemical solution such as, chlorine or hydrogen peroxide.

The bar screen raking mechanism should be checked daily with all moving parts lubricated as directed by the manufacturer. On a routine basis, each bar screen should be taken out for maintenance. The unit should be dewatered and components checked for painting; cable, chain, or teeth replacement; removal of obstruction; straightening of bent bars; and other necessary maintenance works.

6.7.5 Aerated Grit Chamber

Well-trained operators familiar with the peculiarities of the sewer system and the wastewater characteristics should operate the aerated grit chamber. Importantly, the removal efficiency should be maintained at the highest level possible in order to minimise wear on the downstream equipment and a trouble-free treatment processes downstream. The operator must monitor the air supply system by adjusting the airflow whenever necessary, to allow the grit to settle. On the other hand, enough air has to be provided to prevent the organic material from settling.

The designed aerated grit chamber allows one unit to be taken out of service routinely for maintenance, without impairing the process. If the removal facility is not handled properly serious odour problems will take place. Daily disposal of grit removed and regular washing of the facility with chlorine or hydrogen peroxide solution will reduce odour and insect problems. **Table 6.22** below is a troubleshooting guide for the aerated grit chamber.

Table 6.22 COMMON OPERATIONL PROBLEMS AND SUGGESTED SOLUTION FOR AERATED GRIT CHAMBER

Symptom	Problem	Solution
Rotten egg odor	Hydrogen sulfide formation	Increase the aeration: inspect the walls, channels, and chamber for debris Wash the walls, weir and channel with chlorine or hydrogen peroxide solution.
Corrosion or wear on the equipment	Production of hydrogen sulfide and inadequate ventilation	Stop operation for routine maintenance and painting, then increase air supply upon resumption.
Grit smells, greasy and grey in color	Inadequate air supply	Increase the air supply
Reduction of surface turbulence	Diffusers maybe covered	Clean the diffusers
Low recovery of grit	Excessive aeration and inadequate retention time	Reduce the air supply

Overflowing grit chamber	Pump surge problem	Adjust the pump controls
High organic	Low aeration	Increase aeration

6.7.6 Primary Sedimentation Tank

The operation of the primary sedimentation tank requires regular maintenance in order to minimise serious odour problems created by the many odorous compounds that are released into the atmosphere. Additionally, the scum floating on the surface and at the collection devices offers highly favourable condition for odour emission. The odour is further intensified if settled sludge is not pumped frequently, allowing anaerobic decomposition to continue to take place.

The primary sedimentation tank if not properly operated may result to overloading of BOD and solids in the secondary processes. Biological decomposition will be disturbed if grease carryover is not prevented. Therefore, to minimise odour problems in the facility and a trouble-free treatment processes downstream, proper operation and maintenance of the primary treatment facilities is essential. To keep the facility in a satisfactory condition several steps has to be taken as shown in **Table 6.23** and **Table 6.24** below.

Table 6.23 ROUTINE MAINTENANCE STEPS FOR PRIMARY SEDIMENTATION TANK

Frequency of Operation		
Every Shift	**Daily**	**Annually**
Inspect all mechanical equipment	Remove accumulation from influent and effluent baffles, weir and scum box	Drain each primary tank and inspect the underwater section of the concrete structure. Patch all defective concrete.
Determine sludge level and underflow concentration and where necessary, adjust primary sludge pumping rate.	Clean all inside exposed walls and channels.	Inspect all mechanical parts for corrosion and wear, and set proper clearance for flights and tank walls.
Check electrical motors, bearing temperature, and overload detector	Hose down and remove all sludge and wastewater spills as soon as possible	Replace flights when necessary and supply protective coatings.
Check oil levels in gear reducers and bearings	Observe scum pump operation and provide hosing as required	Clean and repaint all exposed metal surfaces.

Table 6.24 COMMON OPERATIONAL PROBLEMS AND SUGGESTED SOLUTIONS FOR PRIMARY SEDIMENTATION TANK

Symptom	Problem	Suggested Solution
Black and odorous septic wastewater	Decomposing wastewater in the collection system, recycling excessively strong digester supernatant, or inadequate pre-treatment of organic discharges from the industries	Pre-aeration, chlorination or hydrogen peroxide treatment of wastes in the collection system, control of digester supernatant, and strict enforcement of industrial pre-treatment regulations.
Floating sludge, excessive sludge accumulation, decomposing organic, or return of well-nitrified, waste-activated sludge	Scrapers may be worn or damaged, sludge withdrawal line may be plugged, or the sludge withdrawal rate may be insufficient	Frequent or increase rate of removal of sludge, clean the sludge lines, or repair or replace sludge collection and pumping equipment
Scum overflow	Less frequent removal of scum, excessive industrial contribution, worn or damaged scum wiper	Frequent removal of scum, limit industrial waste contribution, clean or replace wiper blades, and

	blades, or improper alignment of the skimmer	adjust wiper blade alignment
Sludge removal from hopper is hard	Excessive grit accumulation	Check grit removal facility and act accordingly
Low solids in the sludge	Excessive sludge withdrawal, short-circuiting, or surging flow	Reduce sludge withdrawal, check and install baffles, and check and modify influent pumping rate
Excessive sedimentation in the influent channel	Low velocity	Agitate the influent channel with air or wastewater to re-suspend solids and prevent decomposition
Excessive slime growth on the surfaces and weirs	Accumulation of solids and scum	Inspect surfaces and clean them frequently
Excessive corrosion of metals	Presence of hydrogen sulfide gas caused by septic sewage or sludge	Check items 1 & 2 above. Paint surfaces with corrosion- resistant paint.
Erratic operation of sludge collection mechanism	Broken shear pin or damaged collection mechanism, excessive sludge accumulation, or rags or debris entangled around collector mechanism	Replace or repair damaged parts, remove debris, and increase sludge pumping rate
Frequent broken scraper chain and shear pin failures	Improper shear pin sizing and flight alignment, ice formation, or excessive loading on the sludge scraper	Realign flights and shear pin size, break ice, or remove sludge more often
Noisy chain drive, chain that climbs sprockets, or loose or stiff chain	Misalignment or improper assembly, worn out parts, faulty lubrication, or excessive rust or corrosion	Inspect and correctly align entire drive mechanism: replace the chain, bearings, or sprockets and outer parts: remove dirt and rust; and lubricate properly
Broken chain or sprockets	Caused by shock, overloading, wrong chain size, misalignment, excessive wear, or lack of lubrication	Avoid shock and overload, replace parts and corroded portion, and lubricate properly
Bearing or universal joint failure	Excessive wear and lack of lubrication	Replace joints or bearings, and lubricate properly

6.7.7 Aeration Basin

The following procedures are in **Table 6.25** necessary for the routine operation and maintenance of the aeration basin.

Table 6.25 ROUTINE MAINTENANCE STEPS FOR AERATION BASIN

Frequency of Operation		
Every Shift	**Case-to-case**	**Annually**
Inspect distribution boxes and clean baffles, weirs, and gates to remove solids.	Hose down and remove wastewater spills.	Drain each basin to inspect underwater portions of the concrete structure, pipings and the like.
Remove accumulations of debris from inlet channels, gates and outlet weir.	Prepare lubrication chart for mechanical equipment.	Replace or repair all defective parts.
Keep record of DO, phosphorus, ammonia, nitrate, pH, and MLSS concentrations; SVI and sludge age.		Patch defective concrete, and repaint all clean metal surfaces as required.
Clean all vertical walls and channels.		
Inspect gratings and exposed		

metal for signs of corrosion and deterioration of paint		

6.7.8 Final Sedimentation Tank

The operation of the final sedimentation tank requires careful and efficient routine maintenance steps in order to minimise serious treatment problems and damage to machinery. **Table 6.26** below shows various maintenance steps for the final sedimentation tank.

Table 6.26 ROUTINE MAINTENANCE STEPS FOR FINAL SEDIMENTATION TANK

Frequency of Operation			
Every Shift	**Weekly**	**Annually**	**Case-to-case**
Remove accumulations from the influent baffles, effluent weirs, and scum baffles and scum box.	Check oil level, grease reducer, and rollers on the skimmer.	Drain each clarifier to inspect the underwater portion of the concrete structure and mechanism.	Observe sludge return from individual clarifier, and adjust the flow rate as required from laboratory tests.
Clean all inside Exposed vertical walls and channels.	Check oil level for turntable bearings and refill as required.	Inspect mechanical equipment for wear and corrosion, and apply protective coating. Inspect concrete structure and patch defective areas.	Determine sludge level and adjust waste sludge pump if necessary.
Inspect distribution box and clean weirs, gates, and walls and remove all settled solids. Also check flow to all clarifiers.	Grease the main bearings.	Inspect sludge collection and other equipment for indication of corrosion. Clean and paint all metal works as necessary.	Observe operation of scum pump and provide hosing if necessary.
Inspect effluent box, weirs and walls. Measure the head over the weirs.			Hose down and remove wastewater sludge and spills without delay.
Check electrical motors for overall operation, bearing temperature and overload detector.			Change the oil in the gear reducer.

6.7.9 Sludge Thickener

Poorly designed and improper operation and maintenance of sludge thickener facility can create serious odour problems. Hydraulically overloaded sludge thickener is due to poorly thickened sludge and high solids in the thickener overflow. Therefore, for a trouble-free sludge thickener facility, proper operation and maintenance of the facility is essential. **Table 6.27** and **6.28** below describe the trouble-shooting guide and routine maintenance steps for a sludge thickener facility.

Table 6.27 COMMON OPERATIONAL PROBLEMS AND SUGGESTED SOLUTION FOR SLUDGE THICKENER

Symptom	Problem	Solution
Septic odor or rising sludge	Low or infrequent thickened sludge- pumping rate, low thickener overflow rate, or too	Pump thickened sludge more frequently, increase the dilution for overflow rate, chlorinate

	high a deep of sludge blanket	influent or add air to the blending tank.
Too thin thickened sludge, or uneven discharge of solids over the effluent weir	High overflow rate, high underflow rate, or short-circuiting through the tank.	Reduce the influent sludge-pumping rate, reduce the dilution water, reduce the pumping of thickened sludge, and maintain high sludge blanket. Level the weirs and change the baffles if necessary.
Torque overload of sludge-collecting equipment	Accumulation of dense sludge or a heavy foreign object jamming the scrapper	Agitate the sludge blanket in front of the collector arms with rod or water jets. Foreign objects must be removed by a grappling device or by draining the basin.
Plugging of the sludge lines and pump	Sludge, too thick	Flush the lines and all valves should be fully opened.
Sludge is hard to remove	Grit, too much	Remove grit efficiently.
Excessive growth on weirs	Accumulation of solids and the resultant growth.	Frequent and thorough cleaning of weirs and all surfaces by water jet

Table 6.28 ROUTINE MAINTENANCE STEPS FOR SLUDGE THICKENER

Frequency of Operation			
Every Shift	**Weekly**	**Quarterly**	**Annually**
Clean all vertical walls and channels by squeegee and hose down and clean sludge spills.	Check oil level in gear reducers and add as needed.	Change oil	Drain the thickener and inspect the underwater portion of the concrete structure and mechanism.
Check the sludge level. The sludge level should be kept below the top of the thickener.	Lubricate worn gears.		Inspect the mechanical equipment for wear and corrosion, adjust the mechanism, and set proper clearance for flights at tank walls.
Check the overall operation of the electrical motor, bearing temperature, overload detector, and unusual noise			Patch defective concrete, and inspect metal surfaces for corrosion, clean and paint if necessary.

6.7.10 Sludge Digester

The operation and control of anaerobic digesters is difficult because it depends on several factors such as, (a) the results of the laboratory tests, (b) the operator's judgement and skills, (c) treatment plant loading, (d) industrial wastes, and (e) weather conditions. The routine operations are further complicated by the need for repairs, shutdown, cleaning, and start-up. The following is the summary information on digester routine operation and maintenance based on EPA's operation manual for anaerobic sludge digestion.

(1) Troubleshooting Guide for Anaerobic Sludge Digestion Facility

It is essential that proper operational procedure and troubleshooting guide should be followed in the operation and maintenance of anaerobic sludge digestion facility. **Table 6.29** below lists down important troubleshooting guide in the operation and maintenance of sludge digester.

Table 6.29 TROUBLESHOOTING GUIDE FOR ANAEROBIC DIGESTION FACILITY

Symptom	Problem	Solution
Rise in VA/ALK ratio (greater than 0.3), increase in CO_2 content, decrease in pH, and rancid or H_2S odors	Hydraulic or organic overloading, excessive withdrawal of digested sludge, or incoming toxic materials	Decrease organic loading, decrease the sludge withdrawal rate, increase the mixing rate and mixing time, exercise proper temperature control, and institute a strict industrial pre-treatment regulation
Poor supernatant quality	Excessive mixing, insufficient settling time before sludge withdrawal, too low a supernatant draw off point, and insufficient withdrawal rate	Reduce mixing, allow longer time for settling, use higher supernatant withdrawal ports, and increase the digested sludge withdrawal
Presence of foam in the supernatant	Scum blanket breaking up, excessive gas recirculation, and organic overload	Stop withdrawal of supernatant, throttle compressor output, and reduce feeding rate.
Thin digested sludge	Short-circuiting, excessive mixing, or too high sludge pumping rate	Stop mixing several hours before supernatant draw off and sludge withdrawal, use proper selector level for supernatant removal, and use a short pumping cycle for sludge withdrawal.
Sludge temperature dropping	Sludge recirculation lines are plugged, inadequate mixing, hydraulic overload, lower water feed rate in heat exchangers, and the boiler burner is not firing.	Back flush the sludge recirculation lines by heated and digested sludge and check/correct the boiler and heat exchangers.
Sludge temperature is too high	Faulty controller, boiler and hot water temperature are too high, and high hot water recirculation rate.	Check and take appropriate action.
Insufficient mixing.	Plugged gas mixer feed lines and gas flow too small.	Clean gas lines and valves. Increase the capacity of the compressor. (Recommended gas recirculation rate is 5 - 10 m3/min * 1000 m3 of digester capacity)
Gas pressure in the digester is low.	Gas leak from the pressure relief valve (PRV), digester cover, gas lines, and hoses: gas and supernatant withdrawal rates are too high.	Check and repair leaks, and control gas and supernatant withdrawal rates.
Gas pressure in the digester is high.	Insufficient gas withdrawal, PRV being stuck, or not opening due to freezing or defect.	Increase gas withdrawal and correct the PRV.
Scum blanket is high.	Supernatant overflow is plugged	Decrease the liquid level in the digester using bottom draw-off pipes and then rod the supernatant line.
Scum is too thick.	Insufficient mixing and high grease content.	Manually break the scum, increase mixing, increase the sludge recirculation to discharge liquid above the scum, or use chemicals to soften the blanket.

(2) Routine Operation and Maintenance

The routine operation of the digester utilises laboratory results to protect the digester from upset. The key operational goals are to (a) minimise excess water, (b) control organic loading, (c) control temperature, (d) control mixing, (e) reduce accumulation o f scum, and (f) withdraw supernatant that is low in solids.

Monitoring Program for Process Control. The following important tests must be performed daily for control of the digestion process:

1) Volatile solids (VS) and total alkalinity (TA)
2) Gas production rate and composition (CH_4 and CO_2)
3) pH
4) Volatile solids reduction
5) Digester temperature
6) Feed sludge volume and VS
7) Supernatant volume and TSS and BOD
8) Digested sludge volume and VS
9) Visual gas test (a yellow flame with blue at the base is normal; too much blue and the inability to stay lit indicates too much CO_2; orange flame with smoke indicates H_2S.
10) Sniff test; simply smelling the gas, supernatant, and digested sludge may give an indication of septic, sour putrid, well digested, or presence of chemicals such as oils, solvents, sulfides, etc.

The results of the above tests should be fully utilized in operation and control and in troubleshooting.

Routine Operation and Maintenance Checklist. The following checklist should be used for routine operation and maintenance of high-rate anaerobic digesters.

1) Feed Sludge

   a) Record the daily volume pumped for a 24-hrs. period.
   b) Perform daily total solids tests, and make sure that there is not too much water being fed.
   c) Check daily pump operations for packing gland leaks, proper adjustment of cooling water, unusual noises, undue bearing heat, suction and discharge pressures.
   d) Monitor feed pump time clock operation for on-and-off and running time cycle.

Also check the sludge consistency with these time cycles.

2) Recirculated Sludge

   a) Record the daily temperature and flow of recirculated sludge.
   b) Collect samples of recirculated sludge 2 to 3 times per week and determine pH, alkalinity, TS, TVS, etc.
   c) Check daily boiler temperature, burner flame, and exhaust fan for proper operation.
   d) Check daily temperature and flow of recirculating hot water.

e) Check daily and record heat exchanger inlet and outlet temperatures.
f) Check weekly for leaks in sludge lines.
g) Check daily pump operations – packing gland leaks, proper adjustment of cooling water, unusual noises, undue bearing temperatures, and suction and discharge pressures.

3) Digesters

a) Check daily gas manometers for proper digester gas pressure.
b) Drain daily the condensate traps.
c) Drain daily the sediment traps.
d) Check daily the gas burner for proper flame.
e) Record daily the floating cover position, check cover guides, and check for gas leaks.
f) Record daily digester and natural gas meter readings.
g) Check daily and record fuel oil.
h) Check daily gas-mixing equipment for flow of gas to all feed points.
i) Check daily the pressure relief and vacuum breaker valves. Verify operation with manometer and check for leaking gas.
j) Check daily the supernatant tubes for proper operation, collect sample, and hose down supernatant box.
k) Check daily the level and condition of the water seal on digester cover.
l) Check daily the flow meters for correct flow, leaks and vibration.
m) Check daily the feed sludge density meter for correct density, leaks, and other items specified by the manufacturer.
n) Check daily the scum blanket through sight glass.
o) Check daily the gas storage tank for gas leaks and odors. Record readings on pressure gauges and drain condensate traps.

6.7.11 Belt Filter Press

The operation of a belt filter press uses moving belts to dewater the sludge continuously. The main advantages of belt filter presses are drier cake, low power requirement, and continuous operation. The main disadvantages are short media life and a filtration rate sensitive to incoming sludge. The process involves 4 basic operational stages such as, (a) polymer conditioning zone, (b) gravity conditioning zone for excess water, (c) low pressure zone, and (d) high pressure zone. **Table 6.30** below describes important troubleshooting procedure of a belt filter press facility.

Table 6.30 COMMON OPERATIONAL PROBLEMS AND SUGGESTED SOLUTION FOR BELT FILTER PRESS

Symptom	Problem	Solution
Dewatered sludge is not dry enough	Sludge application rate is too high, belt speed is too high, or incorrect polymer dose.	Check and adjust the influent sludge-pumping rate. Check and adjust the belt speed. Set the optimum polymer dose by jar test procedure.
Excessive belt wear	Improper alignment of the rollers	Check the tracking of the belt and adjust the rollers accordingly. Check, repair or replace faulty belt adjuster mechanism. Also clean the solids that may have accumulated at the bottom of the

		belt.
High solids carryover in the filtrate	Incorrect polymer dose or solids running off the edge of the belt	Check the dilution water feed rate, polymer mixing and dosing system. Conduct a jar test to adjust the polymer dosage. Check and adjust the influent sludge pumping rate and the belt travel rate if necessary.
Oils leaks	Failure of the seal	Check and replace the oil seal.
Noisy or hot bearings or universal joint	Excessive wear caused by improper alignment or lack of lubrication	Replace, lubricate or align joint or bearings as required.
Extrusion of sludge in the gravity zone	Worn-out rubber seals	Replace the seals
Gravity zone has poor drainage causing sludge bulging or extrusion in the gravity zone	Poor flocculation or belt blinding	Check the polymer feed system. Check and correct the spray nozzles for belt cleaning.
Extrusion of solids from a wedge section	Poor flocculation, the belt speed is too low, or the throughput is too high.	Check and correct accordingly.
Extrusion in the high pressure zone	Poor flocculation or excessive pressure on the slurry by the belts	Check the polymer feed system, decrease belt tension, and increase belt speed.
Bulging in the high pressure section	Excessive water in the cake, or belt may be blinded	Check the polymer feed, reduce belt speed, and check spray nozzles.
Belt slippage on the drive roller	Belt tension is too low or excessive sludge in the machine.	Increase the belt tension, shut down the machine and remove the excess sludge.
Cake sticking to the belt	Poor flocculation or mis-aligned or worn-out scrapper blades	Check the polymer feed, and align or adjust scrapper blade pressure.
Belts wrinkling or folding	Poor distribution of feed, incorrect belt tension, cake is too thick, or plows or baffles being mislocated.	Check and correct accordingly.
Non-stop kick of overload relay from the drive system	Overloaded drive or overloaded relay	Adjust the belt tension and replace the relay.
Cake sticking to the belt continuously	Improper filter belt	Change the belt and specify a relatively coarse belt media.
Cake transport conveyor does not operate properly	Slope exceeds 15°	Adjust the slope of the cake transport conveyor.

A well-organised preventative maintenance program of a belt filter press facility will help reduce breakdown and make the operation clean and pleasant. Below are important operational guidelines for a smooth operation of the facility.

(1) The belt should be routinely checked for abnormal wear, holes, tear or any kind of damage. Spare belts of each length and spare pin wire of each belt should be kept at all times. A belt record showing data and information such as, belt specification, source, date of installation, estimated period of operation and nature of belt failures should be maintained.

(2) Keep a regular check on the following operating conditions: (a) sludge feed rate, (b) polymer feed rate, (c) belt speed, (d) sludge and polymer mixer, (e) plow position, and (f) spray wash system, especially nozzles and their setting.

(3) Inspect daily the following routine maintenance items and take corrective measures if an unusual situation that may have occurred: (a) roll coating for tears, (b) wedge and wedge setting, (c) condition of bearings, (d) air compressor, (e) belt tracking device, and (f) pneumatic system oiler.

(4) Perform the following routine maintenance at specified time intervals: (a) grease bearing, (b) check lubricant level in the main drive reducer, (c) change main drive reducer oil, and (d) repack main drive motor bearings.

6.7.12 Impact of Weak Wastewater on WWTP Operation

Wastewater samples taken during the second field investigation indicate that dilute sewage could be possible during start-up and early years of operation. Weak sewage could create several operating problems for the activated sludge treatment and the anaerobic digestion process. Therefore, process calculations have been prepared to assess what the impact will likely be and how operators can adjust the process to optimise treatment in response to influent characteristics.

The calculations presented with other process calculations in the **Appendix,** assume a BOD of 130 mg/l and TSS of 80 mg/l and provide the following information regarding probable operating conditions with dilute sewage.

(1) Oxygen demand in the Aeration Tanks would still be high because primary settling tanks would be less efficient at removing BOD under reduced solids loads. Therefore both aeration tanks would be required at the secondary treatment stage.

(2) Secondary sedimentation tanks would have much spare capacity and one tank could be taken out of service permanently or on a rotational sequence to facilitate maintenance.

(3) The total net production of primary and biological sludge would be greatly reduced to approximately one third of the value obtained using design criteria. Therefore only one digester would be required to process the sludge. Retention times in the digester would increase to 30 days.

(4) The net production of biogas would also drop significantly reducing the excess available to 2,124 m^3/day in the winter. This amount would be sufficient for heating buildings but little would be left over for generating electricity. Therefore overall energy costs would increase. Under this scenario, the investment in engine generators cannot be financially justified.

(5) Only two belt filter presses instead of five would be required to cope with the reduced sludge production. The performance of the presses would be affected by the more dilute digested sludge. A sludge cake with 19% dry solids is expected and more polymer would be required because the sludge would have a higher ratio of volatile matter given the reduced fraction of primary (inorganic) sludge.

In conclusion, the liquid stream of the treatment process would not be affected. The quantity and quality of sludge would be reduced significantly resulting in less gas production and less sludge to process and dispose of.