Chapter 8

WASTEWATER TREATMENT PLANT CONSTRUCTION (PACKAGE E)

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8.1 General

This chapter treats the detailed design of wastewater treatment plant for Phase I. Wastewater treatment plant is proposed to construct in Binh Hung Ward in Binh Chang District. The isolated area is enclosed by Tac Ben Ro river, Xom Cui canal and one small canal. And the area is divided into two (2) parts by high voltage power supply cable crossing at the center of area from east to west. The soil condition of this area is very weak and special attention to bearing capacity of soil for detailed design of the structures. General layout of THBNDT WWTP is shown in Fig. 8.1 and 8.2.

8.2 Scope of the Project

Scope of the project makes the detailed design on wastewater treatment plant with a capacity of 141,000 m^3/day.
The following main facilities are designed;

Wastewater treatment facility
Inlet pumping station, Distribution tank, Primary sedimentation tank, Aeration tank, Final sedimentation tank, and Disinfection tank.

Sludge treatment facility
Sludge thickening, Dewatering, and Composting plant

Mechanical design
All required mechanical equipment for wastewater and sludge treatment facilities

Electrical design
All required power supply and control system for wastewater and sludge treatment facilities

Other facility
Piping system, Production of water using for treatment plant, Pile foundation, Access road and bridge, Site preparation and Supplementary soil improvement

8.3 Wastewater Treatment Plant

8.3.1 Treatment System

To meet the required effluent water quality in Phase I, modified aeration process is adopted from the following reasons;

- Based on the results of the wastewater treatment experimental works, modified aeration system can achieve the required effluent water quality,
- Modified aeration system is similar to conventional activated sludge system and
- Modified aeration system can be easily sifted to conventional activated sludge system in the Final Phase

While sludge treatment system in Phase I, same sludge treatment system as Final Phase is adopted.

Requirement for Phase I is as follows:

Design flow: 141,000 m^3/d
Inflow: BOD = 165 mg/l
SS = 165 mg/l
Effluent quality: BOD ≤ 50 mg/l
SS ≤ 100 mg/l
Process: Modified aeration process (HRT at aeration tank at least 2hr)

Flow and mass balance of wastewater and sludge treatment process in Phase I are shown in Fig.8.3 and 8.7.

8.3.2 Design Standards

Design criteria of modified aeration system are determined based on the results of wastewater treatment experimental works as mentioned in previous Chapter 18 in Vol. I.

Primary Sedimentation Tank

Item	Standards
Surface loading ($m^3/m^2/d$)	About 100
Effective water depth (m)	3.0
Effluent weir loading ($m^3/m/d$)	About 500

Aeration Tank

Item	Standards

HRT (hr)	1.5 – 2.5
MLSS (mg/l)	400 – 800
Return sludge ratio (%)	5 – 10
Effective water depth (m)	5.5
Concentration of return sludge (mg/l)	3,000 – 6,000
BOD – SS Loading (kg-BOD/kg-SS/day)	About 4.0

Final Sedimentation Tank

Item	Standards
Surface loading ($m^3/m^2/d$)	About 60
Effective water depth (m)	3.5
Effluent weir loading ($m^3/m/d$)	About 240
Capacity of Sludge Hopper (min.)	30

Disinfection Tank

Item	Standards
HRT (min)	> 15

8.3.3 Design Influent Quality and Removal Efficiency of WWTP

Influent wastewater quality of BOD and SS to WWTP are estimated as follows;

BOD = 55g/person/day × 425,830 person / 141,000 m^3/day = 166 mg/l
SS = 55 g/person/day × 425,830 person / 141,000 m^3/day = 166 mg/l

Design water quality of treatment plant is determined from design influent wastewater quality and wringed water quality from sludge treatment plant. Wringed water quality from sludge treatment plant of BOD and SS are assumed at 20% and 30% of influent water quality respectively.

Design water quality of treatment plant are as follows:

BOD = 166 mg/l × 120 % = 199.2 mg/l say 200 mg/l
SS = 166 mg/l × 130 % = 215.8 mg/l say 210 mg/l

Hence design water quality of BOD and SS to treatment plant are defined at **200 mg/l** and **210 mg/l**, respectively.

Removal efficiency at each facility in WWTP is designed to achieve effluent quality as follows:

(WWTP Design Removal Efficiency)

Item	Design (mg/l)		Removal Efficiency (%)		
	Influent	Effluent	PST	AT + FST	Total
BOD	200	50	30	64.3	75.0
SS	210	60	35	56.0	71.4

Effluent water quality of SS is required 100 mg/l to public water which is not used for drinking water by Vietnamese effluent water quality standards of TCVN5945-1995 and TCXD188-1996. While based on the result of wastewater treatment experimental works, the modified aeration process can remove SS of at least 70. Then the design removal efficiency of SS is estimated based on the design effluent water quality of SS at 60 mg/l. The capacity of treatment facility is designed under this condition.

8.3.4 Required Number of Train of Wastewater Treatment in Phase I

Necessary train is determined by the criteria of HRT of two (2) hrs at aeration tank for modified aeration process.

The capacity of aeration tank in 1 train, V, are:

$V = Q_3 * HRT_c *$ number of train
$= 512{,}000\ m^3/d * 6hr / 24\ hr/d * 1/8$ train
$= 16{,}000\ m^3/train$

$HRT = V / Q_1$
$= 16{,}000\ m^3/train / 141{,}000\ m^3/d * 24\ hr/d = 2.74\ hr$

where Q_3: design flow in Final Phase
HRT_c: HRT for conventional activated sludge process (in 2020)
Q_1: design flow in Phase I

HRT of aeration tank meets the design criteria of 2hr. Therefore, one (1) train for aeration tank is proposed to implement for Phase I.

8.3.5 Surface Loading in Primary and Final Sedimentation Tanks

The surface loading of primary sedimentation tank (PST) in modified aeration process of

Phase I is estimated at 108.5 m^3/m^2/day, if one (1) train of PST will be constructed in Phase I. This is little higher than the design standard of 100 m^3/m^2/day, which is defined from the result of wastewater treatment experiment works (WTEW), but it is still in the permissible limit.

Surface loading of final sedimentation tank (FST) in modified aeration process is estimated at 54.2 m^3/m^2/day, if one (1) train of FST will be constructed in Phase I. This meets the design standard of surface loading in FST of 60 m^3/m^2/day.

8.3.6 Summary of Wastewater Treatment Facilities in Phase I

Necessary facilities in Phase I are summarized as follows:

Wastewater Treatment Process: modified aeration process

Lift Pumping Station:	D 700mm x 66.7 m^3/min. x 14 m h x 3 units (includes 1 stand-by)
Primary Sedimentation Tank:	1 train (5.0m^w x 13.0m^l x 3.0m^h x 10 tanks (20 waterways)
Aeration Tank:	1 train (10.5 m^w x 28.0 m^l x 5.5 m^h x 10 tanks)
Final Sedimentation Tank:	1 train (5.0 m^w x 26.0 m^l x 3.5 m^h x 10 tanks (20 waterways))
Disinfection tank:	5.0 m^w x 27.o m^l x 5.0 m^h x 4 waterways HRT (5.0 x 27.0 x 5.0 x 4)/141,000 x 24 x 60 = 27.5 min.
Gravity thickener:	1 tank with 14 m diameter and 3.5 m effective height
Centrifugal thickener:	2 units (includes 1 stand-by) with a capacity of 70 m3/hr.
Centrifugal dewatering:	2 units (includes 1 stand-by) with a capacity of 30 m3/hr.
Composting plant:	Fermentation vessel: 90 m x 50 m Curing yard: 60 m x 40 m x 2 yards Storage vessel: 20 m x 25 m x 4 units (for compost) Storage vessel: 15 m x 20 m x 2 units (for chaff)
Inlet pipe:	2 lanes of box culverts, 1,300 mm (w) x 1,200 mm (h)
Effluent pipe:	2,500 mm diameter
Buildings:	Main control building Lift pumping station Chlorination room Blower building Dewatering and centrifugal thickener building
Other facilities:	High voltage power station Piping and Power supply cable Bridge

Fig. 8.2 shows facilities to be constructed in Phase I.

The detailed drawings are prepared and compiled in Tender Drawings.

8.4 Site Preparation Works

8.4.1 General

The Wastewater Treatment Plant is located in Binh Hung ward, Binh Chanh. The area about 41 ha enclosed by canals has following special conditions:

a) No existing access roads to the site, so that until the temporary access road and the Tac Ben Ro bridge will be constructed, the waterway transportation must be used to transport material, equipment and labor to the site.

b) The existing ground level of the site is about +0.50 (mean sea water level of Mui Nai), it is 1.12m lower than the High Water Level of Tac Ben Ro river nearby the site. To avoid the inundation of the treatment plant, design gound elevation is proposed at +2.20.

c) The soil condition of this site is not suitable for construction. The geological structure of this area is similar with the other area nearby the site, while the thickness of soft organic soil layer ranging from 28m to 33m is much deeper than other area of less than 12m. This soft soil condition affects to the construction works seriously, especially to the filling works and excavation. The soil properties were analyzed and summarized in Table 8.1

This section treats the detailed design of site preparation consisting of Applicable codes and standards, Access to the site, Slope stabilization, Soft soil excavation and filling, and Protection of foundation of existing power supply tower.

8.4.2 Applicable Codes and Standards

For detailed design of site preparation, the following Standards shall be used:

a) Japanese Standard
b) ASTM
c) Vietnamese Standard

Special on the geology investigation, due to the available equipment of site test and laboratory test, the ASTM has been used.

8.4.3 Access to the Site

The construction of access to the site is the first priority work. As the access to the site, temporary access road, the Bridge crossing Tac Ben Ro river, and the Jetty are proposed.

a) The temporary access road is proposed from Chanh Hung street, which will be extended to the prison in Nha Be district to the proposed bridge crossing Tac Ben Ro river. The width of the road is designed at 6.00m of crushed stone surface on the laterite road base with a total length of 464m.

b) The Tac Ben Ro bridge will be used for daily operation after construction of the plant, but this bridge is also used as an access to the site for the construction period.

c) The jetty is designed by reinforced concrete structure with RC foundation piles 400mmx400mm. This jetty will be used for loading / unloading of materials and equipments transported by waterway for not only for phase I but also for phase II. The size of the jetty is proposed at 23.4m x 9.9m.

8.4.4 Prevention of Landslide

(a) Stability Calculation :
The Circular Arc Method meted by Fellenius was used for calculation of the total stress condition. Based on this calculation, the existing canal slope (without filling) is stable with the safety factor Fs = 1.09. The landslide will be occurred if any filling is conducted within 70m from the canal bank (Fig. 8.8 and 8.9).

(b) Slope Stabilization:
Due to the difficulty for prevention of slope sliding by normal method as sheet piling and timber piling, three (3) alternative methods of (1) Bamboo reinforced Netting Method, (2) Vacuum Preloading Method and (3) Soil Cement Mixing Method were studied:

Bamboo Reinforced Netting Method
The soft soil layer, which is required to improve shall be excavated to the certain depth and then backfilled mixed with sand and compacted with bamboo net reinforced in every 250mm thickness layer. The depth of the improvement varies depending on the distance from canal bank to the filling slope. The calculation result is as follow:

Distance (m) from the canal bank	10	20	30	40	50	60	70
Thickness (m) of the improvement	4.1	3.7	2.7	2.2	1.7	1.3	0.0
Width of bamboo band (m)	117	112	102	85	80	61	0

The disadvantage of this method requires the wide improvement area to protect the slope sliding with the excavation slope of 1:9 to 4.1 m deep, it means that at least 36m free space is required from the canal bank, so it is not practicable along the canal side. Fig. 8.10 shows the detail of Bamboo Netting Reinforcement Method.

The Vacuum Preloading Method

The Vacuum Preloading Method was studied to increase the strength of soft soil instead of preloading by filling which is impracticable to the soil condition of the Wastewater Treatment Plant area.

- The increment of soil strength by preloading method: Using the relation between Cu/Pc and Ip analyzed by Skemton as shown in Fig. 8.11, the value of Cu/Pc should be selected at 0.1 ~ 0.15. Theoretically, the atmospheric pressure by vacuum is 1kg/cm^2 but actually, the effective pressure is about 60% to 70% of theoretical pressure, the increment of Cu was calculated as follow:
  The increment of Cu after preloading:
  $\Delta Cu = (0.1 \sim 0.15)\ 0.6 \times 1.0 = 0.06 \sim 0.09$ (kg/cm^2)

- The slope stability calculation: Use the new value of Cu for calculation, the result is as follow:

  $Cu = 0.064 + 0.002z$ (kg/cm^2) (original)
  $Cu = (0.124 \sim 0.154) + 0.002z$ (new)

  With the new value of $Cu = 0.154 + 0.002z$ (kg/cm^2), the safety factor is Calculated at 0.88 (Fig. 8.12), it means that the Vacuum Preloading Method is not practicable to this area.

The Soil Cement Mixing Method

The Soil Cement Mixing Method is a new technology, which had been used to improve the soft soil condition at many areas in the world. A part of soft soil (in this case, 30% is adopted) is improved or replaced by cement mixing compound to the required depth. The Fig. 8.13 shows the required improvement area. The safety factor of 1.21 is achieved with the following improvement characteristics:

- Improvement ratio: 30%
- Improvement width: 20.0m
- Improvement depth: 33.0m
- Strength of improvement: 10kg/cm^2

This calculation was conducted based on the condition that the filling was done near the canal bank. This method requires the Reinforced concrete sheet pile along the canal bank for the construction period as supplementary. This makes the total cost of this option to be high. To reduce the cost, one alternative of this option to set back the filling site 23m from the canal bank is considered. This alternative can prevent the slope sliding without reinforced concrete sheet piles along the canal and reduce the required improvement area. Two (2) soil improvement methods of (1) Soil Cement Mixing improvement for lower layer of 25 m deep and (2) Sand Pile improvement for upper layer of 4.5m deep are applied. Fig. 8.14 shows the proposed improvement detail with the lay out of columns.
The equipment for this proposed soil improvement work, Soil Cement Mixing machinery, Bore Pile machinery will be required.

8.4.5 Soft Soil Excavation and Filling

Because of the soft soil condition, the filling work can not be done at once. The best level for excavation work starting is 0.00, if the site is filled higher than this level, the landslide will occur seriously. Finally, the first filling level is designed at 0.00, the piling and the excavation will be carried out, the underground structures will be built and then the final fill to level +2.20 will be done after that. Accordingly the soft soil excavation level is designed at –0.50, if the soft soil is deeper, as checked by Cone Penetration test, the result is less than 100Kpa, the deeper excavation is required.
Because the working level is lower than the high water level, the Care Water has to be considered strictly, the temporary dike, trench, pumping system have to be constructed accordingly.

8.4.6 Site Settlement During Operation and Treatment Procedure

(1) Settlement Calculation

(a) Final Settlement: As described in 8.4.1, the Wastewater Treatment site area contains a very soft soil layer with the thickness of 28 m to 33 m. This layer causes a big settlement by soil filling load. Total final settlement under self-weight and soil filling load is about 2,067 mm. Table 8.2 and 8.3 show the calculation of the settlement under the self-weight and the final filling at EL +2.20.

(b) Over the study about the consolidation and the characteristics of the soil, we found out that this type of soil has a very high plasticity. The velocity of the potential water under pressure is very small about $1*10^{-8}$cm/s. Therefore, the settlement will occur very slowly during the operation. The calculation shows that the total settlement is 109 mm, 208 mm, and 286 mm after 10 years, 30 years, and 50 years, respectively. Table 8.4 to 8.6 show the calculation of the settlement by time.

(2) Countermeasure of Settlement

The settlement under WWTP facility is small because RC pile is driven for the foundation. However, the other area is settled. The internal road and parking areas are over laid on the existing with 100 mm of asphalt after 10 years and 100 mm of asphalt after 30 years again. The rest of area is left without any countermeasure because of no effect for the operation of the facilities.

8.4.7 Existing Power Tower Protection

There are two (2) high voltage power supply towers existed in the site. The influence of the earth works to the foundation of existing towers was studied to find out the protection method. The movement caused by the filling to the tower foundation was calculated as shown below:

During construction period :	Settlement S = 139x1.5 = 209mm (Fs = 1.5)
	Rotation = 209x1/3/15600 = 1/224
After 30 years: Settlement :	S = 208x1.5 = 312mm (Fs = 1.5)
	Rotation = 312x1/3/15600 = 1/150

The calculation of the Settlement and the Settlement by Time are detailed in Table 8.2 to 8.6.

After the discussion with the Electric Consultant Company and the Hiep Phuoc Management who is managing this power system, the displacement as calculated is complied with management regulation and accepted by Hiep Phuoc company. Finally, the protection of the tower is concentrated on the steel tower structure. The lower parts of the tower shall be covered by reinforced concrete and waterproof membrane prior to filling. The protection option is shown in Fig 8.15.

8.5 Civil works

8.5.1 General

This section treats the detailed design of civil works of WWTP.

Civil works consists of Structure works, Earth works and Temporary works.

The civil works cover the substructure design and the architectural works cover the superstructure design.

All structures are designed by reinforced concrete except effluent pipe by pre-cast concrete.

The following main structures and earth works were designed as civil :

a) Lift Pumping Station
b) Wastewater Treatment Plant
c) Disinfection Tank
d) Water Supply Facility
e) Effluent Pipe
f) Pipe Gallery
g) Substructure of Main Building
h) Substructure of Blower Building
i) Substructure of Dewatering Building
j) Gravity Thickener
k) Compost Plant Facilities
l) Connection Pipe
m) Landscape Works
n) Sanitary Sewer
o) Conveyance Sewer
p) Temporary Works

8.5.2 Applicable Codes and standards

In Detail Design, 3 design standards were compared.
(a) Japanese Standard
(b) Vietnam Standard
(c) BS Standard

Comparative table refer to Design Report.
In comparison of 3 Standards, allowable stress of Japanese Standard is the most strict for structure design.
To consider the Wastewater Treatment Plant is important facility and it should be use for more than 50 years, Japanese Standard is the most applicable standard for detailed design.
And Ministry of Construction (MOC) accepted to use the Japanese Standard for detailed design of civil works by MOC's circular on the application of standard, procedure and regulations on construction technique. Hanoi, April 24 1995.
Following design standards were applied for detailed design of civil works:

(a) Road Bridge Substructure Design Standard (Japan Road Association 1994)
(b) Standard Specification for Design and Construction of Concrete Structure (The Japan Society of Civil Engineers 1996)
(c) Structure Design Index (Japan Sewage Works Agency 1998)
(d) Temporary Structure Design Index (Japan Sewage Works Agency 1998)
(e) Hand Book for Design of Road and Bridge (Vietnam)

8.5.3 Design Conditions and Criteria

(a) Allowable stress

Concrete

Concrete	210(kg/cm^2)
Bending compressive stress σ_{ca}	70(kg/cm^2)
Shearing stress τ_{ca}	3.6(kg/cm^2)

Reinforcement

Reinforcement	deformed bar
Tensile and compressive stress τ_{sa}	1,600(kg/cm^2)

(b) Design Loads

- Design ground level + 2.200 m
- Under ground water level 0.00 m
- Unit weight of soil $\gamma = 1.8$(t/m^3), friction angle $\phi = 30$ º
- Under ground water $\gamma' = 0.8$ (t/m^3)
- Vehicle load H30 (30T)
- Under ground water load P_w (unit weight is 1.0t/m^3)
- Soil pressure P = (vertical soil load) × K_o
  $K_o = 0.5$ (Earth pressure at rest)
- Horizontal load pressure P_v = (Vertical load) × K_o
- Axial load $P_a = 1.0$ t/m^2

Here showed main items of design conditions.
Other items refer to Design Report.

8.5.4 Structural Design

(a) Lift Pumping Station
Structure of Lift Pumping Station is shown below.

- Width 35.50 m
- Length 30.60 m

- Depth 7.40 ~ 10.40 m (from + 2.20 m)

6 pumps of ϕ 700 × 3 units and ϕ 1000 × 3 units will be installed at the final phase.
In Phase I, half structure of Lift Pumping station was designed to meet the inflow volume of 192,000 m^3/day in Phase I.
For future expansion of structures, temporary wall were designed for smooth expansion in future.

(b) Wastewater Treatment Plant
Wastewater Treatment Plant consists of 6 main facilities as shown below.

- Inlet Water Way (1800mm × 1800mm × 2 way, L = 300 m)
- Distribution Tank
- Primary Sedimentation Tank (W5.00 × L 13.00 × Water depth 3.00 ~ 3.26, 20 ponds × 8 train = 160 ponds)
- Aeration Tank (W10.50 × L 29.50 × Water depth 5.00, 10 ponds × 8 train = 80 ponds)
- Final Sedimentation Tank (W5.00 × L 26.00 × Water depth 3.50 ~ 4.00, 20 ponds × 8 train = 160 ponds)
- Pipe Gallery (W 4.00, 8.00, 12.00)

For the final phase, Wastewater Treatment Plant is required to treat the wastewater of 512,000 m^3/day and it requires the space of 478 m × 187 m = 89,400m^2.
Wastewater Treatment Plant is divided into eight (8) trains.
For Phase 1, one (1) will be constructed to treat 141,000 m^3/day wastewater.
In this detailed design, one (1) train was designed.
Also temporary wall were designed for future expansion of structures.

(c) Disinfection Tank
For the final phase, Disinfection Tank is required of W 5.00 m × H 5.50 m × L 204 m.
While for phase 1, half of disinfection tank structure will be constructed.
So in Detail Design, half of disinfection tank structure was designed.
Also temporary wall was designed for future expansion of structures.

(d) Water Supply Facility
Water supply facility was designed as the architecture works.
Whole structures were designed in Phase I stage.

- Width 20.50 m
- Length 60.50 m

- Height(inside) 6.80 m

(e) Effluent Pipe

Effluent pipe was planned to discharge a treated wastewater from disinfection tank to TAC BEN RO river.

- Pipe Pre-cast Concrete Pipe
- Diameter 2500 mm
- Construction Length 99.0 m

Effluent pipe passing under the road, the pipe is reinforced by concrete to protect a pipe from vehicle load.

(f) Pipe gallery

Pipe gallery was planned to connect each treatment facilities under the ground.
The shape is box-culvert type and pipelines and electric cables are installed inside of pipe gallery.

- Width 4.00 m, 8.00 m
- Height (inside) 3.50 m
- Total Construction length 267 m

(g) Main Building

All substructures were designed in this stage.

- Pipe Gallery Part (W 8.80m × L 48.00m × H 5.30m)
- First Floor Part (W20.00m × L40.00m)
- Stairs Part (W3.50m × L9.35m)

(h) Blower Building

Necessary part of 1st floor and under ground floor(3 spans among 10 spans) and under ground pipe gallery were designed in this stage.
Also temporary wall were considered.

- Pipe Gallery Part (W 8.80m × L 72.80m × H 5.30m)
- Under Ground Floor Part (W16.00m × L21.00m
- First Floor Part (W24.00m × L21.00m)

(i) Dewatering Building

Necessary part of 1st floor and under ground floor (9 spans among 14 spans) and under ground pipe gallery part were designed in Detail Design.

Also temporary wall were considered.

- Pipe Gallery Part 1 (W 7.30m × L 67.50m × H 5.20m)
- Pipe Gallery Part 2 (W 8.80m × L 26.00m × H 5.20m)
- First Floor Part (W26.00m × L72.00m)
- Stairs Part (W2.70m × L8.20m)

(j) Gravity Thickener

For requirement of Phase I, one (1) tank was designed.

- Diameter 14.00 m
- Water depth 3.50 m

(k) Compost plant facilities

All substructures were designed in this stage.

- Fermenting Vessel W 46.80m × L 89.80m × H 4.60m
- Deodrization Tank W 10.60m × L 42.60m × H 2.15m
- Drain Ditch 0.30m × 0.30m × 170.00m
- Drain Pit W 1.30m × L 2.30m × H 0.95m
  W 1.50m × L 2.50m × H 3.40m

(l) Connection Pipe

Connection pipe was planned to send treated wastewater from Wastewater Treatment Plant to Disinfection tank.

- Pipe Steel Pipe
- Diameter 2500 mm
- Construction Length 67.0 m

8.5.5 Foundation of Structures

According to result of soil investigation, the typical soil condition of Wastewater Treatment Plant sight is shown below.

	+0.50 m Existing GL (average)
OH Layer (Upper Layer) (Organic Clay)	rw = 1.42 t/m^3 (submerged 0.42 t/m^3) qu = 1.76 t/m^2 (C = 0.88 - use 0.9 t/m^2) N = 0 ~ 2 – 19.60 m (Average)
OH Layer (Lower Layer) (Organic Clay)	rw = 1.47 t/m^3 (submerged 0.47 t/m^3) qu = 2.34 t/m^2 (C = 1.17 - use 1.2 t/m^2) N = 2 ~ 3 – 27.70 ~ – 32.10 m
CL Layer (Sandy Clay)	rw = 2.00 t/m^3 (submerged 1.00 t/m^3) qu = 11.8 t/m^2 (C = 5.9 t/m^2) N = 13 ~ 26 – 30.00 ~ – 33.60 m
SP Layer SM Layer (Silty or Poorly Graded Sand)	Rw = 1.80 t/m^3 N = 25 ~ 28 (Maximum friction ratio = 0.2 × 25 = 5 t/m^2)

OH layer is very soft and high plasticity.
As the result of investigation of settlement of consolidation, settlement of consolidation should occur when filling is done.
Settlement of consolidation will continue more than 50 years.
Filling is designed to make a + 2.20 m ground level, which is design ground level of Wastewater Treatment Plant.
According to the result of the calculation, settlement of consolidation is 30 cm within 30 years after filling is finished.
Good soil conditions are from CL layer or lower layer.
Wastewater Treatment plant is designed to treat a wastewater by gravity flow.
Wastewater flow into next facility by necessary difference of water level.
If there occur an uneven settlement, the necessary difference of water level can not keep between each facilities.
That is why pile foundation is necessary to protect the uneven settlement between each facilities.
It is necessary to consider a negative friction for pile, because OH layer is very soft and settlement of consolidation should occur.

Calculation condition
Pile: Precast Concrete Pile 400 × 400, 300 × 300
Average pile length: 35.00 m
Embed depth for SP(SM) Layer is 3.00 m
Consider a positive friction for pile about CL Layer and SP(SM) Layer
Consider a negative friction for pile about OH Layer

8.5.6 Temporary Works Design

From planning construction ground level of 0.00 m to -4.10 m level, open cut method was proposed for excavation method.
And sheet pile method was designed for deep structures, such as Lift Pumping Station and Inlet Water Way.
Sheet pile method was also designed to construct a discharge pipe to protect the river water.

8.6 Architectural Design

8.6.1 Architectural Works

8.6.1.1 General

(1) Introduction
This report presents the outline of the Detail Design of Architectural Works for package E – Wastewater Treatment Plant. The Detail Design was prepared based on the Concept design which had approved in last stage. The Detail Design aims to develop details sufficient for the tendering of the project under the financial assistance from the Japanese Government and Vietnamese Government. This report explains studies carried out since the Concept Design, and should be read in conjunction with the relevant Tender Drawings, Finish Schedules, Bills of Quantities and Engineer's Cost Estimates, which are prepared and submitted in separate volumes.

(2) Scope of Architectural Works
a) Lift Pumping Station
b) Chlorination Storage Building
c) Construction of Blower Building
d) Main Office Building
e) Dewatering Building
f) First Fermentation Tank
g) Second Fermentation Tank

h) Storage Vessel
i) Sub-Storage Vessel
j) Compost Control Building
k) Guard House
l) Staircase A
m) Staircase B
n) Staircase C

(3) Applicable Codes and Standard

National Building Codes of Vietnam, 1999 (TCVN) for construction codes and material requirements.

Fire prevention & fire protection for buildings – Design requirements TCVN 2622 – 1995.

National Building Codes of Japan JIS & JASS.

(4) Design Concept

Overall Concept:

The Design Concept applied for all building is:

- Fit for purpose and function
- Friendly to environment, society of Vietnam
- Harmonize with material market in Vietnam
- Accordant and united architecture external language in whole project

8.6.1.2 Lift Pumping Station

(1) Building Site

The site of Lift Pumping Station is to the northeast of Main Office Building.

(2) Functional requirements

Functional requirements of Lift Pumping Station are:

- Future expandability
- Fit for equipment layout and activities

The total area and its breakdown were estimated from the equipment layout.

(3) Floor Plan

The plan of Lift Pumping Station is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-300-01).

Floor plan includes pump room and staircase. All room has natural ventilating by fixed louvers. In order to install equipments, openings at specified location were opened to fit for purpose.

Considering the future expandability, temporary wall was built in the northwest of

building without any openings to make it easy for demolition in future.
As a result of the Detail Design, total floor area of building is as follows:

- Pump room 203 m^2
- Staircase 23 m^2

  Total 226 m^2

(4) Elevations and Sections

The footprint of this building is 13.5m × 15.2m, and the height is about 10.3m (From the ground to the top of roof ridge). The super structure is of one story with concrete frames. The curved roof with zincalume roofsheet is used to suit weather condition, the corrosion resistance, long life, and have the same architectural language in the whole project. One-slope roof was designed as to ensure a clear space from the concrete roof for equipment activities as to minimize the amount of flush water on concrete roof. The minimum interior height of pump room is 6.8m and the height of steel shutters is 4m so as to allow moving of equipment.

(5) Finishing

The key words of the appropriate finishing materials for Generator building are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.3 Chlorination Storage Building

(1) Building site

Chlorination Storage Building faces to the northeast of Main Office Building.

(2) Functional requirement

Functional requirement of Chlorination Storage Building are:

- Safe for chemical storing
- Facilities for working

The total area and its breakdown were estimated from the capacity and the number of chemical tank.

(3) Floor plan

The plan of Chlorination Storage Building is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-301-01)

600H concrete retaining wall with trench and pit system enclosure the hypochlorite storage to ensure technical condition in chemical storing. Windows were opened to maximize natural lighting in worker room. The removable stainless steel handrail and 4m height steel shutter allow importing chemical and equipment into storages.
As a result of the Detail Design, total floor area of building is as follows:

- Staircase 16.8 m^2
- Chlorination storage 104 m^2
- Hypochlorite storage 61.5 m^2 x 2
- Worker room & corridor 120.7 m^2
- Electric room 74.8 m^2
- Pantry 5 m^2
- Toilet 8 m^2

  Total 452 m^2

(4) Sections and Elevations

The footprint of this building is 14m x 32.3m, the height of lower block is about 6.4m and the height of higher block is about 8m (From the ground to the top of roof ridge). The super structure is of one story with concrete frames. The curved roof with zincalume roofsheet is used to suit weather condition, the corrosion resistance, long life, and have the same architectural language in the whole project.

(5) Finishing

The key words of the appropriate finishing materials for Generator building are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.4 Blower Building

(1) Building Site

The site of Blower Building is in the same line and to the northeast of Main Office Building.

(2) Functional Requirement

Functional requirements of Blower Building are:

- Future expandability
- Fit for equipment layout and activities

- Meet the technical requirements for air corridor

The total area and its breakdown were estimated from the above.

(3) Floor Plan

The plan of Blower Building is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-302-01)

Fresh air was supply for basement through fixed air louvers and concrete corridors. In the whole building, concrete spandek minimize the noise from blower. All ventilating system have were enclosed by sound trap louver for noise minimizing.

Considering the future expandability, temporary wall was built in the northwest of building without any openings to make it easy for demolition in future. In order to install equipments, openings at specified location were opened to fit for purpose. And column bay was stretched along the verticality to ensure crane activity.

As a result of the Detail Design, total floor area of building is as follows:

- Toilet 15 m^2
- Staircase 33 m^2 x 2
- Air corridor 267 m^2
- Blower room (First stage) 980.5 m^2
- Blower room (Future) 416.5 m^2

  Total 1745 m^2

(4) Sections and Elevations

The footprint of this building is 24.8m x 70.4m, and the height is about 14.8m (From the ground to the top of roof ridge). The super structure is of one story with concrete frames. The curved roof with zincalume roofsheet is used to suit weather condition, the corrosion resistance, long life, and have the same architectural language in the whole project.

The requirement height for activities and maintenance of crane is 10.5m; the height of steel shutter is 4m so as allow equipment installation and maintenance. In order to allow a free access of equipment, gentle slope connect the different level from outside into building.

(5) Finishing

The key words of the appropriate finishing materials for Generator building are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.5 Main Office Building

(1) Building Site

Main office building is located in the center of the plot, to be adjacent to Dewatering Building in the Northwest, Lift pumping station in the Southeast, and Compost Control Building in the North.

(2) Functional Requirement

Functional requirements of Main Office Building are:

- Meeting requirements of a workplace of Administration Department, in which people can work, study and have some important meetings.
- Meeting technical requirements for one Laboratory of water samples.
- Meeting technical requirements for one Control room in which people can obverse, check all activities in other surrounding buildings.

(3) Floor Plan

The plan of Blower Building is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-303-01 and PE-WWTP-303-02)

(a) First Floor plan:

- Large lobby with a solemn canopy.
- Laboratory, Electric room, Generator room, and Storage are located at ground floor for convenient setting of technical equipments. Their area is as follow:
  - Lobby: 105m^2
  - Storage: 40m^2
  - Laboratory : 142m^2
  - Electric room : 289.5m^2
  - Generator room: 213m^2
  - Male Restroom: 7m^2
  - Female Restroom: 7m^2

  Total: 896m^2

(b) Second Floor plan: There are rooms in which people need calm atmosphere such as: Office, Worker room, Library ,Meeting room , Control room and Restroom, Locker room, some utility rooms. Their area is as follow:

- Control room : 142m^2
- Library: 83m^2
- Night duty: 20m^2
- Tea room : 19m^2
- Male & female Restroom: 47m^2
- Male & female locker: 41m^2
- Office: 142m^2

- Worker room : 120m^2
- Meeting room: 90m^2

  Total: 896m^2

(4) Elevations and Sections

The footprint of this building is 21m x 40.5m, and the height is about 11.2m (From the ground level to the top of roof ridge). The structure of Main Office Building is concrete frames. The curved roof with zincalume roof sheet is used to suit weather condition, the corrosion resistance, long life, and have the same architectural language in the whole project.

The height of ground floor is 4.5m. There are two 3.5m-height steel shutters and a gentle slope connect the different level from outside into building in order to allow a free access of equipment.

(5) Finishing

The key words of the appropriate finishing materials for Main Office Building are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.6 Dewatering Building

(1) Building Site

The site of Blower Building is in the same line and to the northwest of Main Office Building.

(2) Functional Requirement

Functional requirements of Dewatering Building are:

- Future expandability
- Meeting technical requirements for dewatering process in which waste water can be analyzed into 2 kinds : recycle water, sludge.

  Also, meeting requirements for truck going in and transferring sludge.
- Fit for equipment layout and activities

(3) Floor Plan

The plan of Blower Building is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-304-01 and PE-WWTP-304-02)

(a) First Floor plan :

- Hooper room is located at ground floor. It is easy for truck to go in and out with a slight slope in front of steel shutter.
- Concrete mixed sludge tank, sludge tank, recycle flow tank, treated water tank are set around pump room at ground floor ,with their area as follow:

• Hooper room:	327.5 m^2
• Two mixed sludge tank:	238 m^2
• Sludge tank, recycle tank, treaded water tank:	285 m^2
• Pump room:	1105 m^2
Total:	1956 m^2
Future expansion area:	1090 m^2

(b) Second Floor plan: There are Centrifugal Thickener ,Chemical Fitting Room, Electric room ,Control Room ,Worker Room, Storage and Restroom, with their area as follow:

• Centrifugal Thickener:	881 m^2
• Chemical Fitting Room:	538 m^2
• Electric room:	324 m^2
• Control room:	111 m^2
• Worker room:	53 m^2
• Storage:	18 m^2
• Restroom:	16 m^2
Total:	1956 m^2
Future expansion area:	1090 m^2

(4) Elevations and Sections

The footprint of this building is 27m x 73m. Elevation of this building is formed by two different-height block. The height is about 24.6m for higher block and 17.3m for lower block (From the ground level to the top of roof ridge). The main structure of Dewatering Building is concrete frames. And Roof structure is curved steel truss. Roofsheet is zincalume in order to suit weather condition, the corrosion resistance, long life, and have the same architectural language in the whole project.

The requirement height for activities and maintenance of crane is 8,7m; the height of steel shutter is 4m so as allow equipment installation and truck's transference. In order to allow a free access of equipment, gentle slope connect the different level from outside into building.

(5) Finishing

The key words of the appropriate finishing materials for Generator building are:

- Durability

- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.7 First Fermentation Tank

(1) Building Site

First Fermentation Tank located between Compost Control Building and Second Fermentation Tank.

(2) Functional Requirement

Functional requirement of First Fermentation Tank are:

- Stairway to floor below
- Good ventilating structure

(3) Floor Plan

The plan of First Fermentation Tank is designed to meet with operations of floor layout below and ventilation purpose (Ref. To Detail Design Drawing No. PE-WWTP-305-01)

Total area 4,121 m^2

(4) Elevations and Sections

The footprint of this building is 45.8m x 88.8m, and the height is 8.2m (column base to roof top). Clear span of 19.9 meters / each span provides efficient operation. Two slope metal roof designed to have well flood water draining. Ridge ventilation is provided to give more nature ventilation. Translucent sheeting with ratio 7%, can provide substantial savings in energy consumption due to artificial lighting not being required during daylight hours.

(5) Finishing

The key words of the appropriate finishing materials for the staircases of First Fermentation Tank are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.8 Second Fermentation Tank

(1) Building Site

Second Fermentation tank faced to the northeast side of First Fermentation Tank.

(2) Functional Requirement

Functional requirement of Second Fermentation Tank are:

- Access for folk-lift using
- Enough sludge bunker
- Good ventilating structure

The total area was calculated to contain designed sludge amount.

(3) Floor Plan

The plan of Second Fermentation Tank is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-305-21)

Considering of volume of contained sludge and operations of folk-lift, Sludge bunkers were separated by concrete wall, which is 3.3m high from the ground level.

As a result of the Detail Design, total floor area of building is as follows:

- Sludge bunkers and internal access 5462 m^2

  Total 5462 m^2

(4) Elevations and Sections

The footprint of this building is 40.4m x 135.2m, and the height is 5.1m (column base to roof top). Clear span of 20 meters / each span provides efficient operation and sludge bunker layout. Two slope metal roof designed to have well flood water draining. Translucent sheeting with ratio 7%, can provide substantial savings in energy consumption due to artificial lighting not being required during daylight hours.

(5) Finishing

The key words of the appropriate finishing materials for Second Fermentation Tank are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.9 Storage Vessel

(1) Building Site

Storage Vessel faced to the northwest side of Second Fermentation Tank.

(2) Functional Requirement

Functional requirement of Storage Vessel are:

- Access for folk-lift using

- Enough sludge bunker

The total area was estimated from sludge amount.

(3) Floor Plan

The plan of Storage Vessel is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-305-41).

Considering of volume of contained sludge and operations of folk-lift, Sludge bunkers were separated by concrete wall, which is 3.3m high from the ground level.

As a result of the Detail Design, total floor area of building is as follows:

- Sludge bunkers 2053 m^2
  Total 2053 m^2

(4) Elevations and Sections

The footprint of this building is 20.4m x 100.4m, and the height is about 6m (from the ground to the top of roof ridge). Clear span of 12.5 meters / each span provides efficient operation and sludge bunker layout. One slope metal roof designed to have well flood water draining. Translucent sheeting with ratio 7%, can provide substantial savings in energy consumption due to artificial lighting not being required during daylight hours.

(5) Finishing

The key words of the appropriate finishing materials for Storage Vessel are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.10 Sub-Storage Vessel

(1) Building Site

Sub-Storage Vessel faced to the northwest side of First Fermentation Tank.

(2) Functional Requirement

Functional requirement of Sub-Storage Vessel are:

- Access for folk-lift using
- Enough sludge bunker

The total area was estimated from sludge amount

(3) Floor Plan

The plan of Sub-Storage Vessel is designed under the following considerations (Ref. To

Detail Design Drawing No. PE-WWTP-305-61).

Considering of volume of contained sludge and operations of folk-lift, Sludge bunkers were separated by concrete wall, which is 3.3m high from the ground level.

As a result of the Detail Design, total floor area of building is as follows:

- Sludge bunkers 314 m^2
  Total 314 m^2

(4) Elevations and Sections

The footprint of this building is 20.4m x 15.4m, and the height is about 8.2m (from the ground to the top of roof ridge). Clear span of 20 meters / each span provides efficient operation and sludge bunker layout. Two slope metal roof designed to have well flood water draining. Translucent sheeting with ratio 7%, can provide substantial savings in energy consumption due to artificial lighting not being required during daylight hours.

(5) Finishing

The key words of the appropriate finishing materials for Sub-Storage Vessel are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.11 Compost Control Building

(1) Building Site

Compost Control Building faced and to the northwest of Main Office Building. This building is also in the opposite of Second Fermentation Tank.

(2) Functional Requirement

Functional requirement of Compost Control Building are:

- Future expandability
- Facilities and comfortable office
- Technical condition for equipment installation
- Connect different levels from Pipe Gallery to Compost Electric Room

The total area and its breakdown were estimated from the above.

(3) Floor Plan

The plan of Compost Control Building is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-305-81).

Floor plan includes technical rooms, facilities and office. In order to install and maintenance equipment, the height of steel door is 4m. Natural lighting was maximized

by windows in the whole building for energy saving.

As a result of the Detail Design, total floor area of building is as follows:

- Staircase 19.5 m^2
- Compost electric room 140 m^2
- Office and Control room 124 m^2
- Storage and Workshop room 86 m^2
- Worker room 103 m^2
- Kitchen 26 m^2
- Toilet 55 m^2
- Changing room 26 m^2

Total 580 m^2

(4) Elevations and Sections

The footprint of this building is 55.4m x 10.4m, and the height is about 7.3m (From the ground to the top of roof ridge). The super structure is of one story with concrete frames. The curved roof with zincalume roofsheet is used to suit weather condition, the corrosion resistance, long life, and have the same architectural language in the whole project.

(5) Finishing

The key words of the appropriate finishing materials for Compost Control Building are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.12 Guard House

(1) Building Site

Guard House located nearby the main entry of Plant.

(2) Functional Requirement

Functional requirement of Guard House are:

- Facilities and comfortable office
- Safe and wide-view watching from the security room

The total area and its breakdown were estimated from the above.

(3) Floor Plan

The plan of Guard House is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-306-01).

Floor plan includes security room and facilities, which have natural ventilating. Sliding windows are provided in security room in order to check-in and check out. Natural lighting was maximized by windows in the whole building for energy saving.
As a result of the Detail Design, total floor area of building is as follows:

- Night duty 12 m^2
- Locker 7.5 m^2
- Changing room 10 m^2
- Toilet 9 m^2
- Security room 40 m^2

  Total 79 m^2

(4) Elevations and Sections

The footprint of this building is 7.5m x 10.4m, and the height is about 5m (From the ground to the top of roof ridge). The super structure is of one story with concrete frames. The curved roof with zincalume roofsheet is used to suit weather condition, the corrosion resistance, long life, and have the same architectural language in the whole project.

(5) Finishing

The key words of the appropriate finishing materials for Guard House are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.13 Staircase A

(1) Building Site

Staircase A located behind and to the southeast of Main Office Building.

(2) Functional Requirement

Functional requirement of staircase A is:

- Connect different levels from basement to Wastewater Treatment Plant

The total area and its breakdown were estimated from the above.

(3) Floor Plan

The plan of Staircase A is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-306-21).
Floor plan includes staircase and penetration. In order to install and maintenance equipment, opening at specified location were opened to fit for purpose. It was enclosed by aluminum baluster and handrail for protection.

As a result of the Detail Design, total floor area of building is as follows:

- Staircase (First floor) 71 m^2
- Staircase (Second floor) 55 m^2
- Penetration 11.5 m^2

  Total 82.5 m^2

(4) Elevations and Sections

The footprint of this building is 5.2m x 16.5m, and the height is about 7m (From the ground to the top of roof ridge). The super structure is of two stories with concrete frames.

In order to allow a free access of equipment, gentle slope connects the different level from outside into building. External wall is paint with waterproofing material to suit the weather condition. Closed penetration supplies fresh air to the basement.

(5) Finishing

The key words of the appropriate finishing materials for Staircase A are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.14 Staircase B

(1) Building Site

Staircase B located in the same line and to the northeast of Staircase A. It connects different levels to Wastewater Treatment Plant.

(2) Functional Requirement

Functional requirement of staircase B are:

- Fit for equipment installation and maintenance
- Separated electric room of Wastewater Treatment Plan
- Connect different levels from basement to Wastewater Treatment Plant

The total area and its breakdown were estimated from the above.

(3) Floor Plan

The plan of Staircase B is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-306-41).

Floor plan includes staircase, penetration and electric room, which control Wastewater Treatment Plan. In order to install and maintenance equipment, opening at specified location were opened to fit for purpose. It was enclosed by aluminum baluster and

handrail for protection.

As a result of the Detail Design, total floor area of building is as follows:

- Staircase (First floor) 71 m^2
- Staircase (Second floor) 55 m^2
- Penetration 11.5 m^2
- Electric room 89.5 m^2

  Total 227 m^2

(4) Elevations and Sections

The footprint of this building is 5.2m x34.3m, the height of lower block is about 4m and the height of higher block is 7m (From the ground to the top of roof ridge). The super structure is of two stories with concrete frames.

In order to allow a free access of equipment, gentle slope connect the different level from outside into building. External wall was paint with waterproofing material to suit the weather condition. Closed penetration supplies fresh air to the basement.

(5) Finishing

The key words of the appropriate finishing materials for Staircase B are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.1.15 Staircase C

(1) Building Site

Staircase C located in the same line and to the northeast of Chlorination Storage Building. It connects the basement to Wastewater Treatment Plant.

(2) Functional Requirement

Functional requirement of staircase A is:

- Connect different levels from basement to Wastewater Treatment Plant

The total area was estimated from the above.

(3) Floor Plan

The plan of Staircase C is designed under the following considerations (Ref. To Detail Design Drawing No. PE-WWTP-306-61).

Floor plan only contents staircase, which connect the basement to ground level.

As a result of the Detail Design, total floor area of building is as follows:

- Staircase 40 m^2

Total 40 m^2

(4) Finishing

The key words of the appropriate finishing materials for Staircase C are:

- Durability
- Low cost
- Ease of maintenance

Proposed exterior and interior finishing schedules are shown in Finish Schedule for Architectural Works, which are prepared and submitted, in separate volumes.

8.6.2 Structural Works

8.6.2.1 General

(1) Introduction

This report presents the outline of Detailed Design of Structural Works for the Waste Water Treatment Plant Project (Package E). The Detail Design was prepared based on the Basic Design, which was accepted in principle by the Pacific Consultants International. The Basic Design sets out the following in principle:

a) Applicable design codes and standards
b) Appropriate structural systems

(2) Scope of Structural Works

There have been not any changes in scope of Structural Works for the Wastewater Treatment Plant project (Package E). The scope consists of the following buildings : (In this report, only main buildings are described)

a) Lift Pumping Station
b) Chlorination Storage Building
c) Blower Building
d) Main Office Building
e) Dewatering & Centrifugal Thickener Building
f) First Fermentation Tank
g) Second Fermentation Tank
h) Storage Vessel
i) Sub Storage Vessel
j) Compost Control Building
k) Guard House
l) Stair A (Wastewater Treatment Plan)

m) Stair B (Wastewater Treatment Plan)
n) Stair C (Water Supply Treatment Plan)

(3) Applicable Codes and Standards

There has been no change in applicable codes, standards, and references for the design of Structural Works.

a) British Standard
b) TOVN
c) JIS
d) JASS
e) American Standard for materials ASTM

(4) Structural Materials

(a) Concrete

Unless otherwise stated, concrete used for this project is as follows:

- Concrete grade 300, 10x20 gravel
- Lean concrete grade 100, 40x60 stone

(b) Reinforcement

Unless otherwise stated, reinforcement used for this project is as follows:

Steel diameter (mm)	Design tensile strength (kg/cm^2)
Equal or smaller than 8	2300
From 10 to 16	2800
Greater than 16	3600

(c) Structural steel

- Structural steel, plates to be CT3 type,
  design tensile strength: R_a = 2,100 kg/cm^2
- Bolt type 5.6, design shear strength: R_c = 1,900 kg/cm^2,
  design tensile strength: R_k = 2,100 kg/cm^2
- Weld design strength: R_g = 1,500 kg/cm^2

8.6.2.2 Lift Pumping Station

(1) General :

- Lift pumping Station has a ground floor and a galvanized sheet roof
- Next to the building is a big tank with a thick wall. The designer consider the structure is fix supported by this tank
- Longitudinal column span is 4m, maximum span is 7.15m.

(2) Design Conditions and Parameter

- Roof structure, as shown on drawing, is a steel truss roof

8.6.2.3 Chlorine Storage Building

(1) General

- Chlorination Storage Building has a ground floor and a galvanized sheet roof
- The structure includes 2 parts. First part (from grid line 1~3) has a ground floor and a galvanized sheet roof, maximum span is 5.1m. Ground floor has 6m high tanks with - reinforcement concrete wall. The second part (from grid line 3~6) has a ground floor with a maximum span of 8.2m.
- Maximum longitudinal column span is 8m.

(2) Design Conditions and Parameter

- Water tank system is designed to resist water pressure applying to water tank wall and slab.
- Roof structure, as shown on drawing, is a steel truss roof.

8.6.2.4 Blower Building

(1) General

- The Blower Building has a structural frame consists of reinforcement column system supports a horizontal I beam grid system.
- Roof system supported by 200mm thick wall placed on concrete roof slab. This roof slab is casted on metal galvanized sheets, that are connected to I beam system.
- Maximum roof beam span is 16m, longitudinal frame span is 7m.

(2) Design Conditions and Parameter

- Blower building roof truss system is designed to carry load on roof due to material load (dead load) and worker load in case of repairing.
- For further information, refer to calculation sheet.

8.6.2.5 Main Office Building

(1) General :

- Main Office Building is a 2 story building, including 1 reinforcement concrete slab and 1 roof covered by galvanized sheet. Besides, on the roof has a 8x10m water tank.
- Maximum longitudinal column span is 10m, maximum span is 8m.

(2) Design Conditions and Parameter

- Water tank system is designed to resist water pressure applying to water tank wall and slab.
- Second floor is design to bear a load caused by workers. Refer to calculation sheets for further information.
- Roof structure, as shown on drawing, is a steel truss roof.

8.6.2.6 Dewatering & Centrifugal Thickener Building

(1) General

- Dewater Building is a 2 story building. Besides 2 reinforcement slabs, it has a steel truss roof.
- Ground floor has a water tank system, including Water Tank and Mixed Sludge Tank.
- There have been 2 areas in Dewater Building, the first area (from grid line 10~6) has 2 cranes, with a roof of +23,2m high, height of roof for the other one is 16m.
- There have been 2 spans for first area with length of span is 13m for each.

(2) Design Conditions and Parameter

- Water tank system is designed to resist water pressure as well as machine load imposed on water tank top slab.
- Second floor is design to bear a load caused by machines, workers. Refer to calculation sheets for further information.
- Load applied to frame due to operation of crane to be considered in design works.
- Roof structure, as shown on drawing, is a steel truss roof.

8.6.2.7 Second Fermentation Tank

(1) General

- The Second Fermentation Tank has a structural frame consists of reinforcement column system supports a steel truss roof by Kirby Steel.
- Ground floor slab base on ground beams and pile foundation system.
- There has been 2 spans with length of span is 20m for steel column.

(2) Design Conditions and Parameter

- The Second Fermentation Tank is designed with 300mm thickness RC wall system.
- Ground floor slab is design to bear a load caused by contain mud, workers. Refer to calculation sheets for further information.
- Roof structure, as shown on drawing, is a steel truss roof. Refer to calculation sheets for further information.

(3) Foundation

The Second Fermentation Tank structure is on a pile foundation system. The concrete piles were designed as end bearing piles that penetrate below the liquefiable soil layers by 35m. The concrete piles are the connected to a pile cap, which supports columns. The concrete piles are 300mm x 300mm as located on the foundation plan. The piles are grouped together by a concrete pile cap and the pile caps are connected together by concrete ground beams. The pile caps are designed absorb the vertical forces to the pile tip. The ground beams are designed to absorb the moment forces from the lateral design that are translated from the vertical columns.

8.6.2.8 Storage Vessel

(1) General

- The Storage vessel has a structural frame consists of reinforcement column system supports a concrete roof beams system.
- Ground floor slab base on ground beams and pile foundation system.
- There has been 1 spans with length of span is 20m for concrete column.

(2) Design Conditions and Parameter

- The Storage vessel is designed with 300mm thickness RC wall system.

- Ground floor slab is design to bear a load caused by contain mud, workers. Refer to calculation sheets for further information.
- Roof structure, as shown on drawing, is a concrete roof beams system. Refer to calculation sheets for further information.

(3) Foundation

The Second Fermentation Tank structure is on a pile foundation system. The concrete piles were designed as end bearing piles that penetrate below the liquefiable soil layers by 35m. The concrete piles are the connected to a pile cap, which supports columns. The concrete piles are 300mm x 300mm as located on the foundation plan. The piles are grouped together by a concrete pile cap and the pile caps are connected together by concrete ground beams. The pile caps are designed absorb the vertical forces to the pile tip. The ground beams are designed to absorb the moment forces from the lateral design that are translated from the vertical columns.

8.6.2.9 Compost Control Building

(1) General

- The compost control building has a structural frame consists of reinforcement column system supports a concrete roof beams system.
- Ground floor slab base on ground.
- There has been 1 spans with length of span is 10m for concrete column.

(2) Design Conditions and Parameter

- The compost control building is designed with staircase to go down basement.
- Ground floor slab is design to bear a load caused by machine, workers. Refer to calculation sheets for further information.
- Roof structure, as shown on drawing, is a concrete roof beams system. Refer to calculation sheets for further information.

(3) Foundation

The Second Fermentation Tank structure is on a pile foundation system. The concrete piles were designed as end bearing piles that penetrate below the liquefiable soil layers by 35m. The concrete piles are the connected to a pile cap, which supports columns. The concrete piles are 300mm x 300mm as located on the foundation plan. The piles are grouped together by a concrete pile cap and the pile caps are connected together by concrete ground beams. The pile caps are designed absorb the vertical forces to the pile

tip. The ground beams are designed to absorb the moment forces from the lateral design that are translated from the vertical columns.

8.7 Mechanical Works

8.7.1 General

(1) Introduction

Machinery to be used in this WWTP must be durable and satisfy the required function to operate treatment plant smoothly.

All machinery installed in WWTP will be operated combination with many other device and pipes cooperatively.

In this section, optimum type of machine was selected for each facility and required capacity of each machine was determined.

(2) Scope of the Mechanical Works

Detailed design consisting of selection of optimum type of machine for each facility, determination of required capacity and number of unit, cost estimation and preparation of specifications were conducted for the machinery in the following facilities;

(a) Lift pumping station
(b) Primary sedimentation tank
(c) Aeration tank and blower
(d) Final sedimentation tank
(e) Water supply and sodium hypo chlorite feeding
(f) Gravity thickener and centrifugal thickener Dewatering equipment
(g) Composting plant

(3) Applicable Codes and Standards

In principle, detailed design of machinery and equipment of WWTP follows the standards stipulated by Japan Sewage Works Agency (JSWA) with the following design criteria and standards.

(a) Design standards on sewerage facility by Japan Sewage Works Association
(b) Mechanical Design Standard by JSWA
(c) Japanese industry standard (JIS)
(d) Japanese Sewage Works Association Standard (JSWAS)
(e) Standard of Japan Electrical Manufacturers Association (JEM)

8.7.2 Lift Pumping Station Equipment

(1) General.
This facility is required to lift up wastewater introduced by conveyance sewer to the distribution tank.
Main equipment in this facility is lift pump.

(2) Design Condition and Parameters.
Design wastewater volume: 192,000 m^3/day as hourly maximum wastewater volume for Phase I

(3) Selection of Pump Type
Two (2) types of pump as (1) vertical shaft volute mixed flow pump and (2) submersible pump were compared.
Due to the smaller required space for installation of pump and pump well, submersible pump is more economical. And this type of pump is also adopted in the IWPS. The submersible type pump is proposed in the lift pumping station.

(4) Key specifications.
(a) Lift pump
Pump type: Submerged pump
Specifications: ϕ700×66.7m^3/min×12m (h) ×210kw × 3 units (including 1 stand-by)

8.7.3 Primary Sedimentation Tank Equipment

(1) General.
Suspended solid removed in the primary sedimentation tank should be scraped and absorbed from the bottom. Absorbed sludge should be transferred to the sludge treatment facilities. The equipments in the primary sedimentation tank are required these functions.
Required equipment in the primary sedimentation tank are;

- Sludge collector and
- Raw sludge pump

(2) Design Condition and Parameters.
Based on the following conditions, the optimum type of sludge collector and raw sludge pump were selected.

(a) Sludge collector.
Primary sedimentation tank is a rectangle shape with a width of 5.0m, length of 13.0m, and depth of 3.0m.

(b) Raw sludge pump.

Design discharged solid amount is at 10.364 t/day.
Design discharged sludge amount is at 518.2 m^3/day.
Normal operation hours of pump is set about 12 hours.
Minimum diameter of pump should be larger than 80mm to avoid clogging..
Minimum diameter of sludge pipe should be larger than 150 mm with a velocity of ranging 0.6 m/sec to 1.5 m/sec.

(3) Selection of Optimum Equipment

Due to the rectangle shape of the tank, chain flight sludge collector and meider type sludge collector were compared for the sludge collector. Comparative table is shown in Table 8.7. The evidence from that comparative table, chain flight type sludge collector is proposed.

One (1) unit of sludge collector is installed in each waterway and one (1) unit of motor drive two (2) units of sludge collectors.
Three (3) types of pump of (1) progressing cavity pump, (2) non-clogging pump and (3) centrifugal screw impeller pump are compared in Table 8.8. The evidence from the Table 8.8, non-clogging pump is proposed.
One (1) unit of pump is proposed to install every 5 units of tank to avoid the clogging due to the long suction pipe. And one (1) unit of stand-by is proposed for every two (2) units of pump.

(4) Key specifications

(a) Sludge collector opportunity

Type: Chain flight type. 2 units 1 drive.
Specifications : W5.0m×L13.0m×H3.0m×1.5kw

(b) Raw sludge pump

Type: Non-clogging type sludge pump.
Specifications: ϕ80×0.5m^3/min×14m×5.5kw

8.7.4 Aeration Tank & Blower Equipment

(1) General

Blower is required to supply sufficient air in the aeration tank to accelerate the adsorption and oxidization of activated sludge. Required equipment are;

- Diffuser and
- Blower

(2) Design Condition

Design conditions are shown below;

(a) Diffuser
Modified aeration process in Phase I and Conventional activated sludge process for the final phase are proposed. Diffuser should supply sufficient air in both treatment processes.

(b) Blower
Required aeration is at 300 m^3/day.
Required continuous operation for 24-hour.

(3) Selection of Optimum Equipment
Based on the comparative Table 8.9, spiral flow aeration type diffuser is proposed.
Gear speed increasing type single-stage turbo blower is proposed based on the comparative study mentioned in Table 8.10.

(4) Key specifications.
(a) Diffuser
Type: Diffuser tube (spiral flow aeration type diffuser)
Specifications: 120 l/min, 160 units
(b) Blower
Pattern-type: Gear speed increasing type single-stage turbo blower
Specifications: ϕ600×360m^3/min×6.8mAq×480kw

8.7.5 Final Sedimentation Tank Equipment

(1) General
Final sedimentation tank removes the sludge from aerated wastewater. And removed sludge is returned to aeration tank as activated sludge and excess sludge is transferred to the sludge treatment facility. The sludge collector and sludge absorbed pump.
Following equipment is required.

- Sludge collector
- Return sludge pump
- Excess sludge pump

(2) Design Condition
Based on the following conditions, the optimum type of sludge collector, return sludge pump and excess sludge pump are selected.

(a) Sludge collector
Rectangle type of the tank with width of 5.0m, length of 26.0m and depth of 3.5m

(b) Return sludge pump
Return sludge amount is assumed at ranging from 5 to 10% of wastewater volume.
Pump should be operated continuously for 24-hour.
Minimum diameter of pump should be larger than 80mm to avoid clogging.
Minimum diameter of sludge pipe should be larger than 150 mm with a velocity of ranging 0.6 m/sec. to 1.0 m/sec.

(c) Excess sludge pump
Design discharged solid amount is at 10.778 t/day.
Design discharged sludge amount is at 1,796.3 m^3/day.
Normal operation hour of pump is set about 12 hours.
Minimum diameter of pump should be larger than 80mm to avoid clogging.
Minimum diameter of sludge pipe should be larger than 150 mm with a velocity of ranging 0.6 m/sec. to 1.0 m/sec.

(3) Selection of Optimum Type of Equipment
Same type of sludge collector employed for the primary sedimentation tank of chain flight type is proposed as the same reason as mentioned in the previous section.
Required number of pump and capacity was designed based on the operation condition of conventional activated sludge process of return sludge volume ranging from 50 to 100 % of wastewater volume. And then, required number of pump unit for modified aeration process was determined.
Centrifugal screw impeller pump with a diameter of 250mm is proposed as sludge return pump (refer to Table 8.8).
Non-clogging pump with a diameter of 100mm is proposed as excess sludge pump (refer to Table 8.8).
One (1) unit of pump is proposed to install every 5 units of tank to avoid the clogging due to the long suction pipe. And one (1) unit of stand-by is proposed for every two (2) units of pump.

(4) Key specifications

(a) Sludge collector opportunity
Pattern-type: chain flight type. 2 units 1 drive.
Specifications: W5.0m×L26.0m×H3.5m×2.2kw × 10 units

(b) Return sludge pump
Pattern-type: Centrifugal screw impeller pump.
Specifications: ϕ250×5.6m^3/min×6m×11.0kw × 4 units

(c) Excess sludge pump

Type: Non-clogging type sludge pump.
Specifications: ϕ100×1.2m^3/min×13m×11.0kw × 3 units

8.7.6 Water Supply & Sodium Hypo chlorite Feeding Equipment

(1) General

Water supply system consisting sand filter treats the effluent water from final sedimentation tank to reuse in the treatment plant. This aims to reduce the consumption of public water supply and to reduce the operation and maintenance cost.
The treated water is disinfected before discharging Tac Ben Ro river by chlorination.
Required main equipment are as follows;.

- Sand filter.
- Hypochlorite injection pump.

(2) Design condition

Design conditions are shown below;

(a) Sand filter

Design water consumption in WWTP is at 2.4 m^3/min.

(b) Hypochlorite injection pump

Required injection volume of hypochlorite is estimated at ranging from 1 to 3 ppm of effluent water volume. It should be considered to select the material that hypochlorite will corrode the metal.

(3) Selection of Optimum Equipment

Movable bed filtration and pressure filtration are compared in Table 8.5 as the evidence from Table 8.5, pressure filtration is proposed as water supply sand filter.
Due to high anti-corrosion to hypo-chlorite and high capability of detailed control of injection volume, Diaphragm Pump is proposed as hypo-chlorite injection pump.

(4) Key specifications

(a) Sand filter

Type: Pressure tank sand filter.

Specifications: 2.4 m^3/min

(b) Hypo-chlorite injection pump

Pattern-type: Diaphragm Pump
Specifications: ϕ25×0.82 to 1.62L/min×0.4kw × 3 units

8.7.7 Gravity Type & Centrifugal Type Thickening Equipment

(1) General

This facility reduces the volume of sludge by thickening. Sludge removed in primary sedimentation tank is easier for thickening. While excess sludge from final sedimentation tank is rather difficult for thickening. Then, gravity thickener is adopted for sludge of primary sedimentation tank and mechanical thickening is proposed for excess sludge thickening.
Required equipments are as follows;

- Sludge collector
- Sludge Thickening Machine

(2) Design condition
Design conditions are shown below;

(a) Sludge collector

Raw sludge with a concentration rate of 2.0% should be thickened to 3%.
Circular type tank with a diameter of 14m and depth of 3.5m

(b) Thickening machine

Excess sludge with a concentration rate of 0.6% should be thickened to 4.0%.

(3) Selection of Optimum Type

Due to the circular type gravity thickening tank, center drive chinning type are proposed as sludge collector.
Centrifugal thickener and normal pressure thickener are compared in Table 8.12 as mechanical thickener. From the smaller required space for installation of thickener, centrifugal thickener is proposed.

(4) Key specifications

(a) Sludge collector

Type: Center drive chinning type sludge collector
Specifications: ϕ14.0 m×1.5 kw × 1 unit

(b) Mechanical thickener

Type: Centrifugal-type thickener
Specifications: 70 m3/h×112.75 kw × 2 units

8.7.8 Dewatering Equipment

(1) General

This facility aims to reduce the sludge volume by reducing the water content of sludge and make it easy to handle the sludge.
Required equipment is the sludge dehydrator.

(2) Design condition

(a) Sludge dehydrator

Thickened sludge concentrate rate of 3.350% should be dehydrated up to 22.0%.
Operation hour is 24 hr/day.

(3) Selection of Optimum Type

Belt press dehydrator and centrifugal type dehydrator ware compared shown in Table 8.13. Both types dehydrate the sludge with chemical dosing. Due to the limitation of belt cloth width of maximum 3m, it is difficult to manufacture the big capacity of belt press dehydrator. While, centrifugal dehydrator can be manufactured large capacity to meet the requirement. Moreover, belt press type requires large volume of washing water. And evidence from Table 8.13, centrifugal type dehydrator is proposed.

(4) Key specifications

(a) Sludge dehydrator

Type: Centrifugal-type dehydrator

Specifications: 30 m3/h×147.4 kw × 2 units

8.7.9 Composting Equipment

(1) General

Based on the regulation stipulated by Environmental Protection Agency (EPA) of America, dehydrated sludge treated by composting, heat drying, heat treatment and thermophilic aerobic digestion, can be dumped without any further treatment. The composting facility is proposed to stabilize the dehydrated sludge. It is recommended to keep the moisture content rate of compost ranging from 30 to 40% for process to reduce the moisture content by mechanically and from 40 to 50% for the process to ferment with addition chaff or other organic materials.
Main required equipment for composting plant is sludge mixing machine.

(2) Design condition

Composting plant consists of preconditioning, primary fermentation tank and secondary fermentation. In the preconditioning process, moisture content of dehydrated sludge of 80% should be maintained at about 65% with adding the chaff.
Preconditioned sludge should be kept in primary fermentation tank for about 14 days with aeration and mixing continuously. In secondary fermentation tank, sludge should be kept about 20 days in well ventilated space with turning over by shovel loader moderately.

(3) Key specifications

Sludge mixing machine

type: fermentation mixer
spec: ϕ2.2 * 90kw
unit: 2 units

Mechanical list of WWTP for facilities mentioned in this section is shown in Table 8.15. And pipe materials used at each facility are shown in Table 8.16.

8.8 Electrical Design

8.8.1 General

This Chapter describes the detailed design base of the electrical facilities for the

Wastewater Treatment Plant.

(1) Equipment Selection
All electrical equipment shall be selected in accordance with the general principles;

(a) Equipment shall be sufficient rated values.
(b) Future expansion shall be considered.
(c) Operation must be easy with an extended maintenance period.

(2) Scope of Works
The work covers the construction of the complete electrical systems for above mentioned plant and supply of spare parts for electrical equipment comprising the following items;

(a) 22kV power receiving system (not included to transmission line)
(b) Power distribution system
(c) Emergency Generating system
(d) Instrumentation and control system
(e) Equipment for Intermediate Wastewater Pumping Station
(f) Materials

8.8.2 Applicable Codes and Standards

The equipment, materials, design and test and installation of the electrical facilities shall conform to the local law and regulation and the applicable portions of the latest edition of the standard and codes.

(a) International Electrotechnical Commission (IEC)
(b) Japanese Industrial Standards (JIS)
(c) Standards of Japanese Electrotechnical Committee (JEC)
(d) Standards of the Japanese Electrical Manufactures Associations (JEM)
(e) Vietnam Standards (TCVN)

8.8.3 Design Condition and Criteria

(1) Site Conditions
(a) Altitude: less than 1,000m above sea level.
(b) Ambient temperature:
- Maximum: 45 °C
- Minimum: 5 °C
- Design temperature: 40 °C

(c) Relative humidity: Maximum: 95%

(d) Climatic atmosphere: Tropical
(e) Wind pressure: 45m/s
(f) Salt contamination:

Unless otherwise specified, under the contract, design for salt contamination of the insulators and bushings shall be applied the following conditions:0.03 mg/cm^2.

(2) Design Criteria

The design of the electrical system shall be carried out with the following clarifications.

(a) Electrical system

a) Power receiving system

Power supply from the electric power company will be one-circuit of 15(22)kV overhead lines and connected to the 15(22)kV/380V receiving transformer in the substation within Wastewater Treatment Plant.

The technical parameters of electrical power from the electric power company will be as follows;

- Voltage system: AC15(22)kV, 50Hz, 3 phase 3wire,Solidly grounded
- Voltage variation: ±5%
- Frequency variation: ±2%

b) Power distribution system

Power distribution trough out the Wastewater Treatment Plant Station shall be 50Hz, at the following voltage levels with an earthing system. :

Power Distribution System

Power Distribution System

Service	Rated voltage	Phase/Wire	Earthing	Remarks
Power receiving	15(22) kV	3/3	Solid	with earthing wire (Transmission line)
High voltage distribution	3.3 kV	3/3	Solid	
Low voltage distribution				
Power	380 V	3/4	Solid	
Lighting & Miscellaneous	380/220 V	3/4	Solid	

c) Equipment and load voltage rating shall be as follows:

Equipment and Load Voltage

Service	Rated voltage	Phase/Wire	Remarks
Motor 150kW and above	3,300 V	3/3	except lift pump
Motor 0.2kW to 149kW	380 V	3/3	
Lighting fixtures & Convenient sockets	220 V	1/2 + E	E: Earthing

(b) Allowable Voltage Drop

The maximum allowable voltage drops in cables, as a percentage of system nominal line to line voltage, a full load shall be as follows:

a) Main power distribution:
   - 380 volts motor: 5%
b) Total voltage drop at the terminal of low voltage motor shall not exceed 20% during staring period.
c) Voltage drop between lighting panel-board and the furthest fixture shall not exceed 3%. Voltage drop between main distribution board in substation and local lighting panel-board shall not exceed 2%.

(c) Transformer Sizing

The transformer shall be sized for the maximum demand of load connected to the associated switchgear plus 10 to 15% spare capacity for design allowance and/or future expansion.

The maximum demand of load shall be calculated by summing up the following loads.

a) The normally running loads.
b) 30% of the intermittent loads (i.e. pumps, etc.).

(d) Cable sizing

The cable shall be sized based on the thermal limits in normal service conditions, and the maximum allowable voltage drops in the circuit.
The current carrying capacity (thermal limit) of cables in normal service condition shall take account of the de-rating due to the laying conditions or grouping.
The cables for main power distribution system shall be sized also to withstand without damage the maximum short circuit thermal stress for the full clearance time of the protective devices (i.e. fuses, or circuit breakers with protection relays).
The current rating of the circuit for cable sizing shall be as follows:

a) The transformer primary and secondary cables shall be coved on the rated current of the transformer.
b) For switchgear/panel feeder circuit without a transformer, cables shall have a current carrying capacity equal to the maximum demand of loads connected to the switchgear/panel with 10% surplus.
c) The motor feeder cables shall be sized based on the 110% of motor name-plated rated current.
d) Other cables not mentioned above shall be covered to the maximum current demand.

(e) Lighting Arrangement

The lighting fixture shall be designed and arranged for required areas so as to meet the following illumination level:

Illumination Level

Installation Location	*Illumination Level (Lux)	Elevation	Remarks
Office	300	Floor	Architecture Works
Meeting Room	250	Floor	Architecture Works
Worker Room	100	Floor	Architecture Works
Security Room	150	Floor	Architecture Works
Laboratory	300	Floor	Architecture Works
Library	300	Floor	Architecture Works
Tea Room	100	Floor	Architecture Works
Night Duty	50	Floor	Architecture Works
Lobby	50	Floor	Architecture Works
Toilet	50	Floor	Architecture Works
Storage Room	50	Floor	Architecture Works
Stairway	50	Floor	Architecture Works
Corridor	50	Floor	Architecture Works
Control Room	250	Floor	Architecture Works
Electric Room	100	Floor	Architecture Works
Substation (Outdoor)	20	Floor	Electrical Works
Generator Room	250	Floor	Architecture Works
Pump Room	50	Floor	Architecture Works
Blower Room	50	Floor	Architecture Works
Pipe Gallery	50	Floor	Electrical Works

Outdoor Area	10	Floor	Electrical Works

*Averaged Illumination levels

8.8.4 System Description

(1) General

Electrical system for Wastewater Treatment Plant consists three systems such as power supply system, control system and instrumentation system.

Each system to be related with closely for operation of plant equipment.

(2) Power supply system

Power receiving system for main substation for Wastewater Treatment Plant is 3 [three]-phase, 50Hz. 2 [two]-circuit of 15(22)kV line.

Power will be supplied from two souses of distribution substation owned by HCMC Power Company.

Power sources are Saigon South 4 Substation and Chanh Hung Substation through Intermediate Wastewater Pumping Station.

The main substation will transfer voltage from 15(22)kV to 3.3kV with one 5,000kVA transformer and supplies power to main electric room located in main office by power cables.

Each electric room transfer voltage from 3.3kV to 380/220V by transformer and supply power to each equipment in the plant area through motor control centers or AC distribution panels.

(3) Control and instrumentation system

The control and instrumentation equipment installed in control room shall have following functions;

(a) Main control room

Main control room equipment shall be indicated pump operating condition, fault indication and instrument indication for substation, emergency generator, lift pump equipment, Wastewater Treatment Plant equipment and blower equipment.

Data logging system shall be collected data for all facilities such as substation, emergency generator, lift pump equipment, Wastewater Treatment equipment, blower equipment, chlorination equipment, dewatering equipment and compost equipment through interface panel.

(b) Chlorination electric room

Chlorination electric room equipment shall be indicated pump operating condition, fault indication and instrument indication for Chlorination equipment.

(c) Dewatering electric room
Dewatering electric room equipment shall be indicated pump operating condition, fault indication and instrument indication for Dewatering equipment.

(d) Compost electric room
Compost electric room equipment shall be indicated pump operating condition, fault indication and instrument indication for Compost equipment.

(e) Equipment operation
The operation of the equipment such as pumps and gates shall be controlled by the local control panel near the equipment.
Manual operation: Local control
Automatic operation: Automatic sequential operation by the water level

(f) Other
Outdoor lighting switch board shall be installed in control room.

8.8.5 Key Specification of Electrical Equipment and Instrumentation

Key specification of the major items are described as follows;

(1) Power receiving system
(a) 15(22)kV transmission line

a) Power supply from the electric power company will be two[2] nos. of 15(22)kV underground cable lines and connected to the 22kV C-GIS in the 22kV substation within the Wastewater Treatment Plant [WWTP].

b) The technical data of electric power from the electric power company will be as follows;

- Power capacity of receiving system:
Phase-1 1 x 5000kVA – 15(22)/3.3kV transformer
Phase-2 2 x 5000kVA – 15(22)/3.3kV transformer

- Power supply substation:
Source-1
From 110kV Chanh Hung Substation, connecting to Intermediate Wastewater Pumping Station supplying power to WWTP.
Source-2
From 110kV Saigon South 4 Substation, connecting from temporary connection

point on near Saigon South 4 Substation on the 15(22)kV of Phu Dinh Substation (When Saigon South 4 Substation is constructed the power company will change this connection to busbar of Saigon South 4 substation) to Waste Water Treatment Plant and connecting to Intermediate Pumping Station.

- Voltage system
AC15(22)kV–50Hz-3phase/3wires-Neutral solidly earthed.

- Transmission line cable
This underground cable line will be laid by the electric power company. Connecting to dead-end pole of medium voltage overhead line 3ACV240+AC150 from IWPS and Saigon South 4 Substation. Span from dead-end pole to transformer is 2(3x240) XLPE underground cable, it is constructed cross of unoccupied area.

(b) 22kV Main Substation (C-GIS)
Power supply from the electrical company shall be connected to the 22kV C-GIS (Cubicle type SF6 Gas insulated Switchgear) in the main substation.
The 24kV Metal-enclosed SF6 Gas Insulated Switchgear installed in the main substation shall be of outdoor use cable connected cubicle type, corrosion resistant vermin-proof and be mounted on steel base channels.

Rated voltage	: 24kV
Rated current	: 1200A, 600A
Rated short-circuit breaking current	: 31.5ka, 25kA

(c) Power transformer
The main transformer installed in the electric room shall be of 50Hz, outdoor use, three-phase, oil-immersed, self-cooled with diaphragm conservator and on-load tap changer.

Rated primary voltage	: 15(22)kV
Rated secondary voltage	: 3.3kV
Rated capacity	: 5000kVA
Primary auxiliary tap	: 15kV(22kV)
OLTC Tap voltage	: 15kV ± 5%, (22kV ± 5%)
Impedance voltage (Design value)	: 15% at 15kV, 8.5% at 22kv
No load loss (Design value)	: Less than 2.5kW at 15kV Less than 8.0kW at 22kV

(2) Power distribution system

(a) Distribution system equipment

a) 3.6kV Metal-enclosed switchgear

The 3.6kV metal-enclosed switchgear installed in the each electric room shall be of indoor use cubicle type, and air insulated, corrosion resistant, vermin-proof and be mounted on steel base channels.

Rated voltage	: 3.6kV
Rated current	: 1200A, 600A
Rated short-circuit breaking current	: 25kA
Bus bar rating	: 3 phase 3 wire, 1200A

b) 3.6kV Static Capacitor and Series Reactor Cubicle

The static capacitor and series reactor cubicle(s) installed in the main electric room shall be of indoor use, metal enclosed and self-standing type,and shall include necessary automatic power factor control equipment with protection devices.

Type	: Indoor, hermetically sealed (Capacitor only)
Capacity	: Improved power factor 0.9
Rated voltage	: 3.6kV

c) Low Voltage Metal-enclosed Switchgear

The low voltage metal-enclosed switchgears installed in the each electric room shall be indoor use, metal enclosed and self-standing type, and shall include necessary protection devices, circuit breakers and accessories.

Rated voltage	: 600V
Rated current	: 1200A, 2500A, 4000A
Rated short-circuit breaking current	: 50kA, 65kA
Bus bar rating	: 3 phase 4 wire, 1200A, 2500A, 4000A

d) Lift Pump Starter Panel

The lift pump starter panels installed in the electric room shall be of indoor use, metal enclosed and self-standing type, local remote operation and shall include necessary motor starting equipment with protection device and accessories.

Type	: Circuit transition auto-transformer starting type
Motor capacity	: 220kW

Motor voltage	: 380V
Rated voltage	: 600V
Circuit breaker type	: Air circuit breaker, 3 phase, with alarm contact, 600V - 1000A - 25kA

e) Motor Control Center (CC)

The motor control center installed in the electric room shall be of indoor use metal enclosed and self-standing type, and shall include necessary motor starting equipment with protection device, accessories and motor control relay panel(s).

Each molded case circuit breaker unit shall be housed inside a separate compartment and shall be closed on front side.

The hinged lockable door shall be provided at the front.

The hinged door shall be interlocked with the breaker positions, such that the door cannot be opened unless the breaker is in "isolated position".

Type	: AC380V-3 phase/4 wire-600A-35kA
Type of start circuit	: Motor capacity less than 30kW-Direct start
	: Motor capacity over 30kW-Star-Delta start

f) DC Power Supply System

The DC power supply system shall supply essential DC power to critical loads such as electrical switchgear control circuits, emergency shutdown system, etc.

The DC power supply system installed in the electric room and generator room shall be indoor use, metal enclosed and self-standing type, and shall include necessary protection device and accessories.

The DC power supply system shall be rated 110V DC (nominal voltage), un-earthed (floating earth), with a back-up battery bank for a 30 minute period.

g) AC Uninterruptible Power Supply System (UPS)

The Uninterruptible power supply system (UPS) installed in the each electric room shall be indoor use, metal enclosed and self-standing type, and shall include necessary protection device and accessories, and power supply for essential instrument and data logging system circuits.

The UPS shall be of a inverter(s) system with backup battery and a bypass circuit, and include complete with automatic voltage regulator, molded case circuit breaker, voltmeters, ammeters, relays, warning lamps and other necessary components for the correct operation.

The battery capacity shall be so designed to supply power to the inverter for 30 min. when the power supply to the UPS is lost.

h) Local Motor Control Panel and Switch Box

The local motor control panel and switch box shall be metal enclosed, corrosion resistant, vermin-proof and shall include necessary motor control equipment, meter and accessories.

All motor control devices such as control switches, meters and indication lamps shall be mounted on panel.

Outdoor type local motor control panel shall be weatherproof and shall have self-ventilating device.

(3) Emergency Generator Equipment

The emergency generator installed in generator room shall be normally on stand-by, manually started and connected to the 3.6kV switchgear when the normal power supply is lost.

The emergency generator shall be rated suitable for continuous operation for at least 3 hours and shall supply power to the one (1) 220kW sewage pump and emergency gate loads through a low voltage distribution panel.

One (1) set of emergency generator shall be indoor use, medium speed heavy duty water cooled, soundproof enclosed type, three phases AC synchronous generator with the following specification.

(a) Diesel engine :

Type	: 4 cycle, water cooled
Output	: More than 670kW
Engine starter	: Electric motor starter
Rated speed	: 1500 rpm
Fuel	: Diesel fuel oil
Governor	: Electro static type

(b) Generator :

Type	: Horizontal shaft, self-ventilated type
Rated capacity	: 750kVA
Rated voltage	: 3,300v
Rated frequency	: 50Hz
Rated speed	: 1500 rpm
Number of pole	: 4 poles
Phase/wire	: 3 phase/4 wires
Power factor	: 80% (lagging)
Excitation	: Brushless

(c) Generator auxiliary equipment

The following equipment shall be installed with generator;

Generator control panel
Fuel tank : Capacity for 3 hours operation
DC power supply system

(4) Communication System

The communication system installed in the plant area shall be of indoor use, rack mounted exchanger with paging speakers, and master and local station intercom system. The communication system shall be provided following function;

Individual zone broadcast and paging
Paging announcement with microphone
Paging announcer for intercom station
Master-Local and Local-Local communication
Public telephone interface

(5) Instrumentation and Control System

(a) Level Meter

The level meter installed in the pump station area shall be as following type;

Submerged Diaphragm Type Level Meter

The submerged diaphragm type level meter shall be measured the water level by detecting water pressure with detection element installed in the water.

Diaphragm Type Level Meter

The diaphragm type level meter shall be measured the water level by the difference between water pressure capacity and air.

(b) Flow Meter

The flow meter installed in the plant area shall be as following type;

Orifice Type Flow Meter
Electro Magnetic Flow Meter
Ultrasonic Flow Meter

(c) Density Meter

The density meter installed in the plant area shall be as following type;

Ultrasonic Density Meter

(d) Level Control Switch

The level control switch installed in the plant area shall be as following type;

Electrode Type Level Control Switch
Float Type Level Control Switch

(e) Instrumentation Panel

The Instrumentation panel installed in the main control room, chlorination electric room and dewatering electric room shall be of indoor use, metal enclosed and self-standing type.

(f) Supervisory Panel

The supervisory panel installed in the main control room, chlorination electric room, dewatering electric room and compost electric room shall be of indoor use, metal enclosed and self-standing mini graphic type.

(g) Data Logging System

The Data logging system installed in the main control room shall be of indoor use, microcesor controlled optical fibber cable data link system.

(6) Earthing System

(a) General

The exposed metal frames of all electrical apparatus and machinery not forming parts of the electric circuits, neutral of transformers, etc., shall be grounded.

a) Earthing conductor, plate and rods

The following materials shall be used for earthing systems;

- Earthing conductor

Annealed copper stranded conductor.

The Contractor shall be calculated and selected the adequate size of conductors for main mesh, arrester, transformer neutral connection and each equipment earthing conductors.

- Earthing plate

90 cm square, 1.5 mm thickness copper plate or equivalent

- Earthing rods

16 mm diameter, 3 m length copper clad steel rod with coupling

- Connectors

Compression type connectors which shall be able to connect the annealed copper stranded conductors each other, earthing plate and rod.

b) Earthing works
- Earthing rods, plate and conductors shall be buried deeper than 0.6 m or more from the ground surface.
- The connection between earthing conductor and ground rod, plate and equipment connection conductor shall be electrically and mechanically rigid.
- Earthing systems of the instruments equipment shall be done by separately from common ground.
- The earthing for transformer neutrals and lightning arresters, earthing rod shall be installed in additionally for interconnections with earthing mesh.
- Boundary fences shall be earthed by means of earthing rods, separately from the main earthing mesh.

(7) Materials

This section covers cables, conduits, pull boxes, cable ducts and trays which will be used for the main circuit and secondary circuit of power, control, instrumentation and other requirement.

(a) Power Cables, Control Cables and Instrument Cables

Conductor size for cables shall be adequate for the load requirements, voltage drop, short circuit current, and diversity factor for individual circuit application.

a) Power cables
- 600V power cables for motor circuit, heater circuit and other power circuits shall be of jacket type, 600 V cross-linked polyethylene insulated PVC sheathed type (CV).
- 600 V cross-linked polyethylene insulated PVC sheathed, welded and corrugated steel armoured PVC sheathed power cable (CVMAZV) shall be used for burred portion in the ground of outdoor lighting power cables.
- Section area of cores for 600 V power cables shall not be less than 3.5sq.mm.

b) Control and instrumentation cables
- Except for small wiring of equipment, control cables shall be of jacket type, 600 V polyvinyl chloride insulated and sheathed control cable with copper tape shielding (CVV-S).
- Section area of cores for control and instrumentation cables shall not be less than 2.5sq.mm. In case of important circuits, such as section areas of

CT and VT circuits shall be 3.5sq.mm or more. In consideration of cables, the Contractor shall, if possible, design in such a manner that the size of cores or cables shall be unified.

(b) Steel conduits and flexible conduits

a) Steel conduits shall be steel, hot-dipped galvanized and equipped with couplings and thread protector caps. All surfaces and threads shall be coated with zinc. The sectional areas of a steel conduit shall be, at least, 2.5 times the total cross sectional area of cables to be pulled in.
- Rigid steel conduits shall be installed for all exposed cable route.
- PVC coated conduits shall be installed for corrosive area cable route.
- Couplings and elbows shall be of the same materials as conduit pipes.

b) Flexible metal conduits shall be used for flexible cable connection route. Flexible metal conduits shall have a interlocked flexible galvanized steel core with a permanently bonded outer polyvinyl chloride jacket.

(c) Boxes and Fittings

The pull boxes, outlet boxes, fittings and covers shall be of mild steel and/or cast iron alloy with adequate strength and have sufficient size to provide free space for all conductors enclosed.
- Pull boxes shall be sufficient size to accommodate the connected conduits and enclosed conductors.
- Boxes and fittings shall be plated by melting zinc or coated with rust preventive paint and tow or more finish coatings.
- Outlet boxes shall be of galvanized steel, square and of sufficient size to accommodate all the required conductors enclosed in the box.

(d) Supporting Steel Materials

The supporting steel materials shall be of hot-dipped galvanized steel with adequate strength for support conduits, cable tray and/or wiring duct.

(e) Outdoor Lighting

The pumping station shall be equipped with outdoor lightings apparatuses at appropriate areas. The Contractor shall provide all necessary materials and furnish complete lighting systems.

In the selection of lamps and fittings consideration should be given to ensure the maximum lamp life, the minimum likelihood of internal moisture accumulation, and also effects of vibration, operating temperature, and breathing.

Types of outdoor lighting fixture shall be of straight pole with pole head type

lighting fixture and equipped with screwed base lamp holders, and shall be of high power factor suitable for stable operation in tropical climate and weatherproof type. The lamp shall be of high pressure sodium type and approximately 400 W rating.
Lighting supports for outdoor lighting shall be of base plate type steel poles painted with suitable color. Ballast, cut out switch and terminals shall be equipped in the pole and other attachments necessary for wiring and fixing of the lighting fixtures shall also be provided with the pole.
The Contractor shall provide suitable outdoor lighting switch box for lighting systems. The lighting switch box shall be indoor use, metal enclosed wall mounted type and switching operated by manual at control room. The Contractor shall be provided enough capacity of branch circuit breakers for high pressure sodium lights to avoid tripped by increase of starting current.
600 volt PVC insulated wires of 3.5sq.mm in size shall be laid in the lighting pole for connection from the lighting switch box to the lighting fixtures.

Electrical equipment of 24 kv switchgear, circuit breaker, main transformer, and emergency generator are compared in Table 8.17. In addition, electrical list for WWTP are summarized in Table 8.18.

8.9 Road, Storm Water Drainage and Bridge Design

8.9.1 Road and Car Park

(1) General

Road system designed here are inner roads in Wastewater Treatment Plant (WWTP), use for constructing and working at WWTP.

Location of WWTP is an area of soft soil, surrounded by many canals and its ground elevation is 0.4 – 0.8 m.

(2) Applicable Codes and Standard

These are Codes and Standard applied in Viet Nam :

- 20 TCN 104-83 “Standard for Urban Highway Design” approved by Ministry of Construction, (MOC)
- TCVN 4054-98 “Standard for Rural Highway Design” approved by Ministry of Transportation, (MOT)
- 22 TCN 211-93 “Standard for Flexible Pavement Design” approved by MOT
- TCVN 2201-1993 “ Soil for Construction – Testing method for compacting index in laboratory” approved by MOC
- 22 TCN 249-98 “Specification for asphalt concrete construction, hot laid“ approved by MOT

References have been made to the following publication additionally:

- A policy on Geometric Design of Highways and Streets – AASHTO 1990
- Guide for Design of Pavement Structures – AASHTO 1986
- Standard specification for transportation materials and methods of sampling and testing. AASHTO 1990

(3) Design Condition and Parameters

According to 20 TCN 104-83, class of roads in WWTP are Inner Road (Industrial area), composed by followings:

(a) Access Road (Conveyance road).

Access road is a road reaching from outside to WWTP, which is parallel to conveyance sewer. It is used to install conveyance sewer line and transportation materials at the construction of WWTP, etc.

- Design load for pavement H 30 axle load 12 T
  Tire pressure 6 Kg/cm^2
  Diameter of tire mark 36 cm
- Design traffic volume (H10) 100 vehicle/day
- Design speed 40 – 60 Km/h
- Begin point : Pumping station
- End point : Entrance of WWTP at the end of bridge

Length : 3096 m. Compose 4 portion :

CHARACTERISTICS OF ACCESS ROAD
(Table3-1 in 22 TCN 211-93)

Portion No	*From*	*To*	*Length (m)*	*Road bed wide (m)*	*Pavement wide (m)*	*Right of way*	*Remark*
1	Pumping Station , CM2	Dong Dieu Street, CM5	214.78	6.50	3.75	20.00	New road *Pav Type P2*
2	Dong Dieu Street, CM5	Dong Dieu Str, CM13	823.87	10.00	7.00	30.00	Existing road
3	Dong Dieu str , CM13	Chanh Hung Road, CM31	1576.87	9.00	6.00	30.00	New road *Pave Type P2*
4	Chanh Hung Road, CM31	End of Bridge, CM38	480.64	10.50	7.50	25.00	New road *Pav Type P1*
Total			3096.16				

- Basic design elevation :
  Ground level : 0.60 m
  MWL (maximum water level), sequence P=10%: 1.51 m
  Road surface design level : 2.00 m

- Geological condition

Following "Final report on soil investigation of conveyance route" in June 2000, five bore holes were made (DSC 01 – DSC 05), the typical soil layers are shown below.

GEOLOGICAL CONDITION IN ACCESS ROAD
(Table3-2 in 22 TCN 211-93)

No	*Properties*	*Unit*	*Layer 2*	*Layer 4b*	*Layer 4c*	*Remark*
1	Soil name	-	Organic clay, soft (OH)	Clay sand, medium dense (SC)	Silt sand,, medium dense (SM)	
2	Depth	m	1.6 –21.0	9.5- 22.0	42-44	
3	Thickness	m	0.6-20.0	1.0-8.4	9.5-33.7	
4	Natural moisture content (W)	%	82.48	17.82	16.81	
5	Natural unit weight (γ)	g/cm^3	1.489	2.098	2.031	
6	Dry unit weight (γd)	g/cm^3	0.825	1.782	1.738	
7	Specific gravity (Gs)	-	2.571	2.643	2.642	
8	Porosity (n)	-	0.680	0.330	0.340	
9	Void ratio (eo)	-	2.170	0.486	0.523	
10	Degree saturation (S)	%	97.7	97.0	86.2	
11	Liquid limit (LL)	%	86.3	22.1	19.8	
12	Plastic limit (LP)	%	42.8	14.9	15.1	
13	Plastic index (PI)	%	41.2	7.1	4.7	
14	Water plasticity ratio (B)	%	0.96	0.48	0.64	
15	Unconfined compression (qu)	Kg/cm^2	0.118	0.542	-	
16	Compression index (Cc)	cm^2/Kg	0.8087	0.097	0.091	
17	Coefficient of consolidation (Cv)	cm^2/s	$3.16x10^{-4}$	$7.65x10^{-4}$	$6.5x10^{-4}$	
18	Preconsolidation tressure (Pc)	Kg/cm^2	0.445	0.937	0.882	
19	Permeability (k20)	cm/s	$3.4x10^{-8}$	$2.17x10^{-8}$	$2.07x10^{-8}$	
20	Standard penetration resist (SPT)	blow	0-2	10-14	10-21	

Note: Layer 1 is found at right on surface of all bore holes with thickness of from 0.5 to 1.5 m. Soil is called sandy clay which is made of soft clay with color of blackish gray.

- Hydrological condition : The underground water measured from ground surface is ranged from –0.8 to –1.3 m

(b) Inside road

Inside road is the road located at WWTP, use for constructing and transporting the compost and sludge from inside to outside.

- Design load for pavement as access road

- In general, width of pavement surface is 10 m (between 2 curbs). Total length is about 3000 m (Phase 1).
- Basic design parameters for bed road:

Ground level	0.60 m
MWL (maximum water level . P = 10%)	1.51 m
Average embankment level	2.20 m
Pavement surface level	2.05 - 2.15 m
Height of curb on pavement	0.15 m
Cross slop of pavement	2 %

- Special point when designing the internal road of WWTP

  It must compose closely elevation of pavement surface with side ditches level (bottom), how to drain very well, have not concentrating water point inside WWTP.

  Storm water drainage problem will be stated in details on section 8.9.2.

- Geological condition.

  Following "Final report on soil investigation of wastewater treatment plant site (II a) " in Aug 2000, five bore holes were made, typical soil layers were shown below:

No	*Properties*	*Unit*	*Layer 2*	*Layer 4*	*Layer 4d*	*Remark*
1	Soil name	-	Organic clay, soft (OH)	Sandy lean clay, stiff (CL)	Poorly grade sand, dense (SP)	
2	Depth	m	19-20.5	31.5-35.0	34	
3	Thickness	m	18.5-20	0.6-7.3	2.5 – 5.8	
4	Natural moisture content (W)	%	89.73	17.94	15.85	
5	Natural unit weight (γ)	g/cm^3	1.423	1.977	1.608	
6	Dry unit weight (γd)	g/cm^3	0.753	1.676		
7	Specific gravity (Gs)	-	2.575	2.656		
8	Porosity (n)	-	0.710	0.370		
9	Void ratio (eo)	-	2.443	0.584		
10	Degree saturation (S)	%	94.83	81.40		
11	Liquid limit (LL)	%	91.64	33.8		
12	Plastic limit (LP)	%	45.77	18.5		
13	Plastic index (PI)	%	45.9	15.4		
14	Water plasticity ratio (B)	%	0.96	-0.04		
15	Unconfined compression (qu)	Kg/cm^2	0.170	1.186		
16	Compression index (Cc)	cm^2/Kg	1.1956	0.1255		
17	Coefficient of consolidation (Cv)	cm^2/s	$2.5x10^{-4}$	$8.39x10^{-4}$		
18	Preconsolidation tressure (Pc)	Kg/cm^2	0.908	0.838		
19	Permeability (k20)	cm/s	$3.37x10^{-8}$	$1.92x10^{-8}$		
20	Standard penetration resist.(SPT)	blow	0-2	13-26	25-30	

Note: Layer 1 is in right on surface, sandy clay, 0.5 – 1.5 m of thickness.

(c) Car Parking

Car Park is a pavement surface for parking (same inside road). Location is at the end of the bridge (gate of WWTP).

- Design load for pavement as access road, use pavement type P1
- Area surface is 11000 m^2
- Basic design parameters and geological condition as inside road described above.

(d) Bridge

- Location: Entrance of WWTP, pass over the Tac – Ben Ro canal.
- Technical design parameters :

Live load	H30 and HK 80
Bridge wide	9.00 m
Length of spans (Pre-stress concrete)	5 * 20 = 100 m
Foundation	concrete pile 40 * 40 cm
	length 30 - 40 m
Bridge surface level	4.967 m
Navigation (reference bridge on Chanh Hung road)	2.50 m
MWL (sequence P = 1% for bridge)	1.577 m
LWL (low water level)	- 3.10 m
Bottom level of river (about)	- 5.28 m

- Geological condition

Same as in section of access road described above.

(4) Layout and Dimensions

(a) Access road

Total length of access road is 3096 m. Layout and dimensions of access road are shown in the table "CHARACTERISTICS OF ACCESS ROAD" on section 8.9.1 (3). From the pumping station to the bridge of WWTP, access road runs parallel and at right side of conveyance sewer line. Pavement width of portion 1 is 1 lane (3.75 m), and portion 2 and 4 are 2 lanes (6.00 -7.50 m).

(b) Inside road and car parking

For the layout and dimensions, see drawing No PE-WWTP-222-02
In corner, curb is chamber 5 – 10 m.

(c) Bridge

For the layout and dimension, see drawings

(5) Settlement

a) Internal Road and Parking Area of Wastewater Treatment Plant
The settlement of the WWTP area has been calculated and described in section 8.4. The settlement after 10 and 30 years is 109mm and 208mm, respectively. The road and parking area shall be over laid as mentioned in section 8.4.6.

b) Access Road along Conveyance Sewer
- Soil condition: the soil condition varies along the road. For the calculation, the boring No. DST1-(01) at the abutment of the bridge, which is the worst one, is used. The soil properties are shown in the following table:

No	*Properties*	*Unit*	*Layer 2*	*Layer 4b*		*Remark*
1	Soil name	-	Organic clay, soft (OH)	Lean Clay (CL)		
2	Depth	m	-25.8	-29.97		
3	Thickness	m	26.3	2.3		
4	Natural moisture content (W)	%	76.59	19.51		
5	Natural unit weight (γ)	g/cm^3	1.463	1.987		
6	Dry unit weight (γd)	g/cm^3	0.835	1.663		
7	Specific gravity (Gs)	-	2.574	2.665		
8	Porosity (n)	-	0.675	0.38		
9	Void ratio (eo)	-	2.125	0.603		
10	Degree saturation (S)	%	93.03	86.2		
11	Liquid limit (LL)	%	81.08	35.1		
12	Plastic limit (LP)	%	40.33	18.5		
13	Plastic index (PI)	%	40.75	16.6		
14	Water plasticity ratio (B)	%	0.883	0.06		
15	Unconfined compression (qu)	Kg/cm^2	0.206	1.447		
16	Compression index (Cc)	cm^2/Kg	1.036	1.1906		
17	Coefficient of consolidation (cv)	cm^2/s	2.68E-04	5.89E-04		
18	Preconsolidation Pressure (Pc)	Kg/cm^2	0.862	1.192		
19	Permeability (k20)	cm/s	3.31E-08	2.13E-08		

- Settlement Calculation: The settlement calculation for the road along conveyance sewer is shown in Table 8.19 to 8.22 with the results are as follows:
  - Final settlement under self-weight : 86.80cm
  - Final settlement under the embankment: 91.60cm
  Total : 178.40cm

  After 30 years, the settlements of the road are:

  - Final settlement after 30 years under self-weight : 3.80cm

- Final settlement after 30 years under embankment : 22.90cm
  Total : 26.70cm

- Conclusion: The road settles down 26.70cm after 30 years. The level of the road becomes EL+1.737. However, the road is still higher than the highest water level of EL+1.620. Therefore, the road can be used without any countermeasure in terms of settlement.

(6) Pavement structure

Flexible pavement was used. Traffic volume is purposely estimated 100 vehicles H10/day. Reference "Typical flexible pavement structure – TKM 02-80" approved by MOC.

There are two types:

Type P1

Use for access road (conveyance sewer road) portion 4 (table "CHARACTERISTICS OF ACCESS ROAD" on section 8.9.1 (3)), and inside road of WWTP.

- Demand elastic modulus (young modulus) 1500 Kg/cm^2
- Layers thickness:
  - 5 cm wearing course, asphalt concrete small size, Emulsifies asphalt tack coat 0.2 - 0.7 L/m^2
  - 8 cm binder course, asphalt concrete gross size, Emulsifies asphalt prime coat 1.0 - 2.0 L/m^2
  - 10 cm base course, crushed aggregate
  - 20 cm sub-based course, aggregate (or red gravel grade)

  Total: 43 cm

Type P2

Use for access road (conveyance sewer road) portions 1 and 3 (table "CHARACTERISTICS OF ACCESS ROAD" on section 8.9.1 (3)).

- Demand elastic modulus 1300 Kg/cm^2
- Layers thickness:
  - 9 cm asphalt concrete pavement, Emulsifies asphalt prime coat 0.2- 0.7 lit/m^2
  - 10 cm base course, crushed aggregate
  - 20 cm sub-based course, aggregate (or red gravel grade)

  Total: 39 cm

Designing method is followed "Standard of flexible pavement design – 22 TCN 211-93" approved by MOT. According to this standard, flexible pavement design must be enough

3 conditions:

Checking elastic settlement condition

Elastic settlement of pavement structure must smaller than permitted elastic settlement I_{cp}. That means elastic modulus of structure E_{ch} bigger than demand elastic modulus E_{yc}

$$E_{ch} > E_{yc} = \frac{p\,D\,(1 - \mu^2)}{I_{cp}} = \frac{p\,D}{100\,I_{cp}}$$

p: tier pressure of calculating vehicle, Kg/cm^2
D: diameter of equivalent rounded circular of tier mark, cm
μ: Poisson coefficient, 0.3

Value E_{yc} - follow Table 3-3 of 22 TCN 211-93
Value p, D - see Table 3-1 in 22 TCN 211-93

Checking slide condition

It carries out this condition with soil bed and material layer non cohesive (like gravel, aggregate)

To have not elastic deformation zone in soil bed and material layer non cohesive, pavement structure must be enough following condition :

$\tau_{ax} + \tau_{ay} <= K\,C$
τ_{ax}: maximum shared strength made by vehicle
τ_{ay}: shear strength make by loading of material layers on calculating point.
C: cohesive of soil or material non cohesive
K: coefficient of working condition

Checking tensile strength σ_{ku} in asphalt concrete layer when bending subjected

Pavement structure is good when maximum tensile strength in asphalt concrete layer enough following condition:

$\sigma_{ku} < R_u$
R_u: Permitted tensile strength of asphalt concrete layer when bending subjected (see Appendix 3 in 22 TCN 211-93)

8.9.2 Storm Water Drainage

(1) General

Total Storm Water Drainage in WWTP Phase (I and II) covers about 25 ha, but in Phase I only 17 ha is completed. Drainage System uses U channel at curb (side ditches) to concentrate water from everywhere to 8 Outlets (5 Outlets in Phase I).

(2) Applicable Codes and Standard

There are these Codes and Standard of Vietnam applying:

- 20 TCN 104-83 "Standard for Urban Highway Design" approved by Ministry of Construction , (MOC)
- TCVN 4054-98 "Standard for Rural Highway Design" approved by Ministry of Transportation, (MOT)

(3) Design Condition and Parameters

(a) Design condition
Live load: H30
Design Elevation of Embankment: 2.20 m
Design Elevation of Pavement: 2.05 (at curb) - 2.15 m (center line)
Elevation of foundation bottom of side ditches > 1.00 m
MWL (maximum water level) at outfall: 1.51 m
Average ground level (GL)

(b) Parameters
Width of side ditches in general is B = 0.40m. There are some portion come to outlet B = 0.60 – 1.00 m.
Height of side ditch H is always from 0.20 – 0.70 m
Profile slop of side ditch always uses 0.10%

(4) Modification of System Concept
In Phase I, drainage water flows to 5 outlets O2, O4, O5, O6 and O7. See drawing No PE-WWTP-222-03.
In Phase II, drainage water flows to 3 outlets O1, O3 and O8. See drawing No PE-WWTP-222-01.

(5) Hydraulic Analysis
Hydraulic Analysis of side ditch system is calculated as following:

(a) Storm Intensive q (L/ha^2)

$$q = Ao\ (t + bo)\ n$$

Ho Chi Minh City has the following coefficients:
Ao = 11650, bo = 32, n = 0.95

Therefore,

$q = 11650 * (t + 32) * 0.95$

t (s) : Calculating storm time (= water flowing time from the beginning to calculating time)

(b) Storm Water Volume Q (l/s)

$Q = M\ Y\ F\ q$

M: Storm distribution coefficient

$$M = \frac{1}{1 + 0.001\ F}$$

F: Catching area, ha

Y: Flow coefficient

$$Y = \frac{f_1\ Y_1 + f_2\ Y_2 + f_3\ Y_3}{100}$$

f_1, f_2, f_3,: Flow coefficient for kind of ground surface

$f_1 = 0.95$ with hard pavement

$f_2 = 0.60$ with aggregate pavement

$f_3 = 0.10$ with glass

Water flow time calculated by formula

$t\ (min) = to + tr + tc = 5 + 1.25\ lr/Vr + r\ lc/Vc$

Suppose: $Vr = 1.5$ m/s

$Vc = 1.7$ m/s

$r = 2$

lr (m): Length of gutter at curb

lc (m): Length of side ditch

Calculating results as shown in Table 8.23.

(6) Typical structure

The typical structure is shown in drawing No.PE-WWTP-222-04.

(a) Side Ditches

Side ditch is shaped like U channel with a width of 0.40, 0.60, and 1.00 m.

(b) Catch Basin

Catch basin is installed in cross points of two side ditch dimension. Bottom

elevation of catch basin is 20 cm lower than the bottom of the ditches.
There are two types of catch basin:
Type CB1 : 0.40 x 1.00 m
Type CB2 : 1.00 x 1.00 m

(c) Outlet
V letter shape outlet and wing wall concrete type E use wooden piles to improve soft soil under foundation.
Outlet type X1 uses ditches B = 0.60 m. Type X2 uses B = 1.00 m
There are 5 Outfall (in Phase 1): Type X1 O4, O7
Type X2 O2, O5, O6
Bottom elevation in of Outlet is 0.60 m, the same as ground level.

8.9.3 Bridge Design

(1) General

Existing Conditions and Construction Scale
Tac Ben Ro Bridge is proposed on the road to the site of wastewater treatment plant in District 8 of Ho Chi Minh City. The bridge goes across Tac Ben Ro canal.

(2) Applicable code and standard
Specification design regulations of the Ministry of Transportation are as follows:
- Soft Road Crust Design Procedure 22TCN-211-93
- Highway & Drainage Design Procedure by Limit States Method 2057/QDKT {19/9/1979}
- Pile Foundation Design Standard 20TCN-21-86

(3) Geology and Hydrology Condition

Tac Ben Ro Bridge is proposed on the road to the site of wastewater treatment plant in District 8 of Ho Chi Minh City. The bridge crosses Tac Ben Ro canal and connects to the entrance of the wastewater treatment plant.

(a) Hydrology

Tac Ben Ro canal is in a network reaching Saigon River. The amplitude of the tide is about 3m. The highest water level is +1.577m, the lowest water level is –2.3m, the deepest canal bed level is –5.28m. The highest water level to meet waterway transportation with 5% frequency at site of Tac Ben Ro Bridge is +1.57m based on the Hon Dau line.

(b) Geology

Refer to the geology documents of boring at Tac Ben Ro Bridge area, the result shows that this is the very soft soil with the depth of clay silt of from 25m to 30m. The soil profile of DST (1)-01 as follows:
- From 0m to 1m: Ground made, light brown organic clay.
- From 1m to 27.2m (OH): Very soft, high plasticity organic clay. SPT data: n =2
- From 27.2m to 34.5m (CL): Stiff, low plasticity sandy lean clay. SPT data: n =2
- From 34.5m to 44.4 (SM): Medium dense silt sand. SPT data: n # 20
- From 44.4m to 55m (CH): Hard sandy clay. SPT data: n # 26

The above result of geology shows that the Work completely is appropriate for the deep pile foundation. The end of pile is placed in the SM layer.

(4) Construction Scale

- Reinforced concrete bridge
- The desk size: 9m (no walk side) + 0.5m x 2 railings
- Horizontal gradient of bridge surface: 2%
- Clearance:
  Clearance Height = 2.5m
  Clearance Width >=15m
- Maximum Gradient to the bridge: 4.5%
- Load: H30 – HK80
- Radius of sag vertical curve for the road at two ends of the bridge R = 1,000m.

(5) Structure of Bridge

(a) Plan:
The end of abutment A is located at the top of the curve with the following factors: $\Delta = 71°21'00''$, R = 60m, the permissible speed V = 40km/h.

Even though the bridge shape on the plan is still flat, span No.1 next to abutment A is influenced by the superelevation on the transition of horizontal slope.

(b) Longitudinal Profile
Longitudinally, the bridge consists of five (5) spans. Each span is 20m in length. The longitudinal gradient of the center span is 0%. The longitudinal gradients of the adjacent spans are 2% and 4% respectively. The gradient of the access road at back wall of the abutment is 4.5%.

(c) Superstructure:

In each span of 20m, there are ten (10) pre-stressed concrete cellular plate girders with the rectangular (99cm x 65cm) shape.

The deck plate is made of M300 pre-cast concrete with the thickness of 10cm.

The wearing course is made of the fine asphalt concrete with the thickness of 5cm.

Reinforced rubber joints will be installed in the expansion joints between spans.

The bridge bearing consists of rubber bearing with the size of 35cm x50cm x 5cm and five steel plates.

Bridge railing is made of cast-in-place M250 concrete. The surface of rail concrete will be carved the corrugated grooves for decoration requirement.

(d) Substructure:

Bridge pier inside the canal

Bridge pier bases on pile indirect foundation. The upper part of pile foundation made of 250 grade concrete is a structure shaped frame Π.

Twenty-four (24) M300 pre-cast reinforced concrete piles are used for one bridge pier. Each pile is 36m in length and 40cm x 40cm in section size. Each pile is proposed to be conjoining of three 12m in length pieces. Batter piles are placed with 1/6 obliquity.

The bridge pier should be designed to have enough strength against the hit of the boat based on the VI-stipulated grade for this canal.

Bridge pier at the bank

The bridge pier bases on pile indirect foundation. The upper part of pile foundation made of 250 grade concrete is a structure shaped frame Π.

Twenty-four (24) 300 grade pre-cast reinforced concrete piles are used for one bridge pier. Each pile is 36m in length and 40cm x 40cm in section size. Each pile is proposed to be conjoining of three 12m long pieces. Batter piles are placed with 1/6 obliquity.

Bridge abutment

The bridge abutment bases on pile indirect foundation. The upper part of pile foundation is U shape with grille made of M250 concrete. Twenty of 40 x 40 reinforced concrete piles are used for abutment grill. Each pile is proposed to be conjoining of three 12m long pieces. One inside line of pile is piled straight and two outside lines are piled with obliquity of 1/6.

The outside of two wing walls is the quarry stone bank protection with slope of 1/5.

Two cast-in-place 250 grade reinforced concrete transition slabs with the longitudinal gradient of 10% will be constructed at the back of two abutments.

During construction of each pier and abutment, an experiment of piling should be carried out for one pile to determine the exact length and the real capacity of all piles in the group.

The access road to the bridge

Transition slab made of 250 grade reinforced concrete is constructed at the back of the abutment. The transition slab with the length of 4m is placed with the slope of 10%. Its end puts on the abutment wall and the other puts on the 250 grade RC girder.

In order to limit the press of soil on abutment, the geotextile will be used at the back of abutment. The character of the geotextile is as same as that of the geotextile PEC 100 (one direction strength). Each layer will be filled with the less than 50cm of red gravel grading with the compression vibration index K of 0.95. Gaps between the geotextile and abutment wall will be filled with the 1 x 2 size aggregate. A drainage pipe with small holes made of PVC hard plastic will be installed along the horizontal size of the abutment and across to the outside of the cone.

(6) Insurance of Transportation during Construction of the Bridge

Measure of waterway transportation insurance is required during construction of the bridge. During construction, lane division of waterway, schedule for waterway transportation, installation of float and sign should be decided by the Waterway Management Unit of HCMC.

Construction schedule

Total of 5 months for the completion of the bridge construction is estimated.

8.10 Wastewater Treatment Plant: Landscape

8.10.1 Landscape Design

At both main entrance and service yard entrance, both side sliding gate doors are installed for passing flow of motor vehicles and lorries.

Whole the Plant site shall be enclosed by fences, façade of the entrance shall be installed steel grid fence with good appearance while other area surrounding of the Plant site is installed net fence.

Greenification shall be essential for beautify such Plant site. Medium trees as major objectives shall be introduced for provision of rich greenery, and planting of young coconut palms will be meet with existing environs of the vicinity area.

Some small flowering shrubs shall be planted in concentration from the entrance to the main office building area through focal road side spaces.

Over all open spaces shall be furnished with grass, so that whole the project site will be covered grass expansion without any dust problems.

8.10.2 Landscape facility

Main gate post (pair of posts): 2 (pair) Nos. Steel reinforced concrete post of 565 x 450 x H2500,
Sliding gate door (sliding door for both sides): 4 Nos. for both gates, Size of H=2,000 x W500 x L5,650.
Steel 50 x 50 framed door with wheels on bottom (both side of door) and railway included.

Swing door (swing door with column): 1 No. H2,000 x W1,300 steel 50x 50 framed and the column shall be H2,500 x W 335 x 335 fixing with swing door.

Grid fence: H2,200 x @3,000 span unit of steel bar with base trim. Concrete column of H2,500 x W335 x 220 shall be installed at 3.000 intervals and end concrete column of H2,500 x W335 x 335 shall be installed at corner where fence change it's direction.

Wire net fence: H2.500 x @3,000 span net fence with concrete column of 200 x 200 x H2.200. This column shall be installed at each interval of 3,000 and at corner where fence change it's direction.

8.10.3 Planting

Plantings shall be the main work for landscaping the Plant site and trees become major objectives for provision of rich greenery with seasonal flowerings. Some flowering shrubs shall be also provided for an accent of the focal areas. All planting work shall required proper size of planting hole and existing soil to be replaced agriculture soil.

Medium trees for canopy:

Lagerstroemia reginae (=Lagaestroemia speciosa) 47 Nos., *Mimusops elengi* 32 Nos.,

shall be planted. Both species are H=4.0m, stem diameter is 4cm in 1.2m height from the ground.

Cassia fistula 66Nos, *Khaya senegalensis* 8 Nos., *Mangifera indica* 15 Nos , *Melaleuca leucadendra* 20 Nos., *Plumeria rubra* 8 Nos., *Polyalthia longifolia* 22 Nos., *Tamarindus indica* 8 Nos., *Terminalia catapa* 12 Nos., shall be planted. These species are H=3.0m, stem diameter is 3 to 4cm in 1.2m height from the ground. All trees shall be supported by tripod type support with pole individually to sustain trees in stable.

As palms, *Cocos nucifera* 63 Nos. shall be young palm of 1 year growing after germination requires 1.5m in height when planted. Cocos palm does not require tree support. *Roystonea regia* 6 Nos. shall be planted at front area of the main office building, This species well grown with H=6.0m, stem diameter is 15cm in 1.2m height from the ground also it requires tripod type support.

Flowering shrub:

Bauhinia purpurea 89 Nos. and *Thevetia peruviana (=Cerbera peruviana)* 76 Nos. shall be planted independently. These size shall be required H=1.0m and stem diameter D=1cm.

Hibiscus rosa-sinensis 180m^2, *Ixora coccina (=Ixora chinensis)* 6m^2, *Lantana camara* 36m^2 and *Musaenda pubescens* 54m^2 shall be planted and all these shrubs are 40cm in height and crown width is 25cm and these shall be group planting with 10 Nos/m^2.

Grass sods and sprigs:

Axonopus compressus 694.9m^2 is applied for grass sod at main office entrance areas and 62,225.7m^2 for rest of areas.

8.11 Construction Plan and Schedule

This section deals with the construction plan and schedule of package E : Wastewater Treatment Plant.

8.11.1 Basic Conditions

For preparation of construction plan and schedule, the following considerations have been taken as basic concept of construction works.

(1) Scope of Package E Project

Package E : Wastewater Treatment Plant Construction Project consists of the following main construction component:

(a) Construction of Jetty
(b) Site preparation
- Construction of Temporary Dike
- Soil Improvement

(c) Construction of Bridge
(d) Construction of Temporary Road
(e) ϕ1200 Pipe Jacking
(f) Construction of Wastewater Treatment Plant
- Pilling work
- Excavation work
- Structure work
- Architecture work
- Mechanical work
- Electrical work
- Backfilling and Filling work
- Landscape work

(2) Other conditions

(a) Mode of construction
The construction shall be carried out by sufficient contractor(s) selected through the International Competitive Bidding(ICB).
(b) Availability of Construction Plan and Equipment
The major construction works shall be conducted by applying heavy equipments which mostly procured locally due to the limited construction period and quality control of construction.
(c) Construction Materials
Most of basic construction materials are available in this country. Some particular processed materials (steel sheet pile, H type steel beam, mechanical and electrical equipments etc) are to be procured from outside.

8.11.2 Major Works of the Project

Major works of Wastewater treatment Plant Construction Project consists of the followings :

(1) Site conditions

The Wastewater Treatment Plant is located in Binh Hung ward, Binh Chanh. The area about 41 ha enclosed by canals has following special conditions:

(a) No existing access roads to the site, so that until the temporary access road and the Tac Ben Ro bridge will be constructed, the waterway transportation must be used to transport material, equipment and labor to the site.

(b) The existing ground level of the site is about +0.50 (mean sea water level of Mui Nai), it is 1.12m lower than the High Water Level of Tac Ben Ro River nearby the site. To avoid the inundation of the treatment plant, design ground elevation is proposed at +2.20.

(c) The soil condition of this site is not suitable for construction. The geological structure of this area is similar with the other area nearby the site, while the thickness of soft organic soil layer ranging from 28m to 33m is much deeper than other area of less than 12m. This soft soil condition affects to the construction works seriously, especially to the filling works and excavation.

(2) Jetty, site preparation and temporary road works

Due to the conditions mentioned above, access road and bridge and jetty for waterway transportation must be constructed first.

The temporary access road is proposed from Chanh Hung street, which will be extended to the prison in Nha Be district to the proposed bridge crossing Tac Ben Ro river. The width of the road is designed at 6 m of crushed stone surface on the laterite road base with a total length of 464m.

The Tac Ben Ro bridge will be used for daily operation after construction of the plant, but this bridge is also used as an access to the site for the construction period.

The jetty is designed by reinforced concrete structure with RC foundation piles 400mmx400mm. This jetty will be used for loading / unloading of materials and equipments transported by waterway for not only for phase I but also for phase II. The size of the jetty is proposed at 23.4m x 9.9m.

Due to the existing ground elevation of the site at +0.5 m in average is lower than the high water level of Tac Ben Ro river, temporary dike is required to prevent the inundation.

Before commencement of construction works in the treatment plant site, bearing capacity of the ground should be secured the trafficability of the heavy duties.

(a) Surface soft soil layer of 1 m depth should be excavated first.

(b) The backfilling will be done by black sand with the thickness of 1.0m along Tac

Ben Ro canal where is required to improve the soil condition by cement mixing to prevent the slope sliding.

(c) Backfilling will be done by black sand with a thickness of 0.5 m for the remaining area in the site.

(d) Piling work for all structures is carried out at ground elevation of EL ±0.00m.

The evidence from the analysis of slope sliding, the excavation works till EL- 4.1 m will be done by open cut method with slope of 1:9. Excavation works deeper than EL-4.1 m will be done by sheet piling method.

Due to the low permeability of the soil in the site of 1.50-5.68 $\times 10^{-8}$ cm/sec, the ooze of ground water is not expected large. Then, pump drainage is proposed to drain water from the site.

(3) Bridge construction

Abutments of both sides are constructed after the soil improvement by cement soil mixing to prevent slope sliding.

The following construction works for piers in the river are planed to construct by using the barge.

a) Driving of sheet pile
b) Driving of concrete pile
c) Excavation and setting of strut
d) Construction of pier
e) Backfilling
f) Removal of sheet pile

(4) ϕ1200 Pipe jacking work

ϕ1200 Pipe jacking work is refer to Chapter 4 in Main Report, Vol. II.

(5) Construction of Wastewater Treatment Plant

(a) Pilling work
Pilling work for all structures is carried out at ground elevation of EL ±0.00m . Concrete pile of 400 mm × 400 mm (n = 6150), and 300 mm × 300 mm (n = 10) are proposed for foundation of each facilities.
Concrete pile shall be driven by diesel hammer.

(b) Excavation work

Excavation work shall be conducted mainly by backhoe. Clamshell shall be applied for excavation depth is more than GL - 5.00m.

Excavated soil is transported by dump truck and kept in the treatment site. Excavated soil is also used for backfilling material.

(c) Structure work

Structure work of wastewater treatment plant is to construct reinforced concrete structures of treatment facilities.

Main construction facilities are as follows.

- Lift Pumping Station
- Wastewater Treatment Facilities
- Disinfection tank
- Water Supply Facility
- Gravity Thickener
- Compost Plant Facilities
- Pipe Gallery

Concrete placing shall be conducted by concrete pump machine.

Concrete structures shall be constructed in combination with mechanical and electrical equipments installation.

(d) Architectural work

Architectural work of wastewater treatment plant is to construct following buildings.

- Lift Pumping Station
- Main Building
- Blower Building
- Dewatering Building
- Chlorine Storage Building
- First Fermentation Tank Building
- Second Fermentation Tank Building
- Storage Vessel Building
- Sub Storage Vessel Building
- Compost Control Building
- Guard House
- Stair Case

Architectural works also shall be constructed in combination with mechanical and electrical equipments installation.

(e) Mechanical and electrical works

Mechanical and electrical works are to install mechanical and electrical equipments into the Wastewater Treatment Facilities. Installation of equipments shall be conducted according to drawings and specifications.

Testing of works shall be done after all equipments are installed.

(f) Backfilling and filling works

After structure construction is finished, backfilling and filling shall be conducted. Black sand is proposed for backfilling and excavated soil is proposed for filling to prepare a planting of grass.

8.11.3 Construction Schedule

Construction schedule is prepared based on the following assumptions:

(a) Construction could be commenced at the beginning of June 2002 after due consideration of short period relocation implementation.
(b) Preparatory work period is considered at least two (2) months.
(c) Jetty and bridge construction shall be commenced firstly, of which work period is estimated at three (3) and eleven (11) months.
(d) After completion of the jetty work, site preparation work consisting of site access work, ground improvement work for prevention of land slide, soft soil excavation and filling, and protection work for existing power tower, shall be commenced immediately and finished within eight (8) months.
(e) Construction of Lift Pumping Station and Wastewater Treatment Plant would be commenced at the beginning of May 2003 and completed within 32 months (end of December 2005). However, the design of mechanical and electrical equipment shall be commenced before starting of the civil works.
(f) Main Building construction including mechanical and electrical works would be commenced at the beginning of January 2004 and completed within 24 months.
(g) Sludge Treatment Plant construction shall be commenced at September 2003 and completed within the end of January 2006.
(h) Finally, landscape and cleaning work shall be conducted and completed up to the end of February 2006.

The proposed construction schedule of Package E Project is shown in Table 8.24

TABLE 8.1 SOIL PROPERTIES SUMMARY

No	Layer	Depth (m)	Thickness (m)	N Value	W(%)	γ_t (g/cm³)	γ_{sub} (g/cm³)	WL(%)	Ip(%)	G_s (g/cm³)	e_o	qu (kg/cm²)	C_c	Eo (kg/cm²)	E_{50} (kg/cm²)	C_v (cm²/s)	P_c (kg/cm²)
1	OH1	4	4	2	93.25	1.370	0.432	101.28	52.68	2.576	2.644	0.130	1.112	2.075	1.336	2.22E-04	0.616
2	OH1	8	4	2	92.91	1.440	0.456	90.55	44.65	2.574	2.450	0.153	0.907	2.550	1.575	2.16E-04	0.532
3	OH1	13	5	2	82.98	1.446	0.484	87.30	43.98	2.592	2.288	0.220	0.908	4.125	2.339	2.73E-04	0.635
4	OH1	18	5	2	95.53	1.425	0.445	95.13	46.15	2.568	2.526	0.200	0.976	3.200	2.168	2.86E-04	0.672
Average OH1 :				**2**	**91.17**	**1.420**	**0.454**	**93.56**	**46.86**	**2.577**	**2.477**	**0.176**	**0.976**	**2.988**	**1.854**	**2.49E-04**	**0.614**
5	OH2	23	5	3	82.01	1.465	0.492	86.88	42.18	2.577	2.205	0.244	0.856	4.300	2.632	3.07E-04	0.781
6	OH2	28	5	3	76.87	1.471	0.512	83.85	40.75	2.603	2.130	0.224	0.905	4.275	2.457	2.39E-04	0.756
Average OH2 :				**3**	**79.44**	**1.468**	**0.502**	**85.36**	**41.46**	**2.590**	**2.167**	**0.234**	**0.881**	**4.288**	**2.545**	**2.73E-04**	**0.768**
Average OH1+OH2 :				**2.333**	**87.26**	**1.436**	**0.470**	**90.83**	**45.06**	**2.581**	**2.374**	**0.195**	**0.944**	**3.421**	**2.085**	**2.57E-04**	**0.665**

TABLE 8.2 FINAL SETTLEMENT BY SELF-WEIGHT

Layer	Depth (m)	Thickness (cm)	σ_o (kg/cm²)	P_c (kg/cm²)	e_o	Cc	$\frac{Cc}{1+e_o}$	$\Delta\sigma$	$\frac{Pc+\Delta\sigma}{Pc}$	$\lg\left(\frac{Pc+\Delta\sigma}{Pc}\right)$	S(cm)
OH1	2	400	0.165	0.545	2.644	1.1115	0.305	0.000	1.000	0.000	0.000
OH1	6	400	0.355	0.580	2.454	0.907	0.263	0.000	1.000	0.000	0.000
OH1	10.5	500	0.569	0.619	2.288	0.908	0.276	0.000	1.000	0.000	0.000
OH1	15.5	500	0.807	0.663	2.526	0.976	0.277	0.144	1.218	0.086	11.849
OH1	20.5	500	1.045	0.706	2.205	0.856	0.267	0.339	1.480	0.170	22.735
OH2	25.5	500	1.283	0.750	2.130	0.905	0.289	0.533	1.711	0.233	33.733
OH2	30.5	500	1.521	0.793	2.130	0.905	0.289	0.728	1.918	0.283	40.874
									Total Settlement :		**109.191**

$$S = H\frac{Cc}{1+e_o}\lg\left(\frac{Pc+\Delta\sigma}{Pc}\right)$$

TABLE 8.3 FINAL SETTLEMENT BY FILLING (EL +2.20)

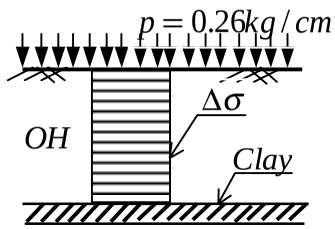
Layer	Depth (m)	Thickness (cm)	σ_o (kg/cm²)	P_c (kg/cm²)	e_o	Cc	$\frac{Cc}{1+e_o}$	σ_o	$\frac{\sigma_o+\Delta\sigma}{\sigma_o}$	$\lg\left(\frac{\sigma_o+\Delta\sigma}{\sigma_o}\right)$	S (cm)
OH1	2	400	0.165	0.545	2.644	1.112	0.305	0.256	2.554	0.407	0.000
OH1	6	400	0.355	0.580	2.454	0.907	0.263	0.256	1.721	0.236	24.764
OH1	10.5	500	0.569	0.619	2.288	0.908	0.276	0.256	1.450	0.161	22.266
OH1	15.5	500	0.807	0.663	2.526	0.976	0.277	0.256	1.317	0.120	16.554
OH1	20.5	500	1.045	0.706	2.205	0.856	0.267	0.256	1.245	0.095	12.707
OH2	25.5	500	1.283	0.750	2.130	0.905	0.289	0.256	σ 1.199	σ 0.079	11.419
OH2	30.5	500	1.521	0.793	2.130	0.905	0.289	0.256	1.168	0.068	9.764
									Total Settlement :		**97.475**

$$S = H\frac{Cc}{1+e_0}\lg\left(\frac{\sigma_o+\Delta\sigma}{\sigma_o}\right)$$

σ

TABLE 8.4 SETTLEMENT BY TIME UNDER FILLING

t(year)	cv(cm²/s)	N	e^{-N}	$e^{-9N}/9$	$e^{-25N}/25$	$e^{-49N}/49$	$e^{-81N}/81$	$e^{-121N}/121$	$e^{-169N}/169$	$e^{-225N}/225$	$e^{-289N}/289$	Ut	St(cm)
1.0	2.57E-04	0.0017	0.998	0.109	0.038	0.019	0.011	0.007	0.004	0.003	0.002	0.030	2.9
2.0	2.57E-04	0.0035	0.997	0.108	0.037	0.017	0.009	0.005	0.003	0.002	0.001	0.042	4.2
3.0	2.57E-04	0.0052	0.995	0.106	0.035	0.016	0.008	0.004	0.002	0.001	0.001	0.052	5.1
4.0	2.57E-04	0.0070	0.993	0.104	0.034	0.014	0.007	0.004	0.002	0.001	0.000	0.060	5.9
5.0	2.57E-04	0.0087	0.991	0.103	0.032	0.013	0.006	0.003	0.001	0.001	0.000	0.067	6.6
10.0	2.57E-04	0.0175	0.983	0.095	0.026	0.009	0.003	0.001	0.000	0.000	0.000	0.095	9.3
11.1	2.57E-04	0.0194	0.981	0.093	0.025	0.008	0.003	0.001	0.000	0.000	0.000	0.100	9.8
20.0	2.57E-04	0.0349	0.966	0.081	0.017	0.004	0.001	0.000	0.000	0.000	0.000	0.134	13.2
30.0	2.57E-04	0.0524	0.949	0.069	0.011	0.002	0.000	0.000	0.000	0.000	0.000	0.164	16.1
33.3	2.57E-04	0.0582	0.943	0.066	0.009	0.001	0.000	0.000	0.000	0.000	0.000	0.173	17.0
40.0	2.57E-04	0.0699	0.933	0.059	0.007	0.001	0.000	0.000	0.000	0.000	0.000	0.190	18.6
50.0	2.57E-04	0.0873	0.916	0.051	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.212	20.8
75.0	2.57E-04	0.1310	0.877	0.034	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.260	25.5
83.3	2.57E-04	0.1455	0.865	0.030	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.274	26.9
100.0	2.57E-04	0.1747	0.840	0.023	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.300	29.4
139.0	2.57E-04	0.2428	0.784									0.354	34.7
222.0	2.57E-04	0.3878	0.679									0.447	43.8
250.0	2.57E-04	0.4367	0.646									0.474	46.5
333.0	2.57E-04	0.5817	0.559									0.546	53.6
500.0	2.57E-04	0.8734	0.418									0.662	64.8
694.0	2.57E-04	1.2123	0.297									0.759	74.4
1000.0	2.57E-04	1.7469	0.174									0.859	84.2
1050.0	2.57E-04	1.8342	0.160									0.871	85.3
1390.0	2.57E-04	2.4282	0.088									0.929	91.0
2220.0	2.57E-04	3.8781	0.021									0.983	96.4
5000.0	2.57E-04	8.7345	0.000									1.000	98.0
6000.0	2.57E-04	10.4814	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	98.0



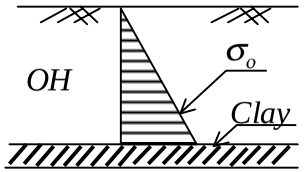
$$St = SxUt$$

$$Ut = 1 - \frac{8}{\Pi^2}\left(e^{-N} + \frac{1}{9e^{-9N}} + \frac{1}{25e^{-25N}} + \ldots\right)$$

$$N = \frac{\Pi^2 C_v 3.10^7 t}{4H^2}$$

TABLE 8.5 SETTLEMENT BY TIME UNDER SELF-WEIGHT

t(year)	cv(cm²/s)	N	e^{-N}	$e^{-9N}/27$	$e^{-25N}/125$	$e^{-49N}/343$	$e^{-81N}/729$	$e^{-121N}/1331$	$e^{-169N}/2197$	$e^{-225N}/3375$	$e^{-289N}/4913$	Ut	St(cm)
1	2.57E-04	0.0017	0.998	0.036	0.008	0.003	0.001	0.001	0.000	0.000	0.000	0.001	0.2
2	2.57E-04	0.0035	0.997	0.036	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.003	0.3
3	2.57E-04	0.0052	0.995	0.035	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.004	0.5
4	2.57E-04	0.0070	0.993	0.035	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.006	0.6
5	2.57E-04	0.0087	0.991	0.034	0.006	0.002	0.001	0.000	0.000	0.000	0.000	0.007	0.8
10	2.57E-04	0.0175	0.983	0.032	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.014	1.6
11.1	2.57E-04	0.0194	0.981	0.031	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.016	1.7
20	2.57E-04	0.0349	0.966	0.027	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.028	3.1
30	2.57E-04	0.0524	0.949	0.023	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.042	4.7
33.3	2.57E-04	0.0582	0.943	0.022	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.047	5.2
40	2.57E-04	0.0699	0.933	0.020	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.057	6.2
50	2.57E-04	0.0873	0.916	0.017	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.071	7.8
75	2.57E-04	0.1310	0.877	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.106	11.7
83.3	2.57E-04	0.1455	0.865	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.118	13.0
100	2.57E-04	0.1747	0.840										15.5
139	2.57E-04	0.2428	0.784										21.4
222	2.57E-04	0.3878	0.679										33.1
250	2.57E-04	0.4367	0.646										36.7
333	2.57E-04	0.5817	0.559										46.6
500	2.57E-04	0.8734	0.418										62.6
694	2.57E-04	1.2123	0.297										76.2
1000	2.57E-04	1.7469	0.174										90.2
1050	2.57E-04	1.8342	0.160										91.9
1390	2.57E-04	2.4282	0.088										100.0
2220	2.57E-04	3.8781	0.021										107.7
5000	2.57E-04	8.7345	0.000										110.0
6000	2.57E-04	10.4814	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	110.0



$$St = SxUt$$

$$Ut = 1 - \frac{32}{\Pi^3}\left(e^{-N} - \frac{1}{27e^{-9N}} + \frac{1}{125e^{-25N}} - \ldots\right)$$

$$N = \frac{\Pi^2 C_v 3.10^7 t}{4H^2}$$

TABLE 8.6 SUMMARY OF SETTLEMENT BY TIME

t(year)	St-Fill(cm)	St-Self(cm)	St-Total
1	2.9	0.2	3.1
2	4.2	0.3	4.5
3	5.1	0.5	5.6
4	5.9	0.6	6.5
5	6.6	0.8	7.4
10	9.3	1.6	10.9
11.1	9.8	1.7	11.5
20	13.2	3.1	16.3
30	16.1	4.7	20.8
33.3	17.0	5.2	22.2
40	18.6	6.2	24.8
50	20.8	7.8	28.6
75	25.5	11.7	37.2
83.3	26.9	13.0	39.8
100	29.4	15.5	45.0
139	34.7	21.4	56.1
222	43.8	33.1	76.9
250	46.5	36.7	83.2
333	53.6	46.6	100.1
500	64.8	62.6	127.4
694	74.4	76.2	150.6
1000	84.2	90.2	174.4
1050	85.3	91.9	177.2
1390	91.0	100.0	191.0
2220	96.4	107.7	204.0
5000	98.0	110.0	208.0
6000	98.0	110.0	208.0

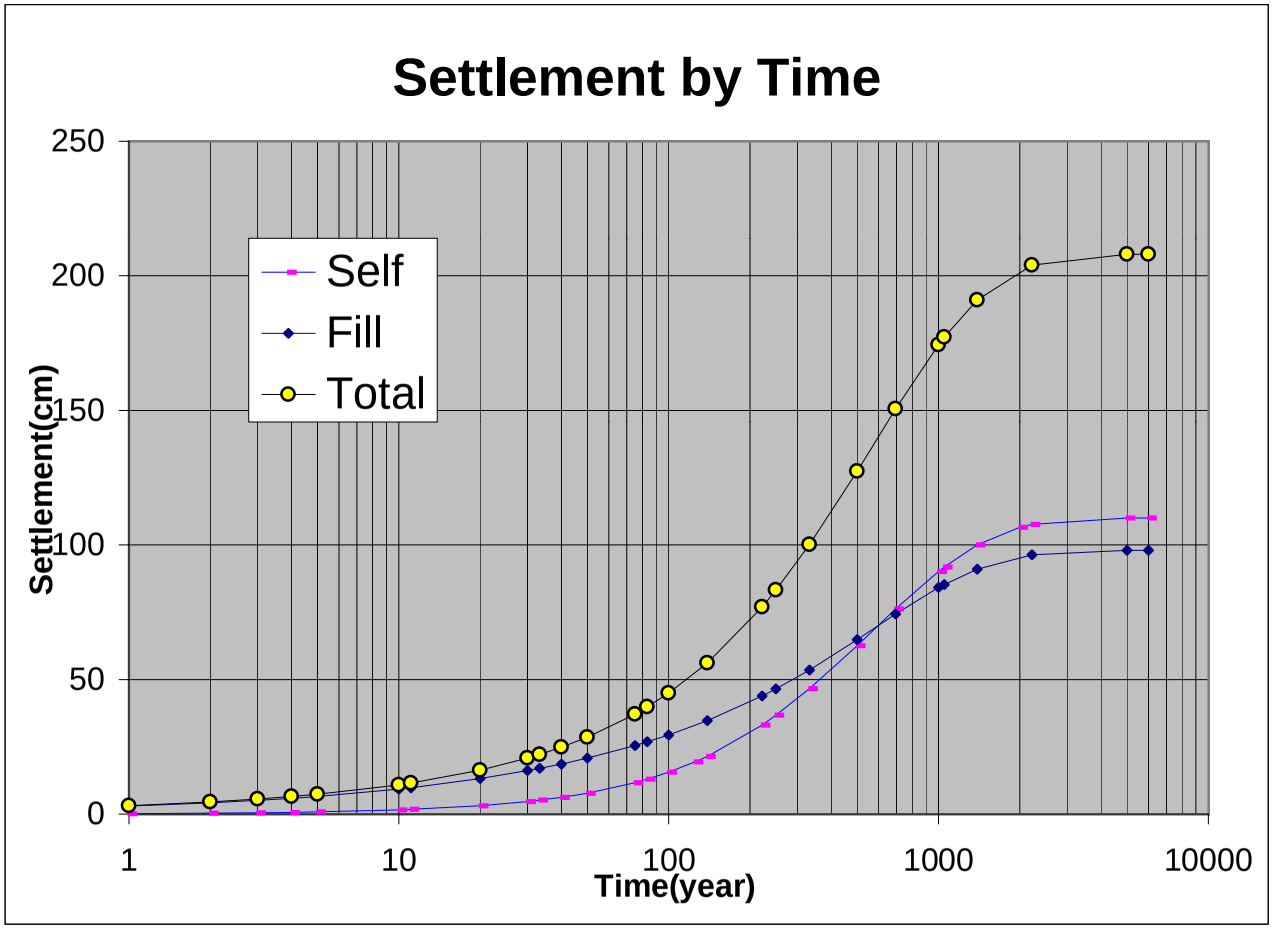


TABLE 8.7 (1/2) COMPARISON OF SLUDGE COLLECTING EQUIPMENT

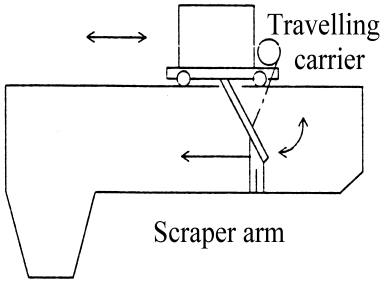
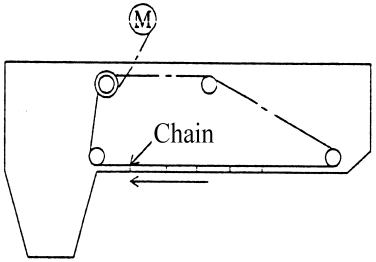
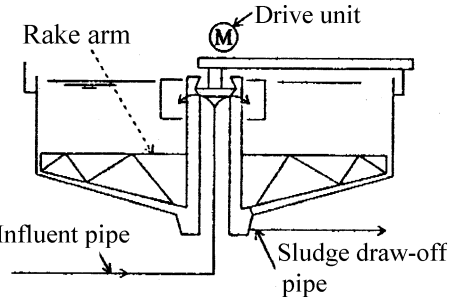
Item	Meider type sludge collector		O Chain flight sludge collector		Clarifier type (circular or square) collector	
1. Schematic diagram						
2. Mechanism	Scraper arms are suspended from the travelling carrier provided over the water. The arm is constructed to rise and lower via rope by means of the take-up drum. This equipment moves forward with the arm lowered and backward with the rake raised so as to scrape the sludge. When the equipment is at stop, the arm should be lifted up to above the water.		Two endless chains have flights (rakes) mounted at about 3m pitches. In this equipment, while chains are travelling in the direction of arrow, the flights scrape the sludge.		The drive unit is mounted to steel plate beams provided over the basin wall and drives the rake plate to scrape the sludge to a hopper installed at the center of the basin.	
3. Actual use	Rather less frequently.	Δ	Frequently.	O	Frequently.	O
4. Maintenance	Complicated because travelling apparatus, limit switches, etc. require check.	Δ	Easy because mechanical construction is simple.	O	Easy because mechanical construction is simple.	O
5. Operation	Complicated because scraping is intermittent and there are many limit switches, etc.	Δ	Easy because scraping is continuous.	O	Easy because scraping is continuous.	O

TABLE 8.7 (2/2) COMPARISON OF SLUDGE COLLECTING EQUIPMENT

Item	Meider type sludge collector		O Chain flight sludge collector		Clarifier type (circular or square) collector	
6. Capability	Rather inferior to the chain flight type.	Δ	Relatively good.	O	Relatively good.	O
7. Initial cost	180	Δ	100	O	130	Δ
8. Running cost	250	Δ	100	O	90	O
9. Life	Limit switches and drive electrical parts require check and replacement every 1 to 2 years.	Δ	Flight shoes every 3 to 4 years or so, chains every 5 to 10 years or so.	O	Limit switches and drive electrical parts should be checked and replaced every 1 to 2 years.	Δ
10. Safety	Inferior because of complicated construction and the presence of many limit switches, etc.	Δ	Superior because of simple construction.	O	Superior because of simple construction.	O
11. Failure rate	Large because of the presence of many limit switches.	Δ	Small because of simple construction.	O	Small.	O
12. Evaluation	(1) Complicated construction, large drive power and intermittent operation. (2) Requiring many limit switches and much labor for maintenance. (3) Usually this equipment is installed when it is difficult to adopt the chain flight type.	Δ	(1) Flight moving speeds at which sludge does not float up can be selected. (2) Scum floated up to the water surface by return side flights can be introduced positively into the scum trough. (3) Because of small flight height, the sludge flow is not disturbed.	O	1) Simple construction.	O
13. Conclusion	In the sewage treatment plants, the chain flight type and the clarifier type are frequently used in general, but because of high efficiency, simple construction, easy maintenance, low running cost and well balanced arrangement, the chain flight type seems to be suitable.					

TABLE 8.8 (1/2) COMPARISON OF SLUDGE PUMP AND CHEMICAL PUMP EQUIPMENT

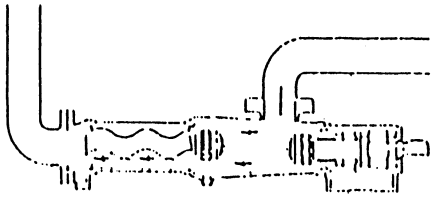
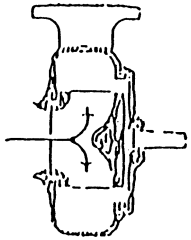
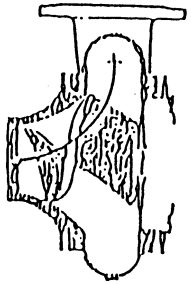
Item	Progressing cavity pump		Non-clogging pump		Centrifugal screw inpeller pump	
1. Schematic diagram						
2.Pump efficiency	20 to 30%	Δ	20 to 50%	O	30 to 60%	O
3. Applicability to sludge	Strong in respect of clogging because of volumetric type in which the sludge is pushed out by piston motion produced by the rotor.	O	Constructionally strong in respect of clogging with inclusions, etc. because of the impeller of non-clogging type.	O	Strong to inclusions because of the impeller of screw type in which inclusions, etc. are pushed toward the blade center portion and carried to the discharge port. Since the sludge does not contact the casing, etc., this pump is excellent also in wear resistance.	O
4. Maintenance	Stator, made of synthetic rubber, easily wears and requires replacement periodically. Mechanical seals require maintenance periodically.	O	Mechanical seals require maintenance periodically.	O	Mechanical seals require maintenance periodically.	O

TABLE 8.8 (2/2) COMPARISON OF SLUDGE PUMP AND CHEMICAL PUMP EQUIPMENT

Item	Progressing cavity pump		Non-clogging pump		Centrifugal screw inpeller pump	
5. Arrangement space	Constructionally, the equipment has a large length and requires a relatively large space.	Δ	If this pump is constructed as the overhead type, the space required is smallest.	O	The equipment length is rather large because of the pump suction portion being of screw construction.	Δ
6. Quantitative-ness	Most quantitative because of the volumetric type. The quantity of sludge can be adjusted in proportion to the number of rotations.	O	Quantitativeness cannot be expected since flow rate is liable to change with changing pump head.	Δ	The pump head curve is sharply inclined, and therefore, the flow rate less changes with changing pump head than in the non-clogging type.	Δ
7. Actual use	Because of quantitativeness, this pump is used frequently as the dehydrator feed pump. Sometimes used as the raw sludge pump, etc., but in these examples, stator replacement is frequently needed uneconomically.	O	Most frequently used for transfer of low-concentration sludge.	O	Because of excellent characteristics such as high pump efficiency, this pump is superseding the non-clogging type in the application of transfer of low-concentration sludge.	O
8. Price	115	Δ	100	O	110	Δ
9. Conclusion	In the case of small-capacity sludge pump of smaller than 100 mm bore, low-price non-clogging type pumps are adopted, but in the case of large capacity of larger than 150 mm bore, centrifugal screw impeller pumps of high efficiency and excellent characteristics are adopted. As sludge feed pump and chemical pump for centrifugal dehydrator and centrifugal thickener, progressing cavity pumps capable of volumetric control and suited for high-concentration sludge transfer are adopted.					

TABLE 8.9 (1/2) COMPARISON OF AERATION TANK EQUIPMENT

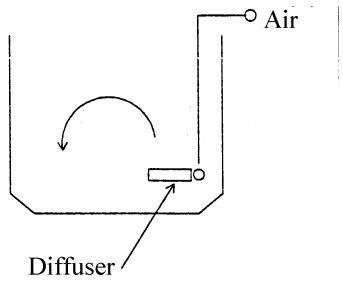
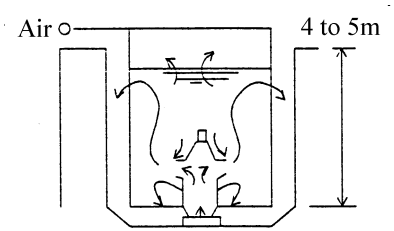
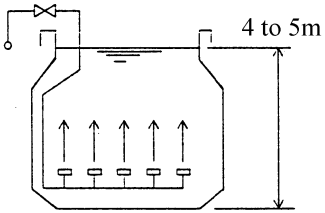
Item	O Spiral flow aeration type		Submerged mixing aeration type		Whole floor aeration type	
1. Schematic diagram						
2. Mechanisum	In parallel with the flow of sewage, diffusers are installed on one side of the tank. As air is injected, the water is allowed to flow in a spiral flow.		On the bottom of the reaction tank, diffusers are installed for aeration or agitation. The air supplied from the blower is converted effectively into minute air bubbles by the agitation capability of the equipment, so as to dissolve oxygen into the sewage.		Diffuser plates used are smaller in size than those conventionally used. Diffuser plates of small air hole diameter are arranged in a scattered way over the whole bottom surface of the tank. It is intended to reduce the foaming area, and also to realize minute air bubbles and good diffusion of air bubbles within the tank, so as to improve the oxygen movement efficiency.	
3. Air supply rate	100	Δ	50	O	75	Δ
4.Electric power consumption	100	Δ	90	O	90	O

TABLE 8.9 (2/2) COMPARISON OF AERATION TANK EQUIPMENT

Item	O Spiral flow aeration type		Submerged mixing aeration type		Whole floor aeration type	
5.Construction cost (including blower)	100	O	150	Δ	130	Δ
6. Maintenance	Diffuser clogging is relatively small.	O	Daily maintenance is easy, but it is necessary to withdraw the equipment out of water once in 2 or 3 years for oil replacement of reducer, etc. and for check and maintenance of bearing, etc.	Δ	Maintenance to avoid clogging should be done sufficiently because the air hole diameter is small.	Δ
7. Air Filter	Air filter is necessary.	O	Air filter is necessary.	O	High-performance air filter is necessary.	Δ
8. Actual use	Most frequently used.	O	Recently, there has been a tendency to increase.	O	Recently, there has been a tendency to increase.	O
9. Conclusion	The spiral type is adopted because of low construction cost and easy maintenance for the scale of the sewage treatment plant, etc. although it is rather inferior in respect of electric power consumption.					

TABLE 8.10 (1/4) COMPARISON OF BLOWER EQUIPMENT

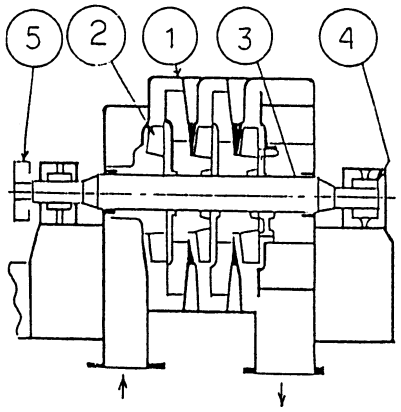
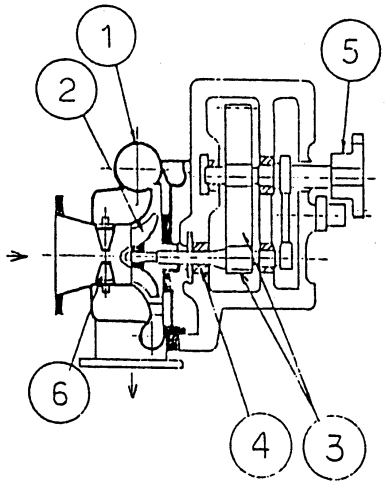
Item	Direct-coupled type multi-stage turbo blower	O Gear speed increasing type single-stage turbo blower	
1. Schematic diagram			
	① Casing (upper-lower 2-split) ② Impeller ③ Spindle ④ Bearing ⑤ Shaft coupling NOTE: In some cases, inlet vanes are mounted.	① Casing ② Impeller ③ Gear (speed increasing gear) ④ Bearing ⑤ Coupling ⑥ Inlet vane	

TABLE 8.10 (2/4) COMPARISON OF BLOWER EQUIPMENT

Item	Direct-coupled type multi-stage turbo blower		O Gear speed increasing type single-stage turbo blower		
2. Mechanisum	Due to the centrifugal force caused by impeller rotation, the fluid (air) gains velocity energy. This velocity energy is converted into pressure energy by means of plural impellers arranged in series on one shaft to operate in a direct-coupled manner with a motor, so that the velocity energy may not be lost hydrodynamically by the casing. Pressure is increased gradually by the impellers of from 1st to final stages and the casing until the specified value is obtained.		Similarly to the multi-stage motor direct-coupled type, the specified pressure is produced centrifugally, but using a single impeller as compared with plural impellers in the case of the multi-stage type. For this porpose, the impeller has a high circumferential speed as required to convert velocity energy at a strike to pressure energy in spite of repeating from velocity energy to pressure energy, to velocity energy, to pressure energy in multi-stage operation. The high-speed operation is realized by using a speed increasing gear.		
3. Scope of application	30 to 1500 m^3/min 5 to 7 mAq	O	30 to 1200 m^3/min 5 to 15 mAq	O	
4. Method of drive	Motor direct coupled The motor used is a 2-pole type. Number of rotations 3,600 rpm (60 Hz synchronous) 3,000 rpm (50 Hz synchronous)	O	Speed increasing gear The motor used is a 4-pole or 2-pole type. Number of rotations 7,000 to 30,000 rpm	Δ	

TABLE 8.10 (3/4) COMPARISON OF BLOWER EQUIPMENT

Item	Direct-coupled type multi-stage turbo blower		O Gear speed increasing type single-stage turbo blower		
5.Operating characteristics	a. Started with discharge valve fully open. b. Cut-off pressure is higher than the specification pressure, and so, for parallel operation, the succeeding unit easily starts. c. Range of safe operation is 30 (40) to 100% (airflow rate). d. Shaft power has a limit load characteristic, so that when the motor output is given an allowance, the motor is not overloaded even at a larger airflow rate (than the specification point).	O	a. Anti-surging device is necessary. b. Cut-off pressure is low and therefore, for parallel operation, the motor should be started with the discharge valve fully open and the anti-surging device air release valve closed. c. Range of safe operation is 55 to 100% (air flow rate). d. Shaft power has a monotonously increasing characteristic, so that there is a possibility that the motor is overload when the airflow rate is too high.	O	
6. Air flow rate control	Range of air flow rate control a. Suction butterfly valve control 40 to 100% b. Inlet vane control 30 to 100%	O	Range of air flow rate control a. Inlet vane control 55 to 100% b. Discharge diffuser control 40 to 100%	O	
7. Vibration	a. Because of double-end supported structure, the action of vibration suppression is large and the vibration does not grow easily. b. Because of low numbers of revolutions, the vibration frequency is low. With the same amplitude, the vibration acceleration is small and the degree of safety is high. c. The tolerance on vibration is relatively large. 20 to 30 μ m	O	a. Because of single-end supported structure, there is a possibility of vibration growing. b. The vibration frequency is high, and with the same amplitude, the vibration acceleration is large. c. To prevent contact between impeller and casing, a vibration-monitoring device is necessary. d. Because of high-speed revolution, the tolerance on vibration is small. About 10 μ m	O	

TABLE 8.10 (4/4) COMPARISON OF BLOWER EQUIPMENT

Item	Direct-coupled type multi-stage turbo blower		O Gear speed increasing type single-stage turbo blower		
8. Noise	a. For the equipment of small and medium capacity (up to 160 m^3/min), noise prevention cover is not necessary. At 1.5m by the equipment, the noise can be held below 85 dB (A). For the equipment of large capacity, in order to reduce the noise to 85 dB (A), noise prevention cover is necessary. b. The noise is of relatively high frequency and the noise prevention measure is relatively easy.	O	a. High-frequency noise is produced due to impeller's air breaking sounds and gear's engagement sounds. b. In order to reduce the noise to 85 dB (A), noise prevention cover is necessary. Moreover, in the suction discharge piping, a silencer is necessary. c. The noise is of relatively high frequency and the noise prevention measure is relatively easy.	O	
9. Maintenance	a. No contact sound is produced other than bearing sound and few points require check. b. Lubrication oil supply unit and lubrication oil periodical maintenance are necessary.	Δ	a. Because of many auxiliary machines such as increasing speed gear and various protective means, many points require check.	Δ	
10. Price	130	Δ	100	O	
11. Actual Use	Rather less frequently	Δ	Frequently	O	
12. Conclusion	The gear speed increasing type single-stage turbo blower will be adopted. Because of many installation record, high reliability of mechanical performance and lower initial cost.				

TABLE 8.11 (1/3) COMPARISON OF WATER SUPPLY EQUIPMENT

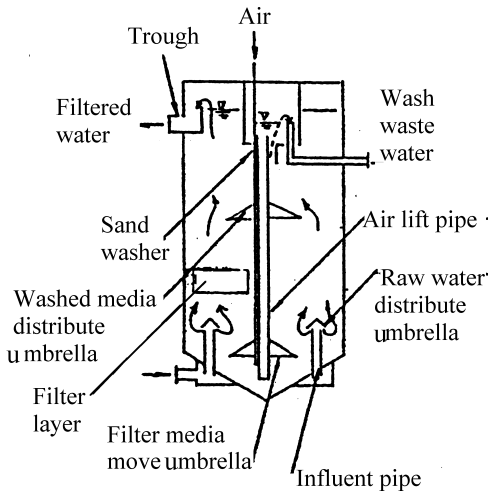
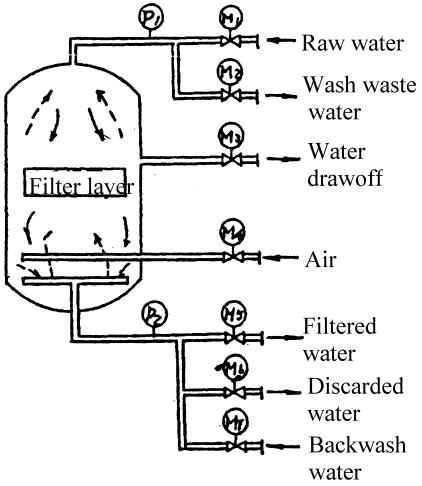
Item	Moving bed filtration	O Pressure filtration	
1. Schematic diagram			
2. Mehanisum	Raw water rises through the inside of raw water influent pipe and is distributed by the raw water distribution umbrella over the entire region of the filter layer. While rising through the filter layer, the raw water is removed of SS and the filtered water rises inside the tank until being collected into the filtered water collecting trough and flows out.	Raw water is supplied under pressure directly to above the filter by means of the pump. While flowing down the filter layer, the raw water is removed of SS and the filtered water is collected into the under drainpipe provided below the filter and flows out.	

TABLE 8.11 (2/3) COMPARISON OF WATER SUPPLY EQUIPMENT

Item	Moving bed filtration		O Pressure filtration		
3. Washing	The air injected into the airlift pipe allows the contaminated filter media to be introduced into and rise up the airlift pipe. At this time, the filter media is collected uniformly by the filter media move umbrella. The contaminated media is air agitated inside the airlift pipe and the SS component is removed from the filter media. In the filter media washer, the contaminated media is washed by a part of the treated water. The washed filter media is dispersed uniformly through the washed media distribution umbrella over the entire filter layer. The SS component is discharged as the washing wastewater. Filtration and washing are accomplished continuously at the same time.	Δ	Suspended substances making ingress into the inside of the filter bed are peeled off the filter media in the air washing process and these substances are washed out by water backwashing. Washing is done based on the 24-hour timer setting and also on the differential pressure detection of head loss.	O	
4. Installation area	Small	O	Small	O	
5. Maintenance	Construction, instrumentation, etc. are simple and maintenance is relatively easy. Therefore, this type equipment is suited for small-scale plants.	O	Backwash pump and blower are necessary and maintenance is rather complicated.	Δ	

TABLE 8.11 (3/3) COMPARISON OF WATER SUPPLY EQUIPMENT

Item	Moving bed filtration		O Pressure filtration		
6. Evaluation	Continuous operation can be done, but the quantity of washing water required is about 10% larger than other type equipment.	O	Treated water quality is stable against variations of raw water quality as compared with other type equipment. Reliability for filter bed regeneration by washing is high.	O	
7. Initial cost	110	Δ	100	O	
8. Running cost	100	O	100	O	
9. Conclusion	Until the 3rd stage of plant construction scheme, the modified aeration process is used and in consequence, it is considered that the raw water quality varies. Therefore, the pressure filter is adopted because the treated water quality is stable against variations of raw water quality and the reliability for filter bed regeneration is high.				

TABLE 8.12 (1/3) COMPARISON OF SLUDGE THICKENING EQUIPMENT

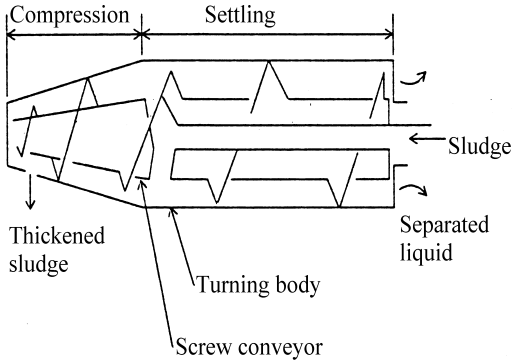
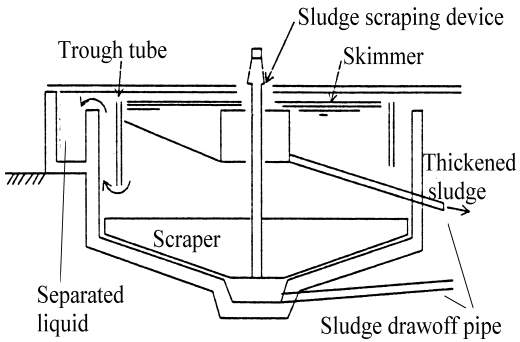
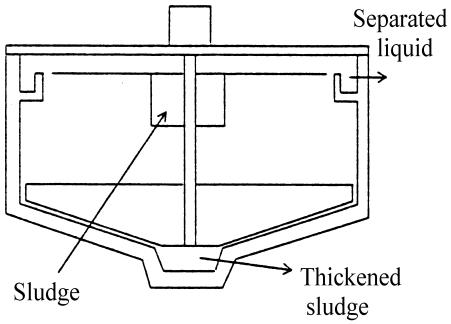
Item	O Centrifugal thickening	Dissolved air flotation thickening	O Gravity thickening
1. Schematic diagram			
2. Mechanisum	Almost the same as the conventional centrifugal thickeners. The sludge supplied is separated inside the turning body and the thickened sludge is screwed out of the discharge port by means of a screw which is different in rotation speed from the turning body. The separated liquid flows over the weir plate portion. Because of continuous thickening, the operation is sensitive to influent concentration changes, but this can be coped with easily by control of differential speed, etc.	Construction is simple. The sludge (containing pressure water) thrown into the tank floats up with fine air bubbles produced from the pressure water inside the tank while it is thickened. The sludge thickened in the upper portion of the tank (froth) is taken out by the sludge scraping device, and the sludge settled on the tank bottom is drawn off by the pump.	The sludge is settled by as it is left rest, scraped and the thickened sludge is drawn off from the tank bottom. The separated liquid flows over the weir provided around the tank and flows out. If the sludge is highly settleable, the cost is cheapest and maintenance is easy.

TABLE 8.12 (2/3) COMPARISON OF SLUDGE THICKENING EQUIPMENT

Item	O Centrifugal thickening		Dissolved air flotation thickening		O Gravity thickening	
3. Difficulty of thickening treatment	Mechanical forced thickening is stable.	O	Depending on the physical and chemical properties of sludge particle surfaces, adhesion of air bubbles to the sludge differs, and as a result, flotation thickening is not stable.	Δ	During the period for which water temperature is high, the sludge is liable to putrefy and gravity thickening is not good.	Δ
4. SS recovery ratio	85 to 95%	O	85 to 95%	O	80 to 90%	Δ
5. Concentration of thickened sludge	4 to 5%	O	3 to 4%	Δ	2 to 4%	Δ
6. Impact on the environment	The main body rotates at high speeds and produces largest noise and vibration, but by providing noise prevention cover, it is possible to avoid the working environment from being degraded. Because the main body is enclosed, odors can be collected efficiently.	Δ	Produces less noise and vibration.	O	Produces least noise and vibration. .	O
7. Maintenance	Because of few auxiliary machines, maintenance is easy. The screw requires repair periodically (every 10,000h or so).	Δ	1) Because of many auxiliary machines, maintenance is complicated. 2) Check of froth thickness, etc. is required once in 2 hours or so.	Δ	1) Upon generation of scum, cleanup is necessary.	O

TABLE 8.12 (3/3) COMPARISON OF SLUDGE THICKENING EQUIPMENT

Item	O Centrifugal thickening		Dissolved air flotation thickening		O Gravity thickening	
8. Installation space	80	O	110	Δ	100	O
9. Initial cost	300	Δ	250	Δ	100	O
10. Running cost	400	Δ	300	Δ	100	O
11. Evaluation	As for excess sludge, this equipment is best suited because high-concentration sludge is obtained stably.	O	Check is complicated because of many factors of operation and many auxiliary machines.	Δ	Use is experienced most frequently, operation is simple and cost is cheap.	O
12. Conclusion	Generally, gravity thickening is used frequently, but with this type, at present, it is difficult to reduce the water content below 99% in the excess sludge. Therefore, as the overall plan, centrifugal thickening is considered best suited because it insures the water content of as low as 94 to 96% (with relative to 99%) and high treatment stability. For these reasons, for the excess sludge of low thickening property, centrifugal thickening is adopted because it insures the water content of as low as 95 to 96% and high treatment stability, and for the raw sludge, gravity thickening is adopted because it has many experiences with use and requires relatively easy maintenance and relatively cheap equipment cost.					

TABLE 8.13 (1/3) COMPARISON OF SLUDGE DEWATERING EQUIPMENT

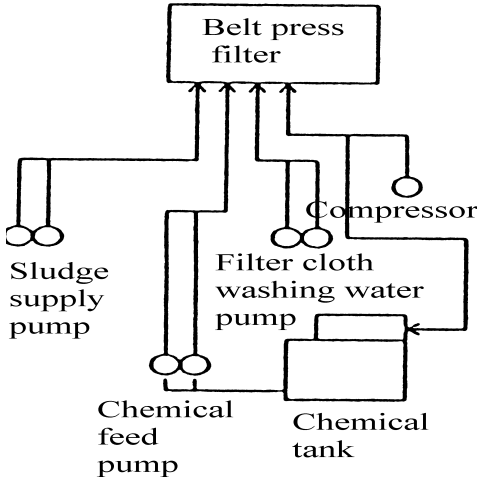
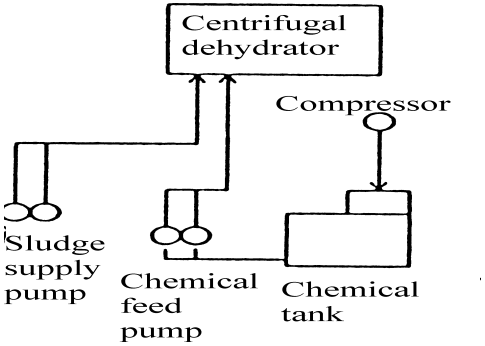
Item	Belt press filter	O Centrifugal dehydrator	
1. Schematic diagram			
2. Mechanisum	Coagulated sludge is supplied onto a filter cloth, and after free water in the sludge is filtered out by gravity, it is dehydrated by squeeze between upper and lower filter cloths and further dehydrated by pressing and pressure application by filter cloth tension. Polymer coagulants are used.	Coagulated sludge is supplied to the high speed turning body for centrifugal separation between solids and liquid. The solids settled is discharged as dehydrated sludge by the screw which has a slight difference in revolution speed with respect to the outer casing. Polymer coagulants are used.	

TABLE 8.13 (2/3) COMPARISON OF SLUDGE DEWATERING EQUIPMENT

Item	Belt press filter		O Centrifugal dehydrator		
3. Dehydration performance	With use of polymer coagulant at feed rate below 1.0%, dry cake water content is 79 to 82%.	Δ	With use of polymer coagulant at feed rate below 1.0%, dry cake water content is 76 to 81%.	O	
4. Washing water	To avoid filter cloth clogging and improve dehydrated sludge peeling-off, washing water of about 100 L/min per filter cloth width is necessary (large quantity). Water quality to be approximately equal to sand filtered water.	Δ	Washing water of about 1/2 of the treatment capacity is used for about 30 minutes in total before and after the operation of dehydration (small quantity). Water quality to be approximately equal to secondary treated water.	O	
5. Maintenance	For use of sand filtered water as washing water, sand filter equipment and filter cloth washing water pump are necessary. Therefore, maintenance is complicated. Filter cloth requires replacement periodically (every 3,000h or so).	Δ	There are few auxiliary machines and maintenance is easy. Screw requires repair periodically (about 10,000h or so).	O	
6. Impact on the environment	Smallest noise and vibration. By providing a cover, it is possible to prevent the working environment from being degraded by odors.	O	Largest noise and vibration because of the body turning at high speeds, but by providing a cover, it is possible to prevent the working environment from being degraded. Because of the enclosed body, odor collection efficiency is high.	Δ	

TABLE 8.13 (3/3) COMPARISON OF SLUDGE DEWATERING EQUIPMENT

Item	Belt press filter		O Centrifugal dehydrator		
7. Reliability of equipment	Reliability is high because of simple mechanisms, low speed of rotations and many experiences with use.	O	Reliability is high because of many experiences with use although the turning speed is relatively high for the machine which handles the sludge.	O	
8. Installation space (Index)	Increasing the machine size is limited (maximum filter cloth width 3m) and the number of machines installed is large. Therefore, the installation space is large. (100)	Δ	Large-size and large-capacity machines can be manufactured, and the number of machines installed is small. Therefore, the installation space is small. (88)	O	
9. Construction cost	100	O	107	Δ	
10. Maintenance cost	100	O	107	Δ	
11. Economics	100	O	104	Δ	
12. Conclusion	The belt press type requires a sand filter for washing water, and the equipment is accordingly large and the quantity of washing water is also large. In contrast, the centrifugal type may use, to advantage, the secondary treated water as washing water. Moreover, the large-size machine can be manufactured and the installation area can be accordingly small. For these reasons and also by considering the low water content of cake for the compost equipment in a later stage, the centrifugal dewatering equipment is adopted.				

TABLE 8.14 (1/3) COMPARISON OF COMPOSTING EQUIPMENT

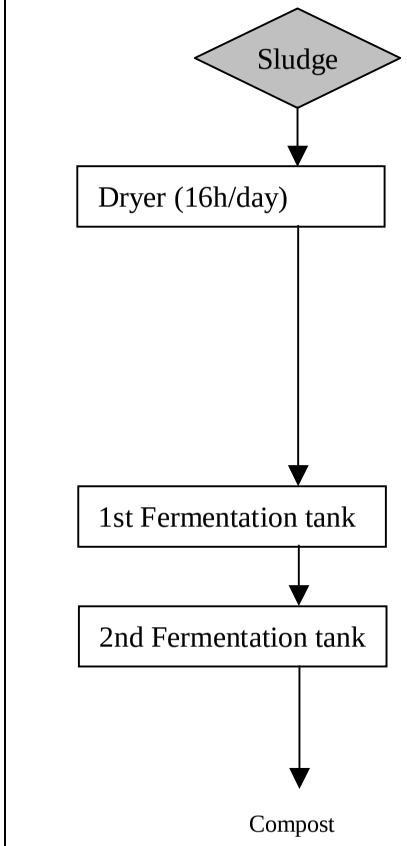
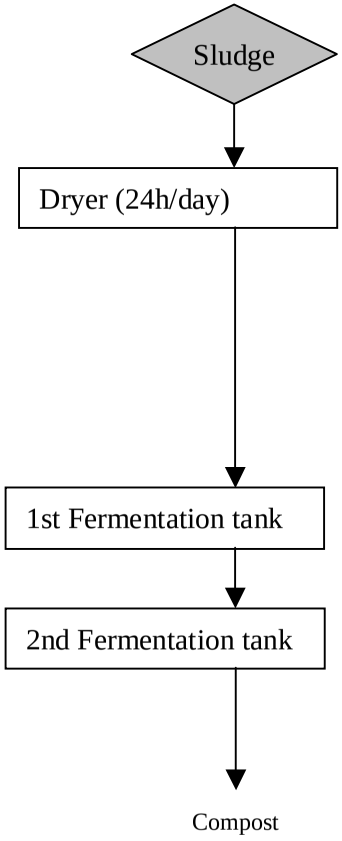
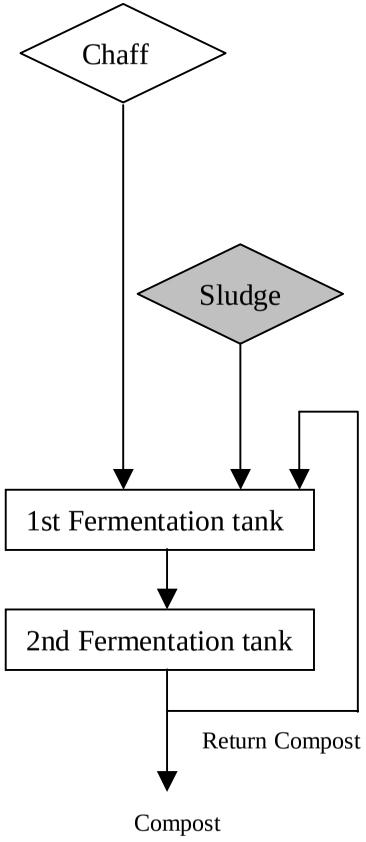
Item	Method of non-addition Dryer (Operation time = 16h/day)	Method of non-addition Dryer (Operation time = 24h/day)	Method of chaff-addition Chaff (Crushed chaff)
Flow chart			

TABLE 8.14 (2/3) COMPARISON OF COMPOSTING EQUIPMENT

Item	Method of non-addition Dryer (Operation time = 16h/day)	Method of non-addition Dryer (Operation time = 24h/day)	Method of chaff-addition Chaff (Crushed chaff)
The injection condition of the sludge and Chaff	**[SLUDGE]** Solid Volume = 21.142 t/day Moisture Content = 80 % Sludge Volume = 105.7 wt/day Total Volume = 117.5 m3/day	**[SLUDGE]** Solid Volume = 21.142 t/day Moisture Content = 80 % Sludge Volume = 105.7 wt/day Total Volume = 117.5 m3/day	**[SLUDGE]** Solid Volume = 21.142 t/day Moisture Content = 80 % Sludge Volume = 105.7 wt/day Total Volume = 117.5 m3/day
	None	None	**[CRUSHED CHAFF]** Solid Volume = 8.5 t/day Moisture Content = 18 % Chaff Volume = 10.3 wt/day Total Volume = 41.3 m3/day
The amount of formation of the compost volume. (The amount of final disposal).	**[COMPOST]** Solid Volume = 20 t/day Moisture Content = 30 % Compost Volume = 28.7 wt/day Total Volume = 65.2 m3/day	**[COMPOST]** Solid Volume = 20 t/day Moisture Content = 30 % Compost Volume = 28.7 wt/day Total Volume = 65.2 m3/day	**[COMPOST]** Solid Volume = 56.239 t/day Moisture Content = 50 % Compost Volume = 112.5 wt/day Total Volume = 193.9 m3/day
Key specification	**[DRYER]** Spec = 5 t/h Operation time = 16 h/day	**[DRYER]** Spec = 3.5 t/h Operation time = 24 h/day	None
	[1ST FERMENTATION TANK] W: 18m*L: 28m*H: 2m	**[1ST FERMENTATION TANK]** W: 18m*L: 28m*H: 2m	**[1ST FERMENTATION TANK]** W: 20m*L: 68m*H: 2m
	[2ND FERMENTATION TANK] W: 15m*L: 150m	**[2ND FERMENTATION TANK]** W: 15m*L: 150m	**[2ND FERMENTATION TANK]** (W: 15m*L: 150m)*2
Phase 1 Construction A necessary area.	W: 110m * L: 90m	W: 110m * L: 90m	W: 110m * L: 170m

TABLE 8.14 (3/3) COMPARISON OF COMPOSTING EQUIPMENT

Item	Method of non-addition Dryer (Operation time = 16h/day)	Method of non-addition Dryer (Operation time = 24h/day)	Method of chaff-addition Chaff (Crushed chaff)
Initial cost (Mechanical equipment only)	YEN 681,000,000 ↓ **91,254,000,000 VND**	YEN 660,000,000 ↓ **88,440,000,000 VND**	YEN 383,000,000 ↓ **51,322,000,000 VND**
Running cost • Electricity • Fuel oil • Chaff	YEN 333,400 ↓ **44,675,600 VND / Day**	YEN 333,400 ↓ **44,675,600 VND / Day**	YEN 54,800 ↓ **7,343,200 VND / Day**
Advantage	• Less final sludge disposal • Smaller required area of installation	← ←	• Low initial cost • Low running cost
Conclusion	The method of chaff addition is recommended. Main reason is to avoid the daily high cost of non-addition system. But, There is a fault in the chaff addition form as well, 8.5 tons (about 41.3m3) of chaff must be provided everyday. Additionally, Vast disposal place is required because there is a lot amount of final disposal.		

Note
It can think about the following additive besides the chaff.
Chaff is the best because moisture content rate is low.

	Moisture Content (%)	Appearance Volume (t/m3)	PH
Chaff	12.5	0.1	7
Crushed chaff	18	0.25	7
Sawdust	30.2	0.25	5.5
Wood-chip	51	0.15	5.9
Straw	10.5	0.05	ND
Coffee bean ground	35	0.2	5.5
Sugar cane	42	0.2	ND
Rice bran	15	0.4	8.0

TABLE 8.15 MECHANICAL LIST OF WASTEWATER TREATMENT PLANT (1/8)

		No.	Name	Model	Spec	Power (kw)	1st	2nd	3rd	Total	S-Load	D-Load	Note
Grit chambe	Grit	111	Inflow gate	Square gate	W1500*H1500	-	2	-	2	4	2.5/3.8	3.0/4.56	
Lift pump	Chamber	112	Coarse screen	Bar screen	Slit width 100mm	-	2	-	2	4	2.0	2.4	
Facility	Equipment	113	Grit pump	Sand pump		7.5	-	-	1	1	-	-	
100	110	114	Grit separator	Cyclone		-	-	-	1	1	-	-	
		115	Chain block	Manual type	1t	-	1	-	-	1	1.3	1.6	
	Lift	121	Lift pump(1)	Submerged sewage pump	Ø700*66.7m3/min*14m	220	3	-	-	3	8.4	10.1	
	Pump	122	Lift Pump(2)	Submerged sewage pump	Ø1000*122.1m3/min*14m	460	-	3	-	3	14.4	17.3	
	Equipment	123	Connecting gate	Square gate	W1500*H1500	-	1	-	-	1	2.2	2.6	
	120	124	Hoist	Hoist	10t	6.55	1	-	-	1	12.0	14.4	
		125	Floor drainage pump	Submerged sewage pump	Ø65*0.3m3/min*10m	2.2	12	2	-	14	0.1	0.12	
	Distribution	131	Distribution weir	Movable weir	W1000*ST1000	-	4	-	4		2.0	2.4	
	Tank												
	Equipment												
	130												

* S-Load : Static load (t)
* D-Load : Dynamic load (t)

TABLE 8.15 MECHANICAL LIST OF WASTEWATER TREATMENT PLANT (2/8)

		No.	Name	Model	Spec	Power (kw)	1st	2nd	3rd	Total	S-Load	D-Load	Note
Blower	**B**lower	211	Blower(1)	Gear-accelerated single-stage turbo blower	Ø600*360m3/min*6.8mAq	480	2	0	-2	0	13.5	16.2	
Facility	**E**quipment	212	Blower(2)	Gear-accelerated single-stage turbo blower	Ø700*600m3/min*6.8mAq	810	0	2	7	9	13.5	16.2	
200	210	213	Discharge valve(1)	Sluice valve	Ø500	0.75	2	0	-2	0	1.0	1.2	
		214	Discharge valve(2)	Sluice valve	Ø600	0.75	0	2	7	9	1.0	1.2	
		215	Air filter	Streaming dry type air filter	Opening 2.3mW*2.8mH	0.2	2	2	5	9	18.0	22	
		216	Floor drainage pump	Submerged sewage pump	Ø65*0.3m3/min*10m	2.2	2	0	-	2	0.1	0.12	
		217	Crane	Crane	10t	8.05	1	-	-	1	0.6	0.72	
		218	Check valve(1)	Check valve	Ø500	-	2	0	-2	0	1.4	1.7	
		219	Check valve(2)	Check valve	Ø600	-	0	2	7	9			

* S-Load : Static load (t)
* D-Load : Dynamic load (t)

TABLE 8.15 MECHANICAL LIST OF WASTEWATER TREATMENT PLANT (3/8)

		No.	Name	Model	Spec	Power (kw)	1st	2nd	3rd	Total	S-Load	D-Load	Note
Water	**P**rimary	311	Inflow weir	Movable weir	W500*ST400	-	10	30	40	80	0.5	0.6	
Treatment	**S**edimenatio	312	Sludge scraper	Chain flight sludge collector	(W5.0*L13.0m*H3.0m)*2chan	1.5	10	30	40	80	6.8	8.2	
Facility	**T**ank	313	Scum skimmer	Pipe skimmer	Ø300	-	20	60	80	160	0.6	0.72	
300	**E**quipment	314	Scum pump	Non-clogging sludge pump	Ø80*0.8m3/min*10m	5.5	2	6	8	16	0.29	0.35	
	310	315	Raw sludge pump	Non-clogging sludge pump	Ø80*0.5m3/min*14m	5.5	3	9	12	24	0.28	0.34	
		316	Raw sludge valve	Sluice valve	Ø150	0.2	10	30	40	80	0.06	0.07	
		317	Comminuter	Vertical 2axis ratation type	1.0m3/min	0.75	1	1	2	4	0.34	0.41	
		318	Bypass gate	Square gate	W1000*ST1000	-	1	3	4	8	4.2	5.0	
		319	Antifoaming spray	Spray	3/8T	-	60	180	240	480	0.01	0.02	
	Aeration	321	Inflow weir	Movable weir	W500*ST500	-	10	30	40	80	0.8	1.0	
	Tank	322	Step feeding weir	Movable weir	W500*ST500	-	30	90	120	240	0.8	1.0	
	Equipment	323	Diffuser (1)	Diffuser tube	120l/min	-	140	420	0	560	0.02	0.03	
	320		Diffuser (2)	Diffuser tube	120l/min	-	20	60	0	80	0.02	0.03	
		324	Air flow control valve	Butterfly valve	Ø350	0.4	10	30	40	80	0.43	0.52	
		325	Air flow meter	Orifice meter	Ø350	-	10	30	40	80	0.01	0.02	
		326	Antifoaming spray	Spray	3/8T	-	200	600	0	800	0.01	0.02	
		327											
	Final	331	Inflow gate	Square gate	W500*H500	-	10	30	40	80	0.5	0.6	
	Sedimenatio	332	Sludge scraper	Chain flight sludge collector	(W5.0*L26.0m*H3.5m)*2chan	2.2	10	30	40	80	7.6	9.1	
	Tank	333	Scum skimmer	Pipe skimmer	Ø300	-	20	60	80	160	0.6	0.72	
	Equipment	334	Scum pump	Non-clogging sludge pump	Ø80*0.8m3/min*10m	5.5	2	6	8	16	0.29	0.35	
	330-340	335	Return sludge pump(25%)	Centrifugal screw impeller pun	Ø250*5.6m3/min*6m	11	4	12	16	32	0.89	1.07	
		336	Return sludge pump(50%)	Centrifugal screw impeller pun	Ø300*11.2m3/min*7m	30	0	0	16	16	1.02	1.22	
		337	Return sludge valve	Sluice valve	Ø350	0.4	10	30	40	80	0.44	0.53	
		338	Excess sludge pump	Non-clogging sludge pump	Ø100*1.2m3/min*13m	11	3	9	12	24	0.45	0.54	
		339	Excess sludge valve	Sluice valve	Ø150	0.2	10	30	40	80	0.06	0.07	
		340	Comminuter	Vertical 2axis ratation type	2.4m3/min	3.7	1	1	2	4	0.38	0.46	
		341	Antifoaming spray	Spray	3/8T	-	60	180	240	480	0.01	0.02	
		342	Sluice valve	Manual sluice valve	Ø350	-	14	42	56	112	0.47	0.56	
	Floor	351	Floor drainage pump	Submerged sewage pump	Ø65*0.3m3/min*10m	2.2	14	30	44	88	0.1	0.12	
	Drainage												
	Equipment												
	350												

* S-Load : Static load (t)
* D-Load : Dynamic load (t)

TABLE 8.15 MECHANICAL LIST OF WASTEWATER TREATMENT PLANT (4/8)

		No.	Name	Model	Spec	Power (kw)	1st	2nd	3rd	Total	S-Load	D-Load	Note
Disinfection Facility 400	Disinfection Equipment 410	411	Inflow gate	Square gate	W2000*H2000	-	1	-	-	1	8.0	9.6	
		412	Bypass gate	Square gate	W2000*H2000	-	1	-	-	1	8.0	9.6	
		413	Sodium hypochlorite tank	FRP tank	13m3	—	2	6	-	8	18.0	21.6	
		414	Sodium hypochlorite pump	Diaphragm pump	Ø25*0.81～1.62 l/min	0.4	3	9	-	12	0.1	0.12	ST
		415											
		416											
		417											
		418											
		419											
Water Supply Facility 500	Treated wate Supply Equipment 510	511	Secondary effluent gate	Square gate	W1000*ST1000	-	1	-	-	1	4.0	4.8	
		512	Treated water supply pump(1)	Volute pump	Ø150*125,3.2m3/min*30m	30	2	3	5	10	0.7	0.84	
		513	Treated water strainer(1)	Automatic washing strainer	Ø250*6.4m3/min	0.4	1	1	2	4	0.9	1.08	
		514	Floor drainage pump	Submerged sewage pump	Ø65*0.3m3/min*10m	2.2	8	-	-	8	0.1	0.12	
		515	Crane	Geared trolley type chain block	2ton*span6.5m	-	1	-	-	1	3.0	3.6	
		516	Treated water supply pump(2)	Volute pump	Ø125*100,2.2m3/min*30m	22	2	2	0	4	0.4	0.48	
		517	Treated water strainer(2)	Automatic washing strainer	Ø250*6.6m3/min	0.4	1	0	0	1	0.75	0.9	
		518											
		519											
	Filtered wate Supply Equipment 520-530	521	Filtration supply pump	Volute pump	Ø80*65,0.7m3/min*10m	3.7	2	0	2	4	0.2	0.24	
		522	Filtration supply strainer	Automatic washing strainer	Ø80*0.7m3/min	0.4	2	0	2	4	0.3	0.36	
		523	Sand filter	Pressure sand filtration	0.6m3/min	-	2	0	2	4	38.0	45.6	
		524	Filtered water supply pump	Volute pump	Ø80*65,1.0m3/min*30m	11	2	1	1	4	0.3	0.36	
		525	Backwash pump	Volute pump	Ø125*100,2.7m3/min*10m	7.5	2	-	-	2	0.4	0.48	
		526	Air wash blower	Roots blower	Ø100*4.5m3/min*4.5kPa	7.5	2	-	-	2	0.15	0.18	
		527	Backwash wastewater pump	Non-clogging type	Ø80*0.4m3/min*10m	3.7	2	-	-	2	0.2	0.24	
		528	Air compressor	Portable air compressor	400l/min	3.7	2	-	-	2			
		529	Dehumidifier	Refrigeration type	400l/min	0.25	1	-	-	1			
		530	Solenoid valve box	Steel plate box	Three-way solenoid valve	-	2	0	2	4			

* S-Load : Static load (t)
* D-Load : Dynamic load (t)

TABLE 8.15 MECHANICAL LIST OF WASTEWATER TREATMENT PLANT (5/8)

		No.	Name	Model	Spec	Power (kw)	1st	2nd	3rd	Total	S-Load	D-Load	Note
Sludge Treatment Facility 600	Gravity Thickening Equipment 610	611	Gravity thickener	Clarifier	Ø14m	1.5	1	3	-	4	11	12.5	
		612	Scum skimmer	Pipe skimmer	L:7000mm	—	1	3	-	4	0.7	0.84	
		613	Thickened sludge pump	Non-clogging sludge pump	Ø80*0.7m3/min*10m	5.5	2	6	-	8	0.29	0.35	
		614	Thickener effluent pump	Non-clogging sludge pump	Ø80*0.4m3/min*15m	5.5	2	6	-	8	0.28	0.34	
		615	Floor drainage pump	Submerged sewage pump	0.3m3/min	2.2	2	6	-	8	0.08	0.10	
		616											
		617											
		618											
		619											
	Centrifugal Thickening Equipment 620	621	Excess sludge mixer	Mixer	140m3	11	1	1	-	2	1.1	1.7	
		622	Excess sludge feed pump	Progressing cavity pump	Ø250*35～105m3/h*10mAq	30	2	4	-	6	2.2	2.6	VS
		623	Centrifugal thickener	Centrifugal thickener	70m3/h	112.75	2	4	-	6	26.6	34.9	
		624	Crane	Crane	20t	15.25	1	-	-	1	28.0	34.0	
		625	Sluice valve	Manual sluice valve	Ø350	-	2	2	-	4	0.47	0.56	
		626											
		627											
	Sludge Dewatering Equipment 630-640	631	Mixed sludge mixer	Mixer	180m3	11	2	6	-	8	1	1.5	
		632	Mixed sludge feed pump	Progressing cavity pump	Ø125*15～45m3/h*10mAq	11	2	4	-	6	0.7	0.84	VS
		633	Centrifugal dehydrator	Centrifugal dehydrator	30m3/h	147.4	2	4	-	6	20.4	22.8	
		634	Cake Hopper	Hopper	10m3	1.5*2	2	4	-	6	16.5	19.8	
		635	Polymer hopper and polymer feeder	Stainless container	1,500L	-	2	4	-	6	1.7	2.0	
				Feeder	2,000cc/min	0.4	2	4	-	6			
		636	Polymer dissolution tank	Steel tank	10m3	5.5	2	4	-	6	23.7	24	
		637	Polymer feed pump	Progressing cavity pump	0.04～0.13m3/min	3.7	2	4	-	6	0.08	0.10	VS
		638	Water supply pump unit	Supply pump unit	2.62m3/min*35mAq	18.5*2	1	1	-	2	1.9	2.3	
		639	Air compressor	Portable air compressor	600l/min	5.5	2	1	-	3	0.23	0.28	
		640	Dehumidifier	Refrigeration type	600l/min	0.25	1	1	-	2	0.03	0.04	
		641	Crane	Crane	20t	15.25	1	-	-	1	28.0	34.0	
		642	Chain block	Chain block	1t	-	1	-	-	1	1.3	1.6	
		643	Treated water inflow valve	Motor operated ball valve	Ø250	0.1	1	-	-	1	0.03	0.04	
		644	Dump truck		10t		2	-	-	2			

* S-Load : Static load (t)
* D-Load : Dynamic load (t)

TABLE 8.15 MECHANICAL LIST OF WASTEWATER TREATMENT PLANT (6/8)

		No.	Name	Model	Spec	Power (kw)	1st	2nd	3rd	Total	S-Load	D-Load	Note
Sludge	**R**ecycle	651	Recycle flow mixer	Mixer	208m3	11	1	1	-	2	1.1	1.7	
Treatment	**F**low	652	Recycle flow pump	Non-clogging sludge pump	Ø200*5.1m3/min*15m	30	2	2	-	4	0.9	1.1	
Facility	**E**quipment	653											
600	650	654											
		655											
		656											
		657											
		658											
		659											
	Deodorizatio	661	Carbon adsorption tower		94m3/min	-	-	1	-	1	8.87	10.6	
	Equipment	662	Deodorization fan	Turbo fan	94m3/min	7.5	-	1		1	0.7	0.84	
	660	663	Mist separater		94m3/min	-	-	1	1	2	-	-	
		664											
		665											
		666											
		667											
		668											
		669											
		671											
		672											
		673											
		674											
		675											
		676											
		677											
		678											
		679											

* S-Load : Static load (t)
* D-Load : Dynamic load (t)

TABLE 8.15 MECHANICAL LIST OF WASTEWATER TREATMENT PLANT (7/8)

		No.	Name	Model	Spec	Power (kw)	1st	2nd	3rd	Total	S-Load	D-Load	Note
Compost Facility 700	Fermenting Equipment 710	711	Mixing machine	Advanced paddle type	2.2mØ	90	2	-	-	2	52.0	62.4	
		712	Suction fan	Turbo fan	45m3/min*3.5kPa	5.5	4	-	-	4	0.4	0.48	
		713	Humidifying pump	Submerged motor pump	0.1m3/min*20m	1.5	2	-	-	2	0.15	0.18	
		714											
		725											
		726											
		727											
		728											
	Curing Equipment 720	721	Dump truck		10t		4	-	-	4			
		722	Shovel loader		2m3		9	-	-	9			
		723	Truck scale		20t type		1	-	-	1			
		724											
		725											
		726											
		727											
		728											
		729											
	Deodorizatic Equipment 730	731	Deodorization soil filter	Odor control by soil filter	500m3/min	-	1	-	-	1			
		732	Deodorization fan	Turbo fan	250m3/min*3.0kPa	30	2	-	-	2	4	4.8	
		733	Spray water pump	Submerged motor pump	0.2m3/min*25m	3.7	1	-	-	1	0.15	0.18	
		734	Wastewater drainage pump	Submerged motor pump	0.2m3/min*25m	3.7	1	-	-	1	0.15	0.18	
		735											
		736											
		737											
		738											
		739											

* S-Load : Static load (t)
* D-Load : Dynamic load (t)

TABLE 8.15 MECHANICAL LIST OF WASTEWATER TREATMENT PLANT (8/8)

		No.	Name	Model	Spec	Power (kw)	1st	2nd	3rd	Total	S-Load	D-Load	Note
Ventilation	Ventilation	801	Air exhaust fan	Crrosion resistant roof fan	Ø600×6900m3/h×60Pa	0.4	4	4	8	16	0.08	0.09	
Facility	Equipment	802	Air exhaust fan	Crrosion resistant roof fan	Ø600×5830m3/h×60Pa	0.4	4	4	8	16	0.08	0.09	
800	800	803	Air exhaust fan	Crrosion resistant roof fan	Ø600×5834m3/h×70Pa	0.4	3	9	12	24	0.08	0.09	
		804	Air exhaust fan	Crrosion resistant roof fan	Ø600×5160m3/h×80Pa	0.4	3	9	12	24	0.08	0.09	
		805	Air exhaust fan	Crrosion resistant roof fan	Ø500×3673m3/h×50Pa	0.3	4	12	16	32	0.05	0.06	
		806	Air exhaust fan	Crrosion resistant roof fan	Ø500×3250m3/h×50Pa	0.3	4	12	16	32	0.05	0.06	
		807	Air exhaust fan	Crrosion resistant roof fan	Ø500×3176m3/h×80Pa	0.3	1	3	4	8	0.05	0.06	
		808	Air exhaust fan	Crrosion resistant roof fan	Ø400×2420m3/h×50Pa	0.3	1	3	4	8	0.05	0.05	
		809	Air intake fan	Axial fan	Ø1000×36780m3/h×400Pa	7.5	2	2	4	8	0.35	0.42	
		810	Air intake fan	Axial fan	Ø1120×55980m3/h×400Pa	15	1	1	2	4	0.47	0.56	
		811	Air exhaust fan	Roof fan	Ø600×7200m3/h×50Pa	0.75	1	0	0	1	0.06	0.07	
		812	Air intake fan	Roof fan	Ø600×7030m3/h×40Pa	0.75	1	-1	0	0	0.06	0.07	
		812	Air intake fan	Roof fan	Ø750×14500m3/h×40Pa	1.5	0	1	0	1	0.1	0.12	
		813	Air intake fan	Axial fan	Ø400×4550m3/h×350Pa	0.9	4	0	0	4	0.08	0.10	
		814	Air exhaust fan	Roof fan	Ø400×3640m3/h×40Pa	0.3	5	0	0	5	0.05	0.05	
		815	Air exhaust fan	Axial fan	Ø800×23010m3/h×500Pa	11	1	0	0	1	0.22	0.26	
		816	Air intake fan	Roof fan	Ø750×14500m3/h×40Pa	1.5	1	0	0	1	0.1	0.12	
		817	Air exhaust fan	Roof fan	Ø900×17690m3/h×60Pa	2.2	1	0	0	1	0.15	0.18	
		818	Air intake fan	Roof fan	Ø600×4900m3/h×90Pa	0.75	1	0	0	1	0.062	0.07	
		819	Air intake fan	Centrifugal fan	# 3×8500m3/h×350Pa	3.75	1	0	0	1	0.13	0.16	
		820	Air intake fan	Axial fan	Ø710×15660m3/h×400Pa	5.5	1	1	0	2	0.16	0.19	
		821	Air exhaust fan	Crrosion resistant roof fan	Ø600×6790m3/h×50Pa	0.4	1	0	1	2	0.08	0.10	
		822	Air exhaust fan	Wall exhaust fan with steel hoo	Ø600×6785m3/h×40Pa	0.75	2	0	0	2	0.03	0.04	
		823	Air exhaust fan	Roof fan	Ø400×2150m3/h×100Pa	0.3	1	0	0	1	0.05	0.05	
		824	Air intake fan	Axial fan	Ø600×12000m3/h×400Pa	3.7	1	0	0	1	0.11	0.13	
		825	Air intake fan	Axial fan	Ø300×600m3/h×350Pa	0.28	2	0	0	2	0.05	0.06	
		826	Air exhaust fan	Wall exhaust fan with stainless	Ø600×6600m3/h×100Pa	0.75	2	0	0	2	0.03	0.04	
		827	Air intake fan	Axial fan	Ø300×1200m3/h×300Pa	0.28	1	1	0	2	0.05	0.06	
		828	Air exhaust fan	Crrosion resistant roof fan	Ø600×7225m3/h×50Pa	0.4	2	2	0	4	0.08	0.10	
		829	Natural exhaust hood	Roof fan style hood	Ø600	-	8	8	16	32	0.05	0.05	
		830											

* S-Load : Static load (t)
* D-Load : Dynamic load (t)

TABLE 8.16 PIPE MATERIAL FOR EACH FACILITIES

class	Cast iron	Steel				Stainless	Copper	Vinyl		
	DCIP	SGPW	STPY	STW400	SGP-FVA	SUS304	Cu	HIVP	VP	VU
(Japan Industrial Standard) Equivalent	JIS G 5526 - 5527	JIS G 3442	JIS G 3457	JIS G 3443	WSP 011-88	JIS G 3459	-	JWWA K127-129	JIS K 6742	JIS K 6741
Sewage pipe	A					B				
Sand pipe	A	B				B				
Floor drain pipe		B				B		B	A	
Tank drain pipe		B				B		B	A	
Raw sludge pipe	A	B				B			B	
Return sludge pipe	B	B				B			A	
Excess sludge pipe	B	B				B			A	
Scum drain pipe		B				B			A	
Air pipe		A	A			B				
Treatment water pipe		A				B				
Antifoaming water pipe		A				B				
Filtered water pipe		A				B				
Thickened sludge pipe	A	B				B			B	
Mixed sludge pipe	A	B				B			B	
Recycle flow pipe		B				B		B	A	
Polymer feed pipe					B			A	B	
Sodium hypochlorite pipe					B			A	B	

A It is the best. B It is good.

∗ As for the design and bills of quantity, it is done with A.
But, after a reason is submitted, a construction dealer is allowed to use other material.

Pipe selection reason.

1) It was the best for the pipe of dealing with the fluid (include Height concentration sludge) which contained many fluids whose corrosion is high, many scale things in corrosion proof, and excellent "**DCIP**" was selected as for wear proof as well.

2) It was cheap, "**SGPW**" of the check and the repair that it was easy was selected for the pipe of dealing with the fluid (a thing beyond the second treatment water) which the fluid for SS was comparatively rare in.

3 "**STPY**" of the big caliber that it could be made was selected for the big size pipe that gas is dealt with. (It could be made was "**SGPW**" for the small size pipe.)

4) "**HIVP**" that the pipe of dealing with chemical could be expected effect on chemical proof was selected.

5) It was cheap, "**VP**" of the check and the repair that it was easy was selected for the pipe of dealing with general drainage and polluted water (include Low concentration sludge).

∗ Pipe was embed of structure that it was uses ″**SUS304**″. And, ″**SUS304**″ was used in the place with the submerged part and the liquid touch part, the fear of the corrosion from the outside as well

TABLE 8.17 (1) COMPARISON TABLE FOR ELECTRIC EQUIPMENT - 24KV SWITCHGEAR -

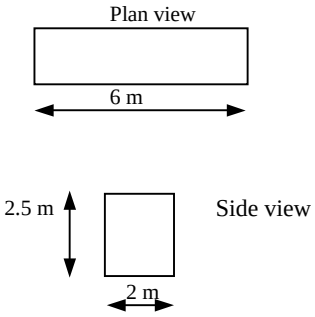
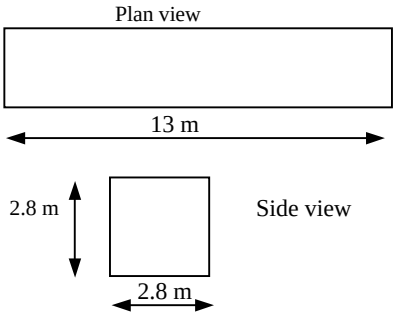
Item	Alternative 1 Gas Insulated Switchgear (GIS)	Alternative 2 Conventional Type Switchgear
1. Specification.		
1) Insulation	SF6 Gas	Air
2) Rated voltage	24 kV	24 kV
3) Rated frequency	50/60 Hz	50/60 Hz
4) Rated normal current	600 - 1200 A	600 - 1200 A
2. Equipment Construction	- Each internal components sealed and closed by earthed metal cases and assembled in the cubicle. - Bus bar and each components insulated by SF6 gas. - All energized parts covered by metal case.	- Each internal components are mounted in the cubicle with bare. - Bus bar and each components insulated by air. - All energized parts covered by metal case.
3. Equipment Size (2 line bay - 2 TR bay type)	(L)6m x (W)2m x (H)2.5m 30 % (Compare with conventional type)  	(L)13m x (W)2.8m x (H)2.8m 
4. Reliability	- Insect protection level High - Dust protection level High - Salt contamination High - Harmful gas protection level High - Contact parts reliability High - Moving parts reliability High	Low (Compare with GIS) Low (Compare with GIS) Low (Compare with GIS) Low (Compare with GIS) Low (Compare with GIS) Low (Compare with GIS)
5. Safety	- No electric shock (HV parts are covered by earthed metal case) - SF6 gas is non-inflammable, harmless and inert gas.	- Safety protection guards of covers must be assembled in cubicle.
6. Installation	Installation works is more difficult compare with conventional type at following point - Gas treatment - Level setting	Easy installation
7. Maintenance	Periodical maintenance is necessary for long life operation Major maintenance item Gas pressure gauge check Operation mechanism check	Periodical maintenance is necessary for long life operation Major maintenance item Internal components check (visual & electrical) Internal components cleaning Operation mechanism check
8. Life of equipment	Approx. 20 years	Approx. 20 years
9. Cost 1) Equipment 2) Construction	High (Compare with conventional type) Same as conventional type	Low Same as GIS type
10. Conclusion	We recommend gas insulated switchgear (GIS) in comparison with conventional type switchgear for the following reason. 1) The reliability of GIS is high in comparison with conventional type switchgear. 2) Maintenance of GIS is more easy in comparison with conventional type switchgear.	

TABLE 8.17 (2) COMPARISON TABLE FOR ELECTRIC EQUIPMENT - 24KV CIRCUIT BREAKER -

Item	Alternative 1 Gas Circuit Breaker (GCB)	Alternative 2 Vacuum Circuit Breaker (VCB)
1. Specification. 1) Rated voltage	24 kV	24 kV
2) Rated frequency	50/60 Hz	50/60 Hz
3) Rated normal current	1200 - 2000 A	1200 - 2000 A
4) Rated shot-circuit breaking current	25 - 31.5 kA	25 - 31.5 kA
5) Breaking time	5 cycle	5 cycle
2. Installation Layout	Assemble in the 24 kV switchgear	Assemble in the 24 kV switchgear
3. Operating Mechanism	Spring charge type Complicate mechanism compare with VCB	Spring charge type Simple mechanism compare with GCB
4. Comparison 1) Breaking performance	High	High
2) Insulation	SF 6 gas	Insulator
3) Contact life At load current breaking	1,000 - 5,000 times	5,000 - 10,000 times
4) Operation sound	Small	Small
5) Puffer system	Arc extinguish by SF 6 gas.	Self extinguish in vacuum chamber
6) Maintenance	Periodical maintenance is necessary for long life operation Major maintenance item Gas pressure leak check Gas component analysis Moisture percentage check Gas charge Totally, GCB maintenance is more difficult compare with VCB.	Periodical maintenance is necessary for long life operation Major maintenance item Vacuum check Totally, VCB maintenance is more easy compare with GCB.
7) Life of equipment	Approx. 20 years	Approx. 20 years
8) Reliability	High	High
5. Cost 1) Equipment 2) Construction	High (Compare with VCB) Difficult (Gas charge)	Low (Compare with GCB) Easy
6. Conclusion	We recommend Vacuum type Circuit Breaker (VCB) in comparison with Gas Circuit Breaker (GCB) for the following reason. 1) The cost of VCB is low in comparison with the GCB. 2) Installation and maintenance of VCB is more easy in comparison with the GCB.	

TABLE 8.17 (3) COMPARISON TABLE FOR ELECTRIC EQUIPMENT - MAIN TRANSFORMER -

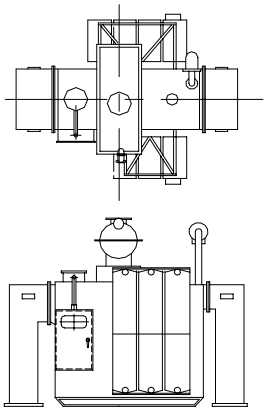
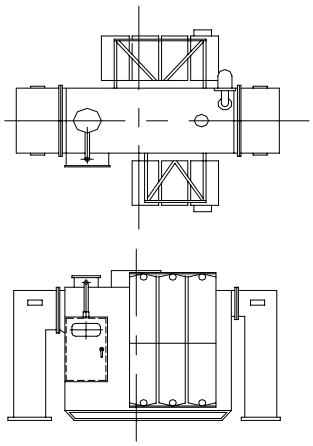
Item	Alternative 1 Oil-Immersed Type TR	Alternative 2 Gas Insulated Type TR
1. Specification.		
1)Rated voltage	22/3.3 kV	22/3.3 kV
2)Rated frequency	50/60 Hz	50/60 Hz
3)Rated Capacity	5000 kVA	5000 kVA
4)Rated Primary current	131 A	131 A
5)Rated secondary current		875 A
6)Weight (with OLTC)	Approx. 21,000 kg	Approx. 30,000 kg
2.Installation Layout		
3.Related Equipment 1) On Load Tap Changer	High voltage side	High voltage side
2) Temperature meter	Yes	Yes
3) Pressure Relay	Yes	Yes
4.Comparison 1) Foundation size	W5.0mxD3.0m=15.0m2	W5.0mxD4.0m=20.0m2
2) Installation	Insulation oil must be purify before fill into TR.	Installation works is easy compare with oil TR.
3) Noise Level	Large (Compare with Gas TR)	Small (Compare with Oil type TR)
4) Loss - Core Loss - Copper Loss	Large (Compare with Gas TR) Large (Compare with Gas TR)	Small (Compare with Oil type TR) Small (Compare with Oil type TR)
5) Maintenance	- Check Oil condition - Oil to be change for OLTC	- Check Gas leakage - Gas to be change for OLTC
6) Life of equipment	30 years	30 years
7) Insulation	Oil	SF6 Gas
8) Reliability	If periodical maintenance is carried out, long life operation and high reliability is expected.	If periodical maintenance is carried out, long life operation and high reliability is expected.
5. Cost 1) Equipment 2) Construction	Low (Compare with Gas TR) Same as Gas TR	1.5 times of Oil type TR Same as Oil type TR
6. Conclusion	We recommend Oil immersed TR in comparison with Gas TR for the following reason. 1) SF6 gas is specified in the discharge regulation gas in environment countermeasure. 2) Due to the TR accident, when SF6 gas is radiated in the atmosphere, it will be becomes a environmental problem. 3) The cost of the gas TR is more expensive in comparison with the oil immersed TR.	

TABLE 8.17 (4) COMPARISON TABLE FOR ELECTRIC EQUIPMENT
- EMERGENCY GENERATOR -

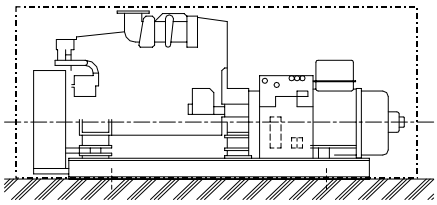
Item	Alternative 1 Diesel Generator	Alternative 2 Turbine Generator
1. Specification. 1) Engine	Diesel engine	Turbine engine
2) Rated voltage	3.3 kV	3.3 kV
3) Rated Capacity	750kVA	750kVA
4) Rated Primary current	131 A	131 A
5) Weight	Approx. 8,000 kg	Approx. 5,000 kg
2.Installation Layout		
3.Related Equipment 1) Aux. Panel	Yes	Yes
2) Control panel	Yes	Yes
3) Cooling Unit	Yes	Yes
4.Comparison 1) Foundation size	W4.0mxD1.5m=6.0m2	W6.0mxD2.0m=12.0m2
2) Installation	Easy installation	Easy installation
3) Operation	Automatic Operation	Automatic Operation
4) Maintenance	- Check with Manufacturer's manual - Easy Maintenance - Spare Parts cost is low compare with Turbine generator.	- Check with Manufacturer's manual - Maintenance is difficult - Spare Parts cost is high compare with Diesel generator.
5) Life of equipment	20 years	20 years
6) Fuel	Heavy oil Fuel cost is low.	Jet fuel Fuel cost is high.
7) Reliability	If periodical maintenance is carried out, long life operation and high reliability is expected.	If periodical maintenance is carried out, long life operation and high reliability is expected.
5. Cost 1) Equipment 2) Construction	Low (Compare with Turbine generator) Same as Turbine generator	High (2 times of Diesel generator) Same as Diesel generator
6. Conclusion	We recommend Diesel generator in comparison with Turbine generator for the following reason. 1) Equipment cost of Diesel generator is low in comparison with Turbine generator. 2) Maintenance of Diesel generator is more easy in comparison with Turbine generator. 3) Running cost of Diesel generator is low in comparison with Turbine generator.	

TABLE 8.18 ELECTRICAL EQUIPMENT LIST FOR WASTEWATER TREATMENT PLANT (1/9)

No.	Name of Equipment	Type	Specification	Unit	Q'ty	Remarks
5.1.1	22kV Substation (MSUB)					
5.1.1.1	22kV Incoming C-GIS unit	Outdoor, Cubicle type	24kV, 3phase, 1200A, 31.5kA	sets	2	
5.1.1.2	22kV Bus Tie C-GIS unit	Outdoor, Cubicle type	24kV, 3phase, 1200A, 31.5kA	set	1	
5.1.1.3	22kV Metring C-GIS unit	Outdoor, Cubicle type	24kV, 3phase, CT, VT	set	1	
5.1.1.4	22kV Transformer primary C-GIS unit	Outdoor, Cubicle type	24kV, 3phase, 600A, 25kA	set	1	
5.1.1.5	Main Transformer	Oil immersed, Outdoor type	15(22)kV/ 3.3kV, 5000kVA with OLTC	set	1	
5.1.2	Main Building					
5.1.2.1	Main Electric Room (ELCR)					
5.1.2.1.1	3.3kV Incoming Switchgear	Indoor, Cubicle type	3.6V, 3phase, 1200A, 25kA	set	1	
5.1.2.1.2	3.3kV Feeder Switchgear	Indoor, Cubicle type	3.6V, 3phase, 600A, 25kA, 2 CB	sets	5	
5.1.2.1.3	3.3kV Section Panel	Indoor, Cubicle type	3.6V, 3phase, 1200A, 25kA	set	1	
5.1.2.1.4	3.3kV Capacitor Panel	Indoor, Cubicle type	3.6kV, 3phase, VS, SC & SR for PF 0.9	sets	4	
5.1.2.1.5	3.3kV Transformer Primary Panel	Indoor, Cubicle type	3.6V, 3phase, 200A, FDS	set	1	
5.1.2.1.6	750kVA Transformer Cubicle	Indoor, Cubicle type	3.3kV/380-220V, 750kVA	set	1	
5.1.2.1.7	Low voltage Switchgear	Indoor, Cubicle type	600V, 3phase, 1200A, 65kA	set	1	
5.1.2.1.8	AC Distribution Panel	Indoor, Cubicle type	600V, 3phase, MCCB 100AF	set	1	
5.1.2.1.9	Motor Control Center	Indoor, Front unit type	600V, 3phase, 600A, 35kA	sets	5	
5.1.2.1.10	Ry Panel for Motor Control Center	Indoor, Cubicle type	Power Ry unit type	sets	3	
5.1.2.1.11	DC Power Supply System	Indoor, Cubicle type	DC110V, Sealed lead acid type battery	set	1	
5.1.2.1.12	UPS	Indoor, Cubicle type	AC100V, Sealed lead acid type battery	set	1	
5.1.2.1.13	22kV Substation Control and Protection Panel	Indoor, Cubicle type	OC, OCG, Def, FI, Indication etc.	set	1	
5.1.2.1.14	OLTC Control Panel	Indoor, Cubicle type	Tap control, 90, VM, CS etc.	set	1	

TABLE 8.18 ELECTRICAL EQUIPMENT LIST FOR WASTEWATER TREATMENT PLANT (2/9)

No.	Name of Equipment	Type	Specification	Unit	Q'ty	Remarks
5.1.2.1.15	Pipe Gallery Lighting Distribution Board	Indoor, Wall mounted type	MCCB 2P	set	1	
5.1.2.1.16	Outdoor Lighting Distribution Board	Indoor, Wall mounted type	MCCB 2P, MC	set	1	
5.1.2.1.17	Pipe Gallery Ventilation Fan Control Board	Indoor, Wall mounted type	MC, Aux Ry	set	1	
5.1.2.2	Main Control Room (CCTR) Equipment					
5.1.2.2.1	Supervisory Panel	Indoor, Desk type	FI, PI, Mini Graphics etc.	sets	4	
5.1.2.2.2	Instrumentation Panel	Indoor, Cubicle type	LI, DI, FrC, Counter	set	1	
5.1.2.2.3	Data Logging System	Indoor, Microprocessor Controlled type	FI 6000, Pulse 500, Analogue 500 points	set	1	
5.1.2.2.4	Interface Panel	Indoor, Cubicle type	Optical link interface, 4-20mA, 1-5V	sets	2	
5.1.2.2.5	Bill Metering Panel	Indoor, Cubicle type	WhM, WM	set	1	
5.1.2.2.6	Communication Panel	Indoor, Rack mounted cubicle type	Paging and intercom system	set	1	
5.1.2.3	Emergency Generator (GENR)					
5.1.2.3.1	750kVA, 3.3kV Engine generator	Indoor, Soundproof type	750kVA, 3phase-4wire, 3.3kV	set	1	
5.1.2.3.2	Generator control panel	Indoor, Cubicle type	AVR, OC, OCG, UV, OV etc.	set	1	
5.1.2.3.3	Fuel tank	Indoor type	Diesel fuel, 3hur operation for DEG	set	1	
5.1.2.3.4	Cooling Unit	Indoor, Cubicle type	AVR, OC, OCG, UV, OV etc.	set	1	
5.1.2.3.5	Air Compressor	Indoor, Cubicle type	600V, 3phase, 2.2kW with air ank	set	1	
5.1.2.3.6	Inlet Fan	Axial Fan	Dia 1000 x 20600m3/h x 68pa	sets	4	
5.1.2.3.7	Exhaust Fan	Axial Fan	Dia 750 x 12000m3/h x 390pa	sets	4	

TABLE 8.18 ELECTRICAL EQUIPMENT LIST FOR WASTEWATER TREATMENT PLANT (3/9)

No.	Name of Equipment	Type	Specification	Unit	Q'ty	Remarks
5.1.3	Lift Pumping Station					
5.1.3.1	Lift Pump Electric Room (LFER)					
5.1.3.1.1	3.3kV Transformer Primary Panel (Incoming Panel)	Outdoor, Cubicle type	3.6V, 3phase, 400A, FDS	set	1	
5.1.3.1.2	3.3kV/380-220V, 1500kVA Transformer	Oil immersed, Outdoor type	3.3kV/ 380-220V, 1500kVA	set	1	
5.1.3.1.3	Transformer Primary and Secondary Bus Duct	Outdoor, Air insulated type	3.3kV, 400V / 600V, 2500A	set	1	
5.1.3.1.4	Low voltage Switchgear	Indoor, Cubicle type	600V, 3phase, 2500A, 65kA	set	1	
5.1.3.1.5	220kW Lift Pump Starter Panel	Indoor, Cubicle type	600V, 3phase, 1000A, Auto-TR type	sets	3	
5.1.3.1.6	380V Capacitor Panel	Indoor, Cubicle type	600V, 3phase, SC & SR for PF 0.9	sets	3	
5.1.3.1.7	AC Distribution Panel	Indoor, Cubicle type	600V, 3phase, MCCB 225,100,50AF	set	1	
5.1.3.1.8	Motor Control Center	Indoor, Front unit type	600V, 3phase, 600A, 35kA	sets	3	
5.1.3.1.9	Ry Panel for Motor Control Center	Indoor, Cubicle type	Power Ry unit type	set	1	
5.1.3.1.10	DC Power Supply System	Indoor, Cubicle type	DC110V, Sealed lead acid type battery	set	1	
5.1.3.1.11	Interface Panel	Indoor, Cubicle type	Optical link interface, 4-20mA, 1-5V	set	1	
5.1.3.1.12	Outdoor Lighting Distribution Board	Indoor, Wall mounted type	MCCB 2P, MC	set	1	
5.1.3.2	Local Control Panel					
5.1.3.2.1	Local Control Panel for Motor	Indoor type	COS, CS, AM, PBS, Indication etc.	sets	9	
5.1.3.2.2	Local Control Panel for Instrument	Indoor type	Metal enclosed box	set	1	
5.1.3.3	Instrumentation Equipment					
5.1.3.3.1	Submerged Diaphram Type Level Meter	Submerged diaphragm type	0-10m, DC 4-20mA	set	1	
5.1.3.3.2	Electrode Type Level Control Switch	Electrode type	4 contacts	sets	6	

TABLE 8.18 ELECTRICAL EQUIPMENT LIST FOR WASTEWATER TREATMENT PLANT (4/9)

No.	Name of Equipment	Type	Specification	Unit	Q'ty	Remarks
5.1.4	Wastewater Treatment Facility					
5.1.4.1	Wastewater Treatment Electric Room (WTER)					
5.1.4.1.1	3.3kV Transformer Primary Panel (Incoming Panel)	Indoor, Cubicle type	3.6V, 3phase, 200A, FDS	set	1	
5.1.4.1.2	750kVA Transformer Cubicle	Indoor, Cubicle type	3.3kV/380-220V, 750kVA	set	1	
5.1.4.1.3	Low voltage Switchgear	Indoor, Cubicle type	600V, 3phase, 1200A, 50kA	set	1	
5.1.4.1.4	AC Distribution Panel	Indoor, Cubicle type	600V, 3phase, MCCB 400,100AF	set	1	
5.1.4.1.5	Motor Control Center	Indoor, Front unit type	600V, 3phase, 600A, 35kA	sets	14	
5.1.4.1.6	Ry Panel for Motor Control Center	Indoor, Cubicle type	Power Ry unit type	set	7	
5.1.4.1.7	DC Power Supply System	Indoor, Cubicle type	DC110V, Sealed lead acid type battery	set	1	
5.1.4.1.8	UPS	Indoor, Cubicle type	AC100V, Sealed lead acid type battery	set	1	
5.1.4.1.9	Interface Panel	Indoor, Cubicle type	Optical link interface, 4-20mA, 1-5V	set	1	
5.1.4.1.10	Pipe Gallery Lighting Distribution Board	Indoor, Wall mounted type	MCCB 2P	set	1	
5.1.4.1.11	Outdoor Lighting Distribution Board	Indoor, Wall mounted type	MCCB 2P, MC	set	1	
5.1.4.2	Local Control Panel					
5.1.4.2.1	Local Control Panel for Motor	Indoor and Outdoor type	COS, CS, AM, PBS, Indication etc.	sets	58	
5.1.4.2.2	Local Control Panel for Instrument	Indoor type	Signal converter etc.	sets	7	
5.1.4.3	Instrumentation Equipment					
5.1.4.3.1	Orifice Type Flow Meter 350m/m	Concentric Oriffice type	350m/m	sets	10	
5.1.4.3.2	Orifice Type Flow Meter Converter	Electrostatic Capacity type	DC 4-20mA	sets	10	
5.1.4.3.3	Electromagnetic Type Flow Meter 100m/m	Electromagnetic Type	100m/m, DC 4-20mA	set	1	
5.1.4.3.4	Electromagnetic Type Flow Meter 150m/m	Electromagnetic Type	150m/m, DC 4-20mA	set	1	

TABLE 8.18 ELECTRICAL EQUIPMENT LIST FOR WASTEWATER TREATMENT PLANT (5/9)

No.	Name of Equipment	Type	Specification	Unit	Q'ty	Remarks
5.1.4.3.5	Electromagnetic Type Flow Meter 350m/m	Electromagnetic Type	350m/m, DC 4-20mA	sets	2	
5.1.4.3.6	Ultrasonic Type Density Meter 100m/m	Ultrasonic, Non deforming Type	100m/m, +/-3%, DC 4-20mA	set	1	
5.1.4.3.7	Ultrasonic Type Density Meter 350m/m	Ultrasonic, Non deforming Type	350m/m, +/-3%, DC 4-20mA	sets	2	
5.1.4.3.8	Float Type Level Control Switch	Float Type	4 contacts	sets	2	
5.1.4.3.9	Electrode Type Level Control Switch	Electrode type	4 contacts	sets	7	
5.1.5	Chlorianation Storage Building Facility					
5.1.5.1	Chlorination Electric Room (CHER)					
5.1.5.1.1	3.3kV Transformer Primary Panel (Incoming Panel)	Indoor, Cubicle type	3.6V, 3phase, 200A, FDS	set	1	
5.1.5.1.2	750kVA Transformer Cubicle	Indoor, Cubicle type	3.3kV/380-220V, 750kVA	set	1	
5.1.5.1.3	Low voltage Switchgear	Indoor, Cubicle type	600V, 3phase, 1200A, 50kA	set	1	
5.1.5.1.4	AC Distribution Panel	Indoor, Cubicle type	600V, 3phase, MCCB 400,100AF	set	1	
5.1.5.1.5	Motor Control Center	Indoor, Front unit type	600V, 3phase, 600A, 35kA	sets	8	
5.1.5.1.6	Ry Panel for Motor Control Center	Indoor, Cubicle type	Power Ry unit type	sets	4	
5.1.5.1.7	DC Power Supply System	Indoor, Cubicle type	DC110V, Sealed lead acid type battery	set	1	
5.1.5.1.8	UPS	Indoor, Cubicle type	AC110V, Sealed lead acid type battery	set	1	
5.1.5.1.9	Supervisory Panel	Indoor, Desk type	FI, PI, Mini Graphics etc.	set	1	
5.1.5.1.10	Instrumentation Panel	Indoor, Cubicle type	LI, DI, Counter	set	1	
5.1.5.1.11	Interface Panel	Indoor, Cubicle type	Optical link interface, 4-20mA, 1-5V	set	1	
5.1.5.1.12	Pipe Gallery Lighting Distribution Board	Indoor, Wall mounted type	MCCB 2P	set	1	
5.1.5.1.13	Outdoor Lighting Distribution Board	Indoor, Wall mounted type	MCCB 2P, MC	set	1	

TABLE 8.18 ELECTRICAL EQUIPMENT LIST FOR WASTEWATER TREATMENT PLANT (6/9)

No.	Name of Equipment	Type	Specification	Unit	Q'ty	Remarks
5.1.5.2	Local Control Panel					
5.1.5.2.1	Local Control Panel for Motor	Indoor type	COS, CS, AM, PBS, Indication etc.	sets	14	
5.1.5.2.2	Local Control Panel for Instrument	Indoor type	Signal converter etc.	sets	5	
5.1.5.3	Instrumentation Equipment					
5.1.5.3.1	Submerged Diaphram Type Level Meter	Submerged diaphragm type	0-10m, DC 4-20mA	set	1	
5.1.5.3.2	Diaphram Type Level Meter	Diaphram type	250-10000mm, DC 4-20mA	sets	2	
5.1.5.3.3	Ultrasonic Type Flow Meter with Weir	Ultrasonic type	0.5-19.5m, DC 4-20mA, with Wire	set	1	
5.1.5.3.4	Electromagnetic Type Flow Meter 25m/m	Electromagnetic type	25m/m, DC 4-20mA	set	1	
5.1.5.3.5	Float Type Level Control Switch	Float type	4 contacts	set	1	
5.1.5.3.6	Electrode Type Level Control Switch	Electrode type	4 contacts	sets	5	
5.1.6	Dewatering & Centrifugal Thickener Facility					
5.1.6.1	Dewatering Electric Room (DCER)					
5.1.6.1.1	3.3kV Transformer Primary Panel (Incoming Panel)	Indoor, Cubicle type	3.6V, 3phase, 600A, CB	set	1	
5.1.6.1.2	2500kVA Transformer Cubicle	Indoor, Cubicle type	3.3kV/380-220V, 2500kVA	set	1	
5.1.6.1.3	Low voltage Switchgear	Indoor, Cubicle type	600V, 3phase, 4000A, 65kA	set	1	
5.1.6.1.4	AC Distribution Panel	Indoor, Cubicle type	600V, 3phase, MCCB 1000,600,225,100AF	sets	3	
5.1.6.1.5	Motor Control Center	Indoor, Front unit type	600V, 3phase, 600A, 35kA	sets	14	
5.1.6.1.6	Ry Panel for Motor Control Center	Indoor, Cubicle type	Power Ry unit type	sets	7	
5.1.6.1.7	DC Power Supply System	Indoor, Cubicle type	DC110V, Sealed lead acid type battery	set	1	
5.1.6.1.8	UPS	Indoor, Cubicle type	AC110V, Sealed lead acid type battery	set	1	
5.1.6.1.9	Supervisory Panel	Indoor, Desk type	FI, PI, Mini Graphics etc.	sets	3	

TABLE 8.18 ELECTRICAL EQUIPMENT LIST FOR WASTEWATER TREATMENT PLANT (7/9)

No.	Name of Equipment	Type	Specification	Unit	Q'ty	Remarks
5.1.6.1.10	Instrumentation Panel	Indoor, Cubicle type	LI, DI, WI, Counter	set	1	
5.1.6.1.11	Interface Panel	Indoor, Cubicle type	Optical link interface, 4-20mA, 1-5V	set	1	
5.1.6.1.12	Pipe Gallery Lighting Distribution Board	Indoor, Wall mounted type	MCCB 2P	set	1	
5.1.6.2	Local Control Panel					
5.1.6.2.1	Local Control Panel for Motor	Indoor type	COS, CS, AM, PBS, Indication etc.	sets	18	
5.1.6.2.2	Local Control Panel for Instrument	Indoor type	Signal converter etc.	sets	5	
5.1.6.3	Instrumentation Equipment					
5.1.6.3.1	Diaphragm Type Level Meter	Diaphram type	250-10000mm, DC 4-20mA	sets	2	
5.1.6.3.2	Electromagnetic Type Flow Meter 50m/m	Electromagnetic type	50m/m, DC 4-20mA	sets	2	
5.1.6.3.3	Electromagnetic Type Flow Meter 80m/m	Electromagnetic type	80m/m, DC 4-20mA	sets	3	
5.1.6.3.4	Electromagnetic Type Flow Meter 100m/m	Electromagnetic type	100m/m, DC 4-20mA	sets	2	
5.1.6.3.5	Ultrasonic Type Density meter 80m/m	Ultrasonic, Deforming Type	80m/m, +/-3%, DC 4-20mA	set	1	
5.1.6.3.6	Ultrasonic Type Density meter 150m/m	Ultrasonic, Deforming Type	150m/m, +/-3%, DC 4-20mA	set	1	
5.1.6.3.7	Ultrasonic Type Density meter 200m/m	Ultrasonic, Deforming Type	200m/m, +/-3%, DC 4-20mA	set	1	
5.1.6.3.8	Float Type Level Control Switch	Float type	4 contacts	sets	2	
5.1.6.3.9	Electrode Type Level Control Switch	Electrode type	4 contacts	sets	2	
5.1.7	Blower Building Facility					
5.1.7.1	Electrical Equipment					
5.1.7.1.1	3.3kV Incoming Panel	Indoor, Cubicle type	3.6V, 3phase, 600A, CB	sets	2	
5.1.7.1.2	480kW Blower Control Panel	Indoor, Cubicle type	COS, CS, AM, PBS, Indication etc.	sets	2	

TABLE 8.18 ELECTRICAL EQUIPMENT LIST FOR WASTEWATER TREATMENT PLANT (8/9)

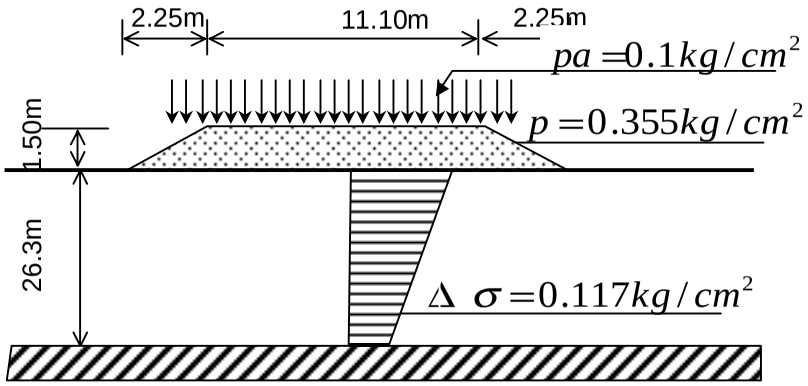
No.	Name of Equipment	Type	Specification	Unit	Q'ty	Remarks
5.1.7.2	Local Control Panel					
5.1.7.2.1	Local Control Panel for Motor and AUX.	Indoor type	COS, CS, AM, PBS, Indication etc.	set	1	
5.1.7.3	Instrumentation Equipment					
5.1.7.3.1	Orifice Type Flow Meter 600m/m	Concentric Oriffice type	600m/m	sets	2	
5.1.7.3.2	Orifice Type Flow Meter Converter	Electrostatic Capacity type	DC 4-20mA	sets	2	
5.1.7.3.3	Electrode Type Level Control Switch	Electrode type	4 contacts	set	1	
5.1.8	Compost Plant Facility					
5.1.8.1	Compost Electric Room (CPER) Equipment					
5.1.8.1.1	3.3kV Transformer Primary Panel (Incoming Panel)	Indoor, Cubicle type	3.6V, 3phase, 200A, FDS	set	1	
5.1.8.1.2	750kVA Transformer Cubicle	Indoor, Cubicle type	3.3kV/380-220V, 750kVA	set	1	
5.1.8.1.3	Low voltage Switchgear	Indoor, Cubicle type	600V, 3phase, 1200A, 50kA	set	1	
5.1.8.1.4	AC Distribution Panel	Indoor, Cubicle type	600V, 3phase, MCCB 600,100AF	set	1	
5.1.8.1.5	Motor Control Center	Indoor, Front unit type	600V, 3phase, 600A, 35kA	sets	5	
5.1.8.1.6	Ry Panel for Motor Control Center	Indoor, Cubicle type	Power Ry unit type	sets	3	
5.1.8.1.7	DC Power Supply System	Indoor, Cubicle type	DC110V, Sealed lead acid type battery	set	1	
5.1.8.1.8	UPS	Indoor, Cubicle type	AC110V, Sealed lead acid type battery	set	1	
5.1.8.1.9	Supervisory Panel	Indoor, Desk type	FI, PI, Mini Graphics etc.	set	1	
5.1.8.1.10	Interface Panel	Indoor, Cubicle type	Optical link interface, 4-20mA, 1-5V	set	1	
5.1.8.1.11	Outdoor Lighting Distribution Board	Indoor, Wall mounted type	MCCB 2P, MC	set	1	

TABLE 8.18 ELECTRICAL EQUIPMENT LIST FOR WASTEWATER TREATMENT PLANT (9/9)

No.	Name of Equipment	Type	Specification	Unit	Q'ty	Remarks
5.1.8.2	Local Control Panel					
5.1.8.2.1	Local Control Panel for Motor	Indoor type	COS, CS, AM, PBS, Indication etc.	sets	8	
5.1.8.3	Instrumentation Equipment					
5.1.8.3.1	Electrode Type Level Control Switch	Electrode type	4 contacts	sets	3	
5.1.9	Pipe Gallary Equipment					
5.1.9.1	Pipe Gallary					
5.1.9.1.1	Pipe Gallery Lighting Switch Box	Indoor, Wall mounted type	MCCB 2P	sets	12	
5.1.9.1.2	Pipe Gallery Receptacle Box	Indoor, Wall mounted type	2P, 3P, 2P+E, 3P+E	sets	26	
5.1.10	Outdoor & Road Lighting Equipment					
5.1.10.1	Guard House					
5.1.10.1.1	Outdoor Lighting Switch Box	Indoor, Wall mounted type	MC, Aux Ry	set	1	

TABLE 8.19 SETTLEMENT OF THE ROAD UNDER EMBANKMENT

Layer	Depth z (m)	z/b	$\frac{\Delta\sigma}{p}$	Thickness (cm)	σ_o (kg/cm²)	P_c (kg/cm²)	e_o	Cc	$\frac{Cc}{1+e_o}$	Δσ	$\frac{\sigma_o+\Delta\sigma}{\sigma_o}$	$\lg\left(\frac{\sigma_o+\Delta\sigma}{\sigma_o}\right)$	**S(cm)**
OH1	2	0.148	0.98	400	0.154	0.315	2.261	0.9274	0.284	0.348	3.253	0.512	58.268
OH1	6	0.444	0.85	400	0.340	1,632	2.824	1.5358	0.402	0.302	1.888	0.276	0.000
OH1	10.5	0.778	0.62	500	0.548	0.264	2.157	0.8819	0.279	0.220	1.402	0.147	20.481
OH1	15.5	1.148	0.51	500	0.780	0.381	1.981	0.8456	0.284	0.181	1.232	0.091	12.865
OH1	20.5	1.519	0.38	500	1.011	1,181	1.696	1.0075	0.374	0.135	1.133	0.054	0.000
OH2	24.65	1.826	0.33	330	1.203	1,399	1.829	1.0168	0.359	0.117	1.097	0.040	0.000
											Total Settlement :		**91.614**



$$S = H\frac{Cc}{1+e_0}\lg\left(\frac{\sigma_o+\Delta\sigma}{\sigma_o}\right)$$

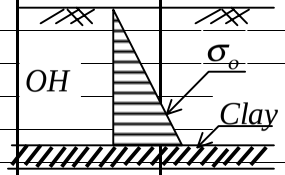
TABLE 8.20 FINAL SETTLEMENT BY SELF-WEIGHT

Layer	Depth (m)	Thickness (cm)	σ_o (kg/cm²)	P_c (kg/cm²)	e_o	Cc	$\frac{Cc}{1+e_o}$	$\Delta\sigma$	$\frac{Pc+\Delta\sigma}{Pc}$	$\lg\left(\frac{Pc+\Delta\sigma}{Pc}\right)$	S(cm)
OH1	2	400	0.154	0.315	2.261	0.9274	0.305	0.000	1.000	0.000	0.000
OH1	6	400	0.340	1,632	2.824	1.5358	0.263	0.000	1.000	0.000	0.000
OH1	10.5	500	0.548	0.264	2.157	0.8819	0.276	0.284	2.076	0.317	43.792
OH1	15.5	500	0.780	0.381	1.981	0.8456	0.277	0.399	2.046	0.311	43.024
OH1	20.5	500	1.011	1,181	1.696	1.0075	0.267	0.000	1.000	0.000	0.000
OH2	24.65	330	1.203	1,399	1.829	1.0168	0.289	0.000	1.000	0.000	0.000
									Total Settlement :		**86.816**

$$S = H\frac{Cc}{1+e_o}\lg\left(\frac{Pc+\Delta\sigma}{Pc}\right)$$

TABLE 8.21 SETTLEMENT BY TIME UNDER SELF-WEIGHT

t(year)	cv(cm²/s)	N	e^{-N}	$e^{-9N}/27$	$e^{-25N}/125$	$e^{-49N}/343$	$e^{-81N}/729$	$e^{-121N}/1331$	$e^{-169N}/2197$	$e^{-225N}/3375$	$e^{-289N}/4913$	Ut	St(cm)
1	2.67E-04	0.00023	1.000	0.037	0.008	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.0
2	2.67E-04	0.00363	0.996	0.036	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.003	0.3
3	2.67E-04	0.00544	0.995	0.035	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.004	0.4
4	2.67E-04	0.00726	0.993	0.035	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.006	0.5
5	2.67E-04	0.00907	0.991	0.034	0.006	0.002	0.001	0.000	0.000	0.000	0.000	0.007	0.6
10	2.67E-04	0.01815	0.982	0.031	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.015	1.3
11.1	2.67E-04	0.02015	0.980	0.031	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.016	1.4
20	2.67E-04	0.03630	0.964	0.027	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.029	2.6
30	2.67E-04	0.05445	0.947	0.023	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.044	3.8
33.3	2.67E-04	0.06044	0.941	0.021	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.049	4.3
40	2.67E-04	0.07259	0.930	0.019	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.059	5.1
50	2.67E-04	0.09074	0.913	0.016	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.074	6.4
75	2.67E-04	0.13611	0.873	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.110	9.6
83.3	2.67E-04												10.6
100	2.67E-04												12.7
139	2.67E-04												17.5
222	2.67E-04												27.0
250	2.67E-04												29.9
333	2.67E-04												37.9
500	2.67E-04												50.6
694	2.67E-04												61.4
1000	2.67E-04												72.2
1050	2.67E-04												73.5
1390	2.67E-04												79.6
2220	2.67E-04												85.2
5000	2.67E-04												86.8
6000	2.57E-04	10.48136	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	86.8



$$St = SxUt$$

$$Ut = 1 - \frac{32}{\Pi^3}\left(e^{-N} - \frac{1}{27e^{-9N}} + \frac{1}{125e^{-25N}} - \ldots\right)$$

$$N = \frac{\Pi^2 C_v 3.10^7 t}{4H^2}$$

TABLE 8.22 SETTLEMENT BY TIME OF THE ROAD

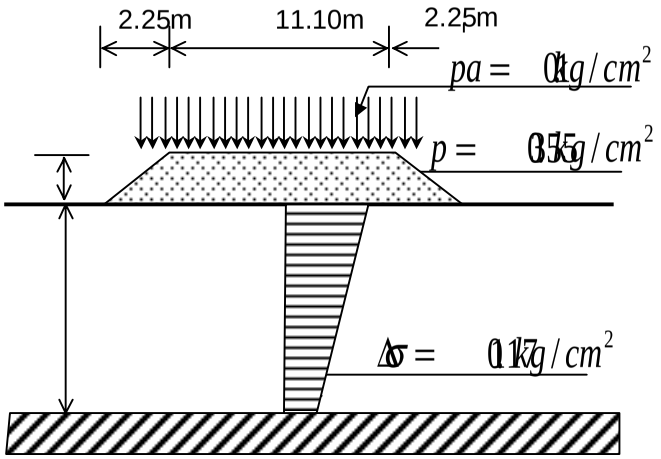
Relation between Ut and N-02

Ut	N-0	N-2	N-02
0.05	0.005	0.002	0.00365
0.1	0.02	0.005	0.01325
0.15	0.04	0.01	0.0265
0.2	0.08	0.02	0.053
0.25	0.12	0.04	0.084
0.3	0.17	0.06	0.1205
0.35	0.24	0.09	0.1725
0.4	0.31	0.13	0.229
0.45	0.39	0.18	0.2955
0.5	0.49	0.24	0.3775
0.55	0.59	0.32	0.4685
0.6	0.71	0.42	0.5795
0.65	0.84	0.54	0.705
0.7	1	0.69	0.8605
0.75	1.18	0.88	1.045
0.8	1.4	1.08	1.256
0.85	1.69	1.36	1.5415
0.9	2.09	1.77	1.946
0.95	2.8	2.54	2.683
1			

$$N-02 = N2 + (N0 - N2)0.55$$

Settlement Calculation

t(year)	cv(cm²/s)	N-02	Ut	St(cm)
1.0	2.68E-04	0.0029	0.035	3.2
2.0	2.68E-04	0.0057	0.060	5.5
3.0	2.68E-04	0.0086	0.080	7.3
4.0	2.68E-04	0.0115	0.090	8.2
5.0	2.68E-04	0.0143	0.110	10.1
10.0	2.68E-04	0.0287	0.150	13.7
11.1	2.68E-04	0.0318	0.180	16.5
20.0	2.68E-04	0.0574	0.210	19.2
30.0	2.68E-04	0.0860	0.250	22.9
33.3	2.68E-04	0.0955	0.270	24.7
40.0	2.68E-04	0.1147	0.290	26.6
50.0	2.68E-04	0.1434	0.320	29.3
75.0	2.68E-04	0.2151	0.370	33.9
83.3	2.68E-04	0.2389	0.410	37.6
100.0	2.68E-04	0.2868	0.430	39.4
139.0	2.68E-04	0.3987	0.520	47.6
222.0	2.68E-04	0.6367	0.620	56.8
250.0	2.68E-04	0.7170	0.670	61.4
333.0	2.68E-04	0.9551	0.720	66.0
500.0	2.68E-04	1.4340	0.810	74.2
694.0	2.68E-04	1.9904	0.920	84.3
1000.0	2.68E-04	2.8680	0.980	89.8



$$St = Sx Ut$$

With :

$$N-02 = \frac{\Pi^2 C_v 3.10^7 t}{4H^2}$$

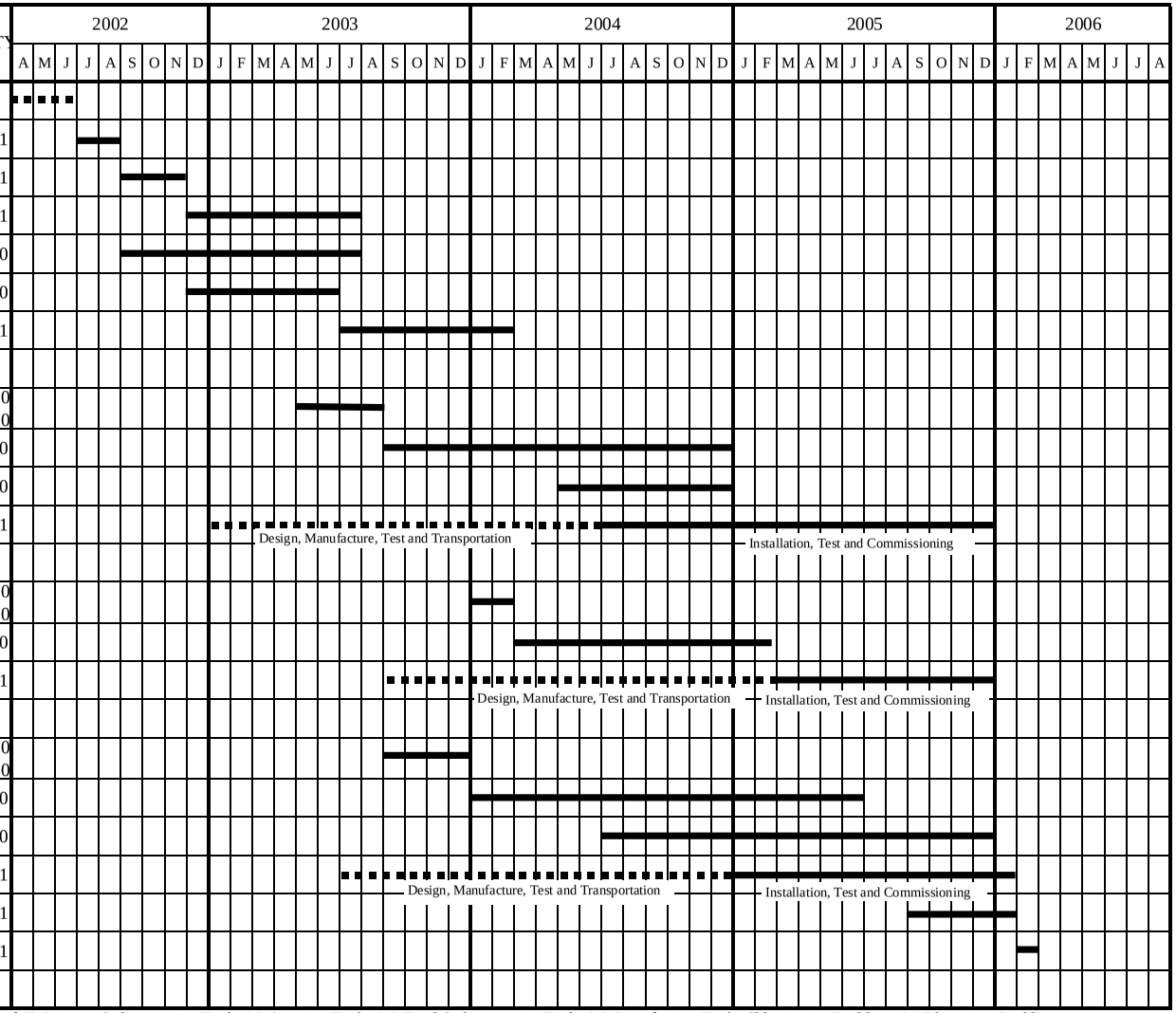
*** Total settlement after 30 years: 3.80cm (Self-weight) + 22.90cm (Embankment) = 26.70cm**

Table 8.23 Calculating Water Volume of Outfall

Outfall No	F (ha)	Pav (f1)	Area % Aggre (f2)	Glass (f3)	Y	M	lr (m)	lc (m)	t (min)	q (l/s.ha)	Q (l/s)	Remark
1	2	3	4	5	6	7	8	9	10	11	12	13
O1	*2.8*	*95*	*0*	*5*	*0.908*	*0.997*	*0*	*330*	*11*	*324*	***820***	*Phase 2*
F1-1	0.55	95	0	5	0.908	0.999	0	130	8	354	177	
F1-2	2.25	95	0	5	0.908	0.998	0	330	11	324	659	
O2	***5.73***	***60***	***0***	***40***	***0.61***	***0.994***	***0***	***143***	***8***	***352***	1223	***Phase 1***
F2-1	0.16	50	0	50	0.525	1	0	80	7	363	30	
F2-2	0.61	90	0	10	0.865	0.999	0	120	7	356	188	
F2-3	0.42	70	0	30	0.695	1	0	120	7	356	104	
F2-4	0.16	10	0	90	0.185	1	0	120	7	356	11	
F2-5	0.42	50	0	50	0.525	1	0	80	7	363	80	
F2-6	0.26	30	0	70	0.355	1	0	120	7	356	33	
F2-7	0.04	30	0	70	0.355	1	0	30	6	372	5	
F2-8	0.04	30	0	70	0.355	1	0	30	6	372	5	
F2-9	0.26	30	0	70	0.355	1	0	120	7	356	33	
F2-10	0.26	30	0	70	0.355	1	0	100	7	359	33	
F2-11	0.26	30	0	70	0.355	1	0	100	7	359	33	
F2-12	0.04	30	0	70	0.355	1	0	30	6	372	5	
F2-13	0.04	30	0	70	0.355	1	0	30	6	372	5	
F2-14	1.73	90	0	10	0.865	0.998	0	220	9	340	507	
F2-15	0.55	90	0	10	0.865	0.999	0	100	7	359	171	
F2-16	0.48	100	0	0	0.95	1	0	70	6	364	166	
O3	*1.29*	*25*	*0*	*75*	*0.313*	*0.999*	*0*	*300*	*11*	*328*	***132***	*Phase 2*
F3-1	0.9	20	0	80	0.27	0.999	0	250	10	335	81	
F3-2	0.39	30	0	70	0.355	1	0	110	7	357	49	
O4	***2.5***	***25***	***50***	***25***	***0.563***	***0.998***	***0***	***370***	***12***	**318**	***446***	***Phase 1***
F4-1	0.77	10	80	10	0.585	0.999	0	160	8	349	157	
F4-2	0.44	40	40	20	0.64	1	0	120	7	356	100	
F4-3	0.63	10	80	10	0.585	0.999	0	120	7	356	131	
F4-4	0.66	50	0	50	0.525	0.999	0	160	8	349	121	
O5	***3.56***	***60***	***0***	***40***	***0.61***	***0.996***	***0***	***236***	***10***	***337***	***730***	***Phase 1***
F5-1	0.6	90	0	10	0.865	0.999	0	131	8	354	184	
F5-2	0.21	60	0	40	0.61	1	0	112	7	357	46	
F5-3	0.21	40	0	60	0.44	1	0	50	6	368	34	
F5-4	0.14	50	0	50	0.525	1	0	57	6	367	27	
F5-5	0.09	60	0	40	0.61	1	0	36	6	370	20	
F5-6	0.24	50	0	50	0.525	1	0	50	6	368	46	
F5-7	0.24	50	0	50	0.525	1	0	50	6	368	46	
F5-8	0.09	60	0	40	0.61	1	0	36	6	370	20	
F5-9	0.06	60	0	40	0.61	1	0	39	6	370	14	
F5-10	0.15	50	0	50	0.525	1	0	50	6	368	29	
F5-11	0.15	50	0	50	0.525	1	0	50	6	368	29	
F5-12	0.06	50	0	50	0.525	1	0	48	6	368	12	
F5-13	0.16	50	0	50	0.525	1	0	66	6	365	31	
F5-14	0.24	80	0	20	0.78	1	0	66	6	365	68	
F5-15	0.48	20	0	80	0.27	1	0	120	7	356	46	
F5-16	0.22	40	0	60	0.44	1	0	131	8	354	34	
F5-17	0.22	90	0	10	0.865	1	0	131	8	354	67	
O6	***3.61***	***70***	***0***	***30***	***0.695***	***0.996***	***0***	***260***	***10***	***334***	***834***	***Phase 1***
F6-1	0.75	90	0	10	0.865	0.999	0	80	7	363	235	
F6-2	0.16	50	0	50	0.525	1	0	46	6	369	31	
F6-3	0.16	50	0	50	0.525	1	0	66	6	365	31	
F6-4	0.04	60	0	40	0.61	1	0	30	6	372	9	
F6-5	0.04	60	0	40	0.61	1	0	30	6	372	9	
F6-6	0.38	50	0	50	0.525	1	0	70	6	364	73	
F6-7	0.38	50	0	50	0.525	1	0	70	6	364	73	
F6-8	0.04	50	0	50	0.525	1	0	30	6	372	8	
F6-9	0.04	50	0	50	0.525	1	0	30	6	372	8	
F6-10	0.27	60	0	40	0.61	1	0	80	7	363	60	
F6-11	0.48	80	0	20	0.78	1	0	50	6	368	138	
F6-12	0.27	50	0	50	0.525	1	0	90	7	361	51	
F6-13	0.6	70	0	30	0.695	0.999	0	110	7	357	149	
O7	***2.18***	***60***	***0***	***40***	***0.61***	***0.998***	***0***	***175***	***8***	***347***	***460***	***Phase 1***
F7-1	0.3	80	0	20	0.78	1	0	127	7	355	83	
F7-2	0.7	70	0	30	0.695	0.999	0	175	8	347	169	
F7-3	0.8	20	0	80	0.27	0.999	0	127	7	355	77	
F7-4	0.38	20	0	80	0.27	1	0	127	7	355	36	
O8	*2.6*	*90*	*0*	*10*	*0.865*	*0.997*	*0*	*300*	*11*	*328*	*735*	*Phase 2*
F8-1	2.05	90	0	10	0.865	0.998	0	250	10	335	593	
F8-2	0.55	90	0	10	0.865	0.999	0	100	7	359	171	
	24.27										***5380***	

TABLE 8.24 CONSTRUCTION SCHEDULE OF WASTEWATER TREATMENT PLANT CONSTRUCTION (PACKAGE E)

NO	DESCRIPTION	UNIT	QUANTITY
1	Relocation and Tendering		
2	Preparation Work	L.S.	1
3	Jetty Work	L.S.	1
4	Site Preparation Work	L.S.	1
3	Reinforced Concrete Bridge Work	m	100
4	Temporary Road Work	m	500
5	Conveyance Sewer Work (ϕ1200 Pipe Jacking)	m	221
6	Lift Pumping Station and Wastewater Treatment Plant Work		
6.1	RC Piling and Earth Work	m m^2	165,500 72,100
6.2	Structural Work	m^3	48,500
6.3	Architectural Work	m^3	1,400
6.4	Mechanical and Electrical Work	L.S.	1
7	Main Building Work		
7.1	PC Piling and Earth Work	m m^3	7,200 5,200
7.2	Architectural Work	m^2	1,600
7.3	Mechanical and Electrical Work	L.S.	1
8	Sludge Treatment Plant Work		
8.1	RC Piling and Earth Work	m m^3	45,000 26,000
8.2	Structural Work	m^3	5,100
8.3	Architectural Work	m^2	13,000
8.4	Mechanical and Electrical Work	L.S.	1
9	Landscape Work	L.S.	1
10	Cleaning and Hand Over	L.S.	1



Note: 1. Wastewater treatment plant work includes the construction of (I) Primary Sedimentation Tank, (ii) Aeration Tank, (iii) Final Sedimentation Tank, (iv) Disinfection Tank, Chlorination Building, (v) Blowering Building, (iv) Distribution Tank, (iv) Effluent Pipe, and (iiiv) Pipe Gallery.

2. Sludge treatment plant work includes (i) Compost Plant Facility, (ii) Dewatering and Centrifugal Thickener Building, and (iii) Truck Scale.

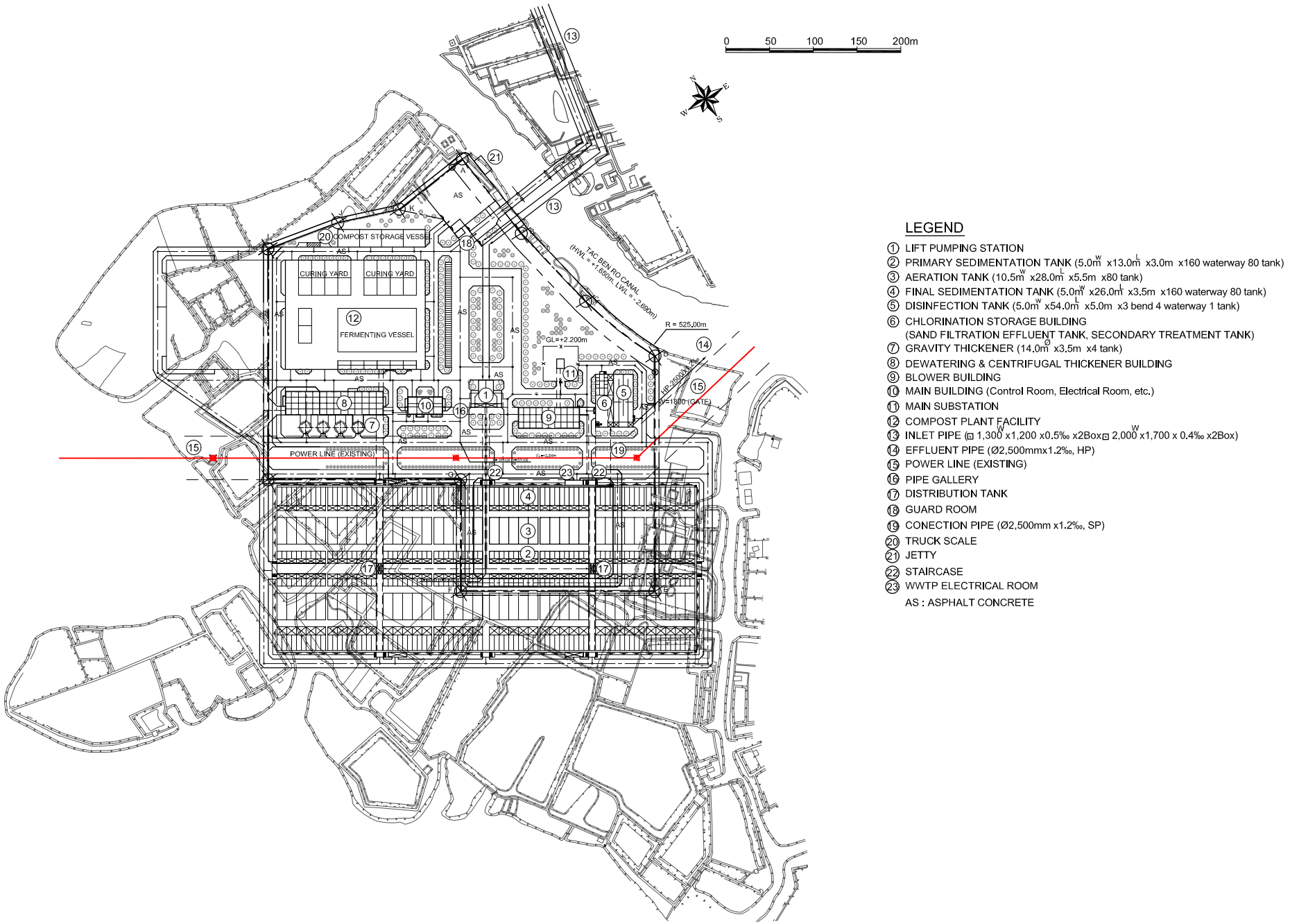


FIG. 8.1 GENERAL LAYOUT OF THBNDT WASTEWATER TREATMENT PLANT

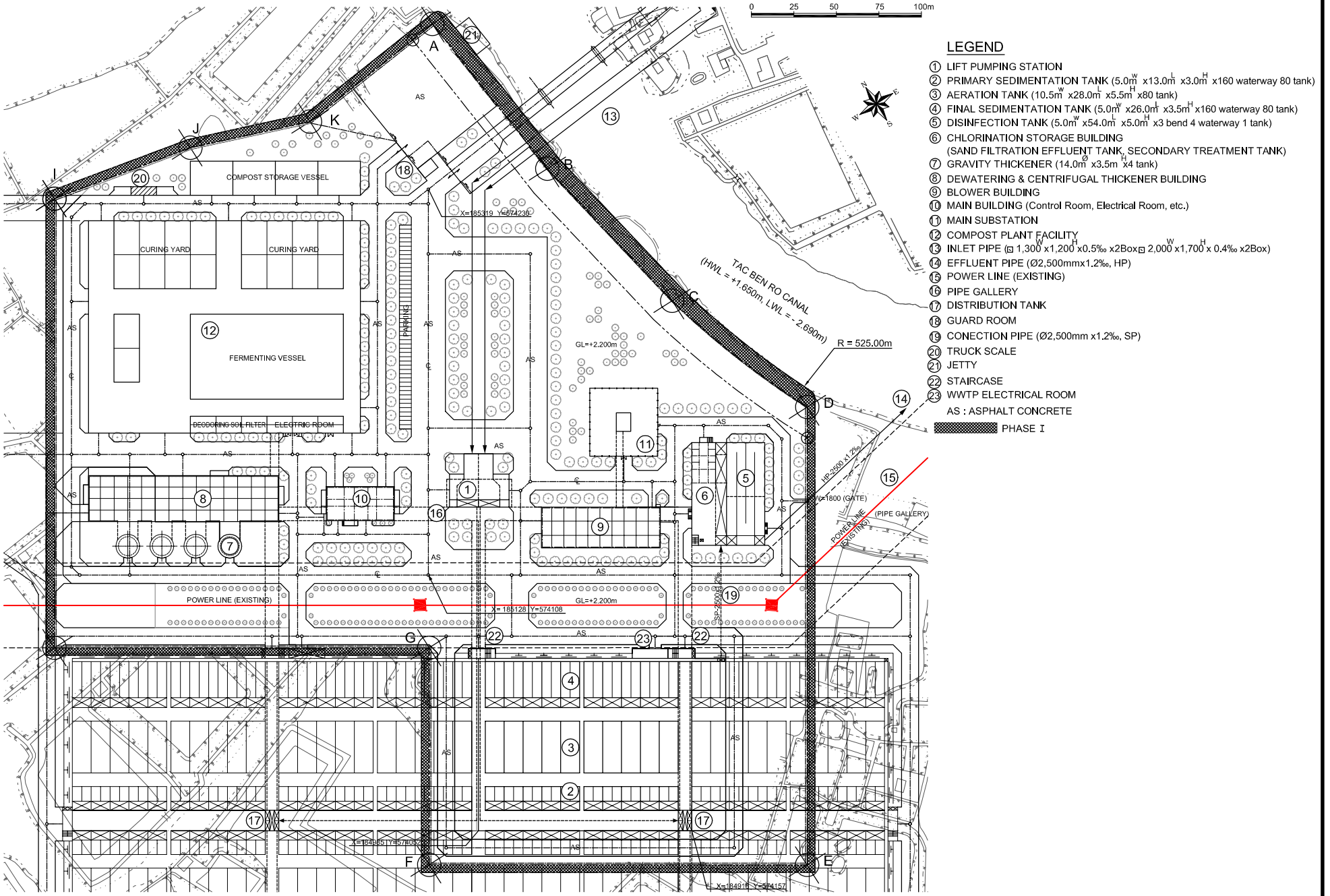


FIG. 8.2 GENERAL LAYOUT OF WASTEWATER TREATMENT PLANT

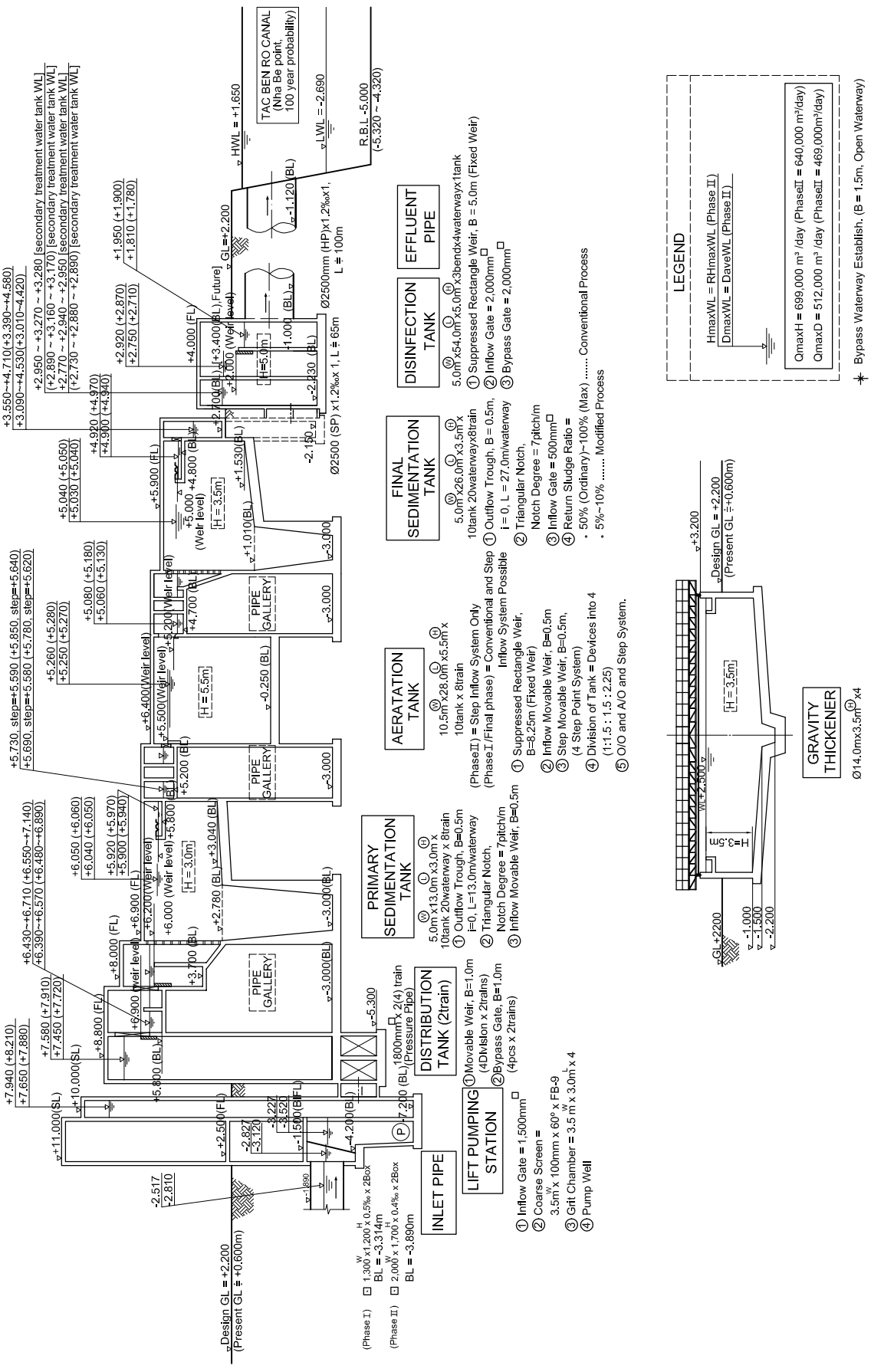


FIG. 8.3 HYDRAULIC PROFILE OF THBNDT WASTEWATER TREATMENT PLANT

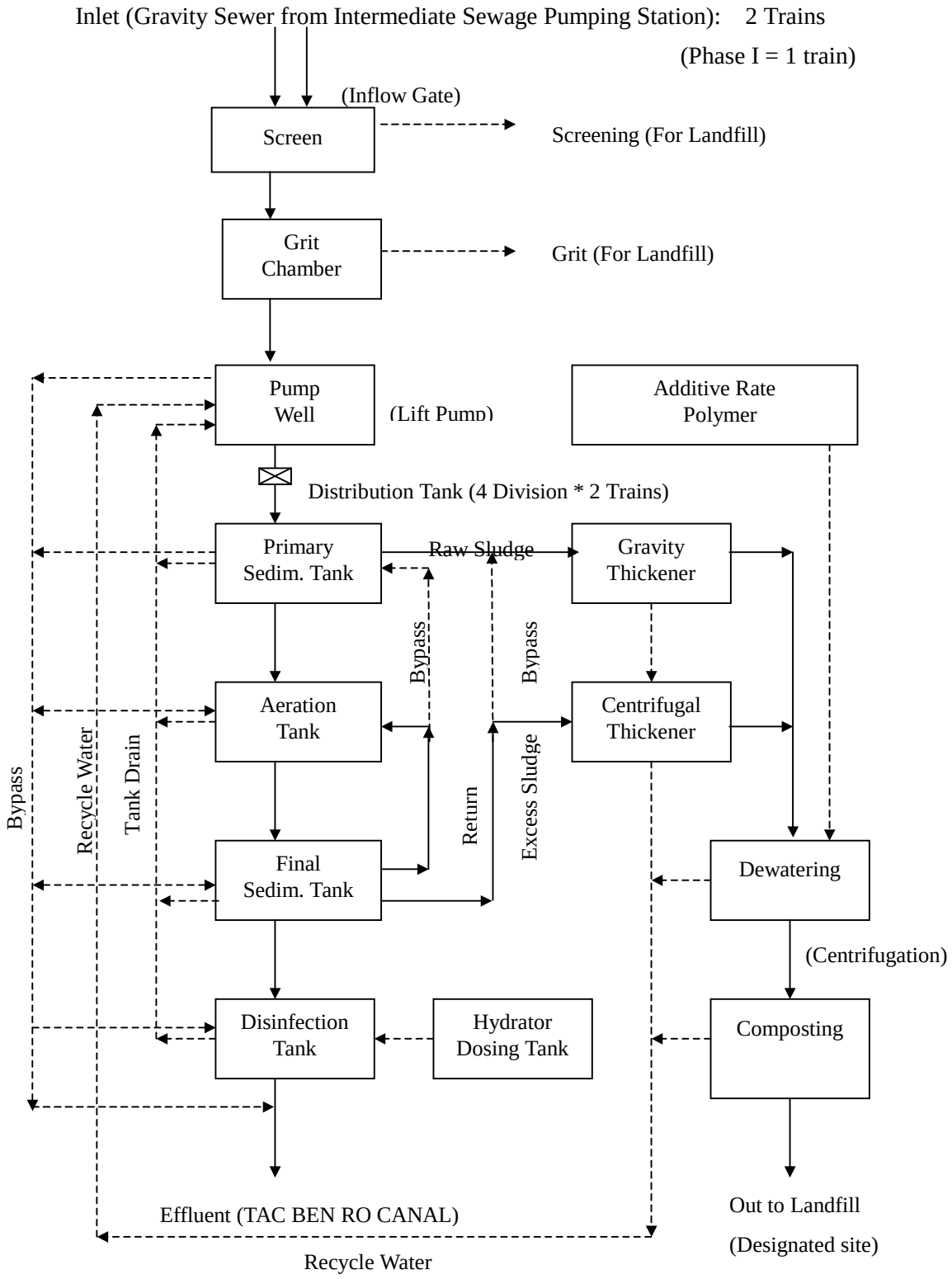


FIG. 8.4 WASTEWATER TREATMENT SYSTEM FLOW

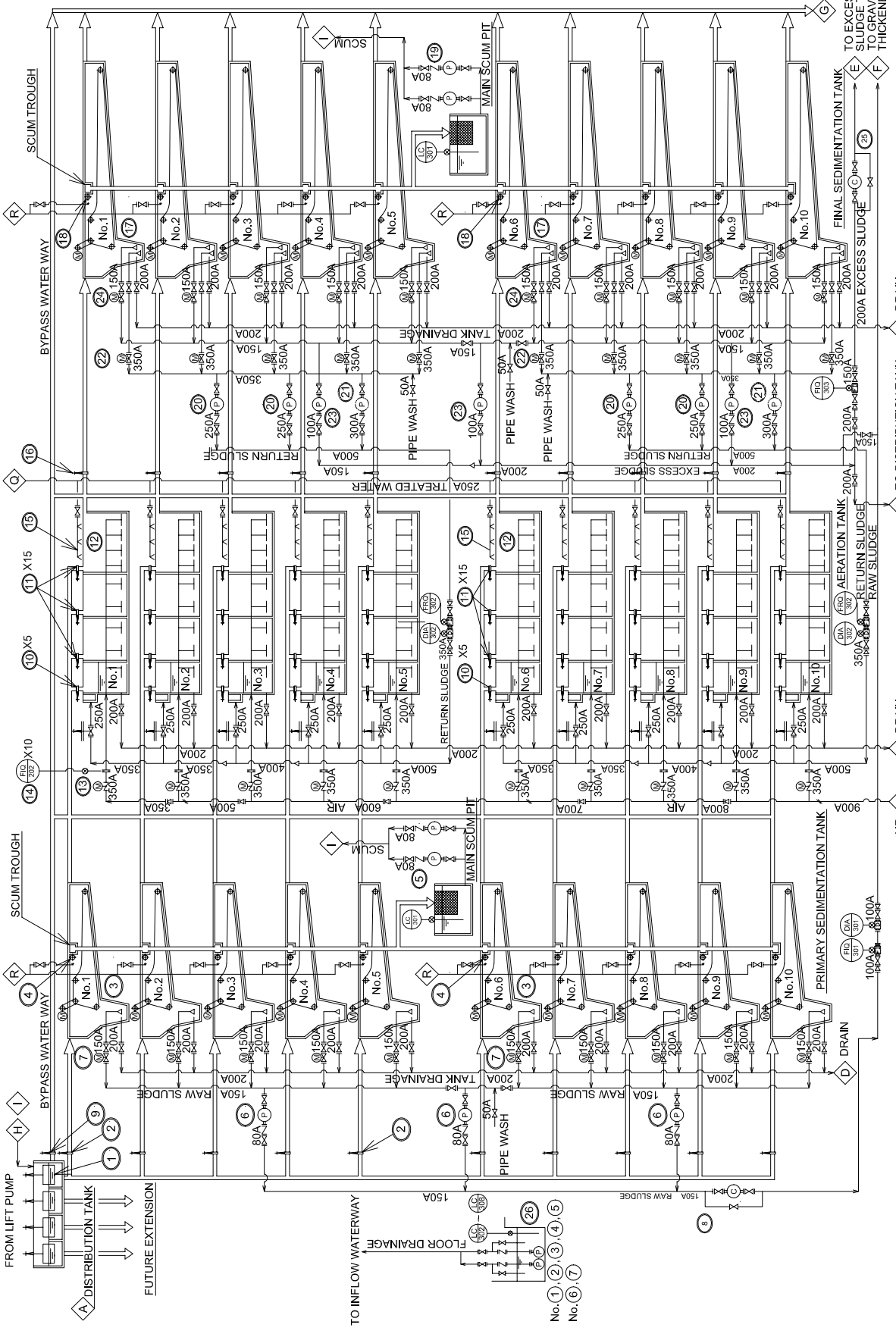


FIG. 8.5 FLOW SHEET OF WATER TREATMENT FACILITY

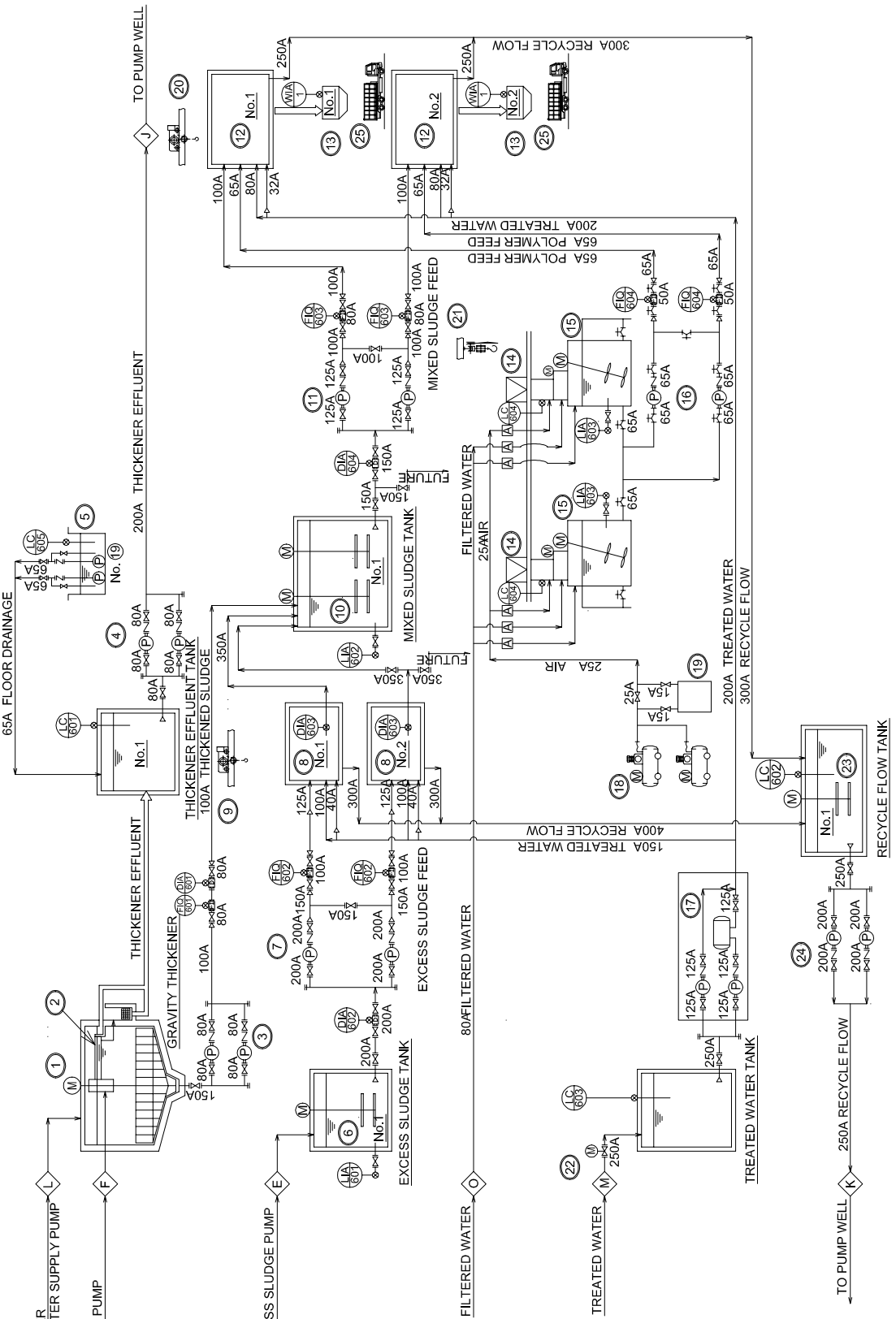


FIG. 8.6 FLOW SHEET OF SLUDGE TREATMENT FACILITY

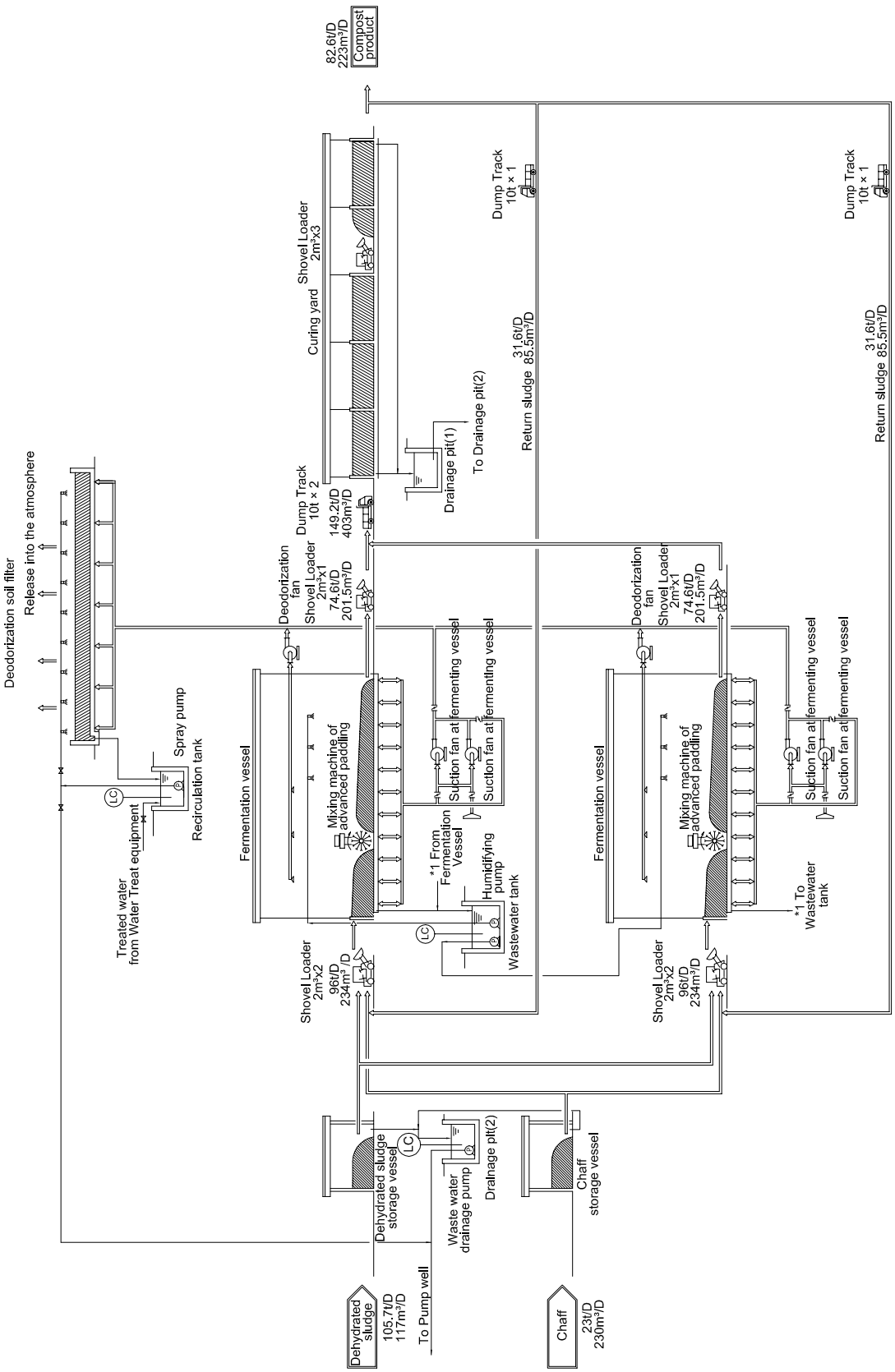


FIG. 8.7 FLOW SHEET OF COMPOST FACILITY

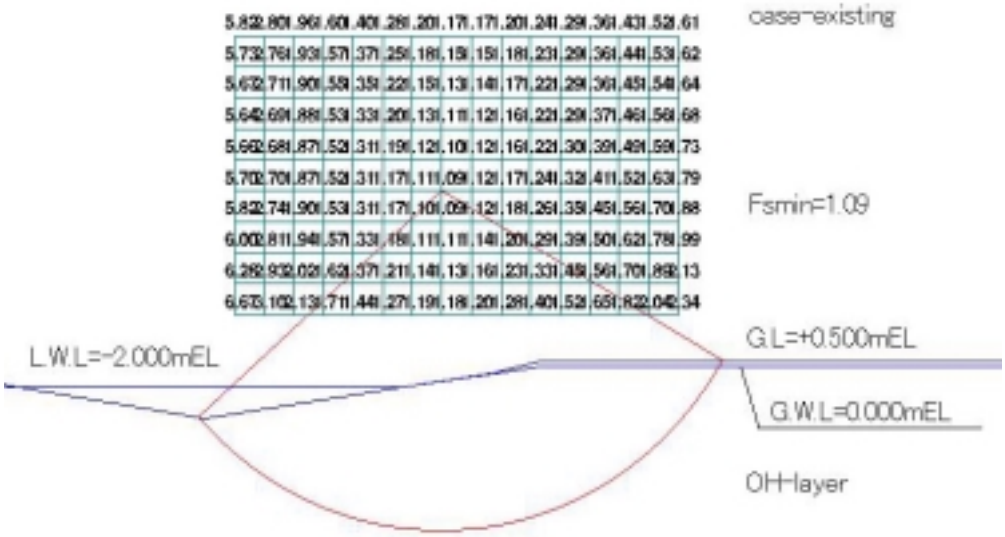


FIG. 8.8 EXISTING SLOPE STABILITY

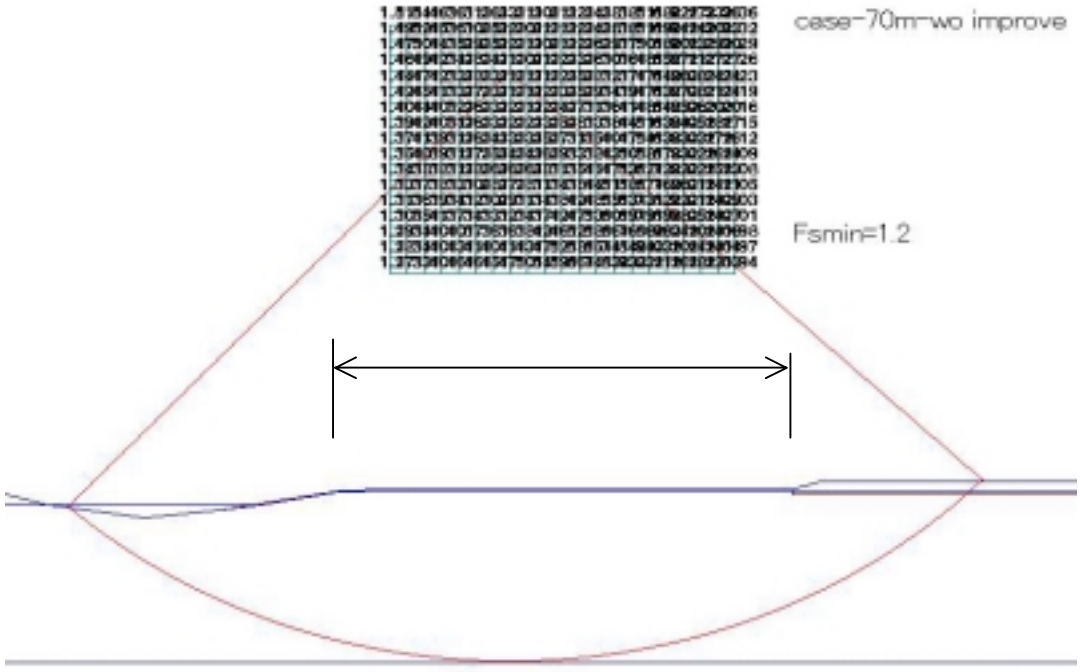


FIG. 8.9 SAFE DISTANCE OF FILLING

*

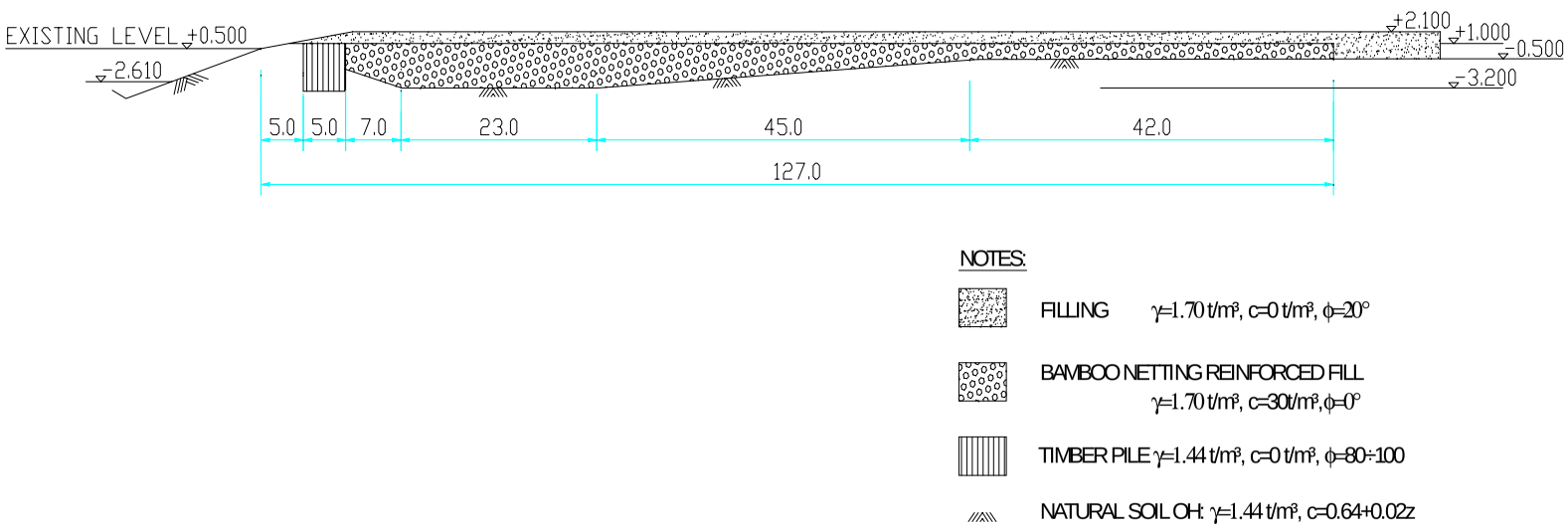


FIG. 8.10 BAMBOO REINFORCED NETTING METHOD

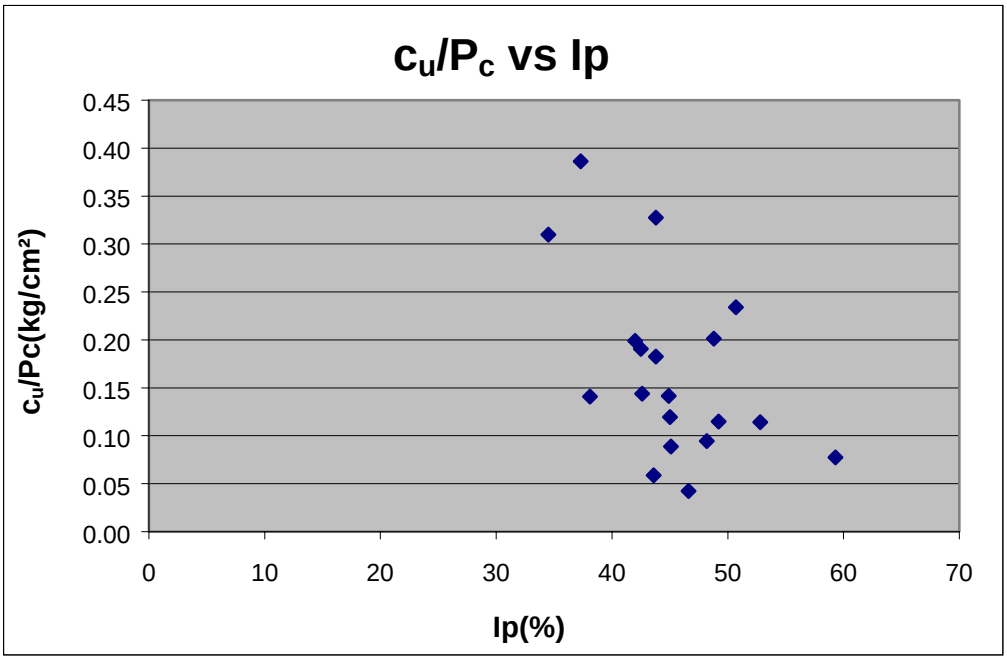


FIG. 8.11 RELATION BETWEEN CU/PC - IP

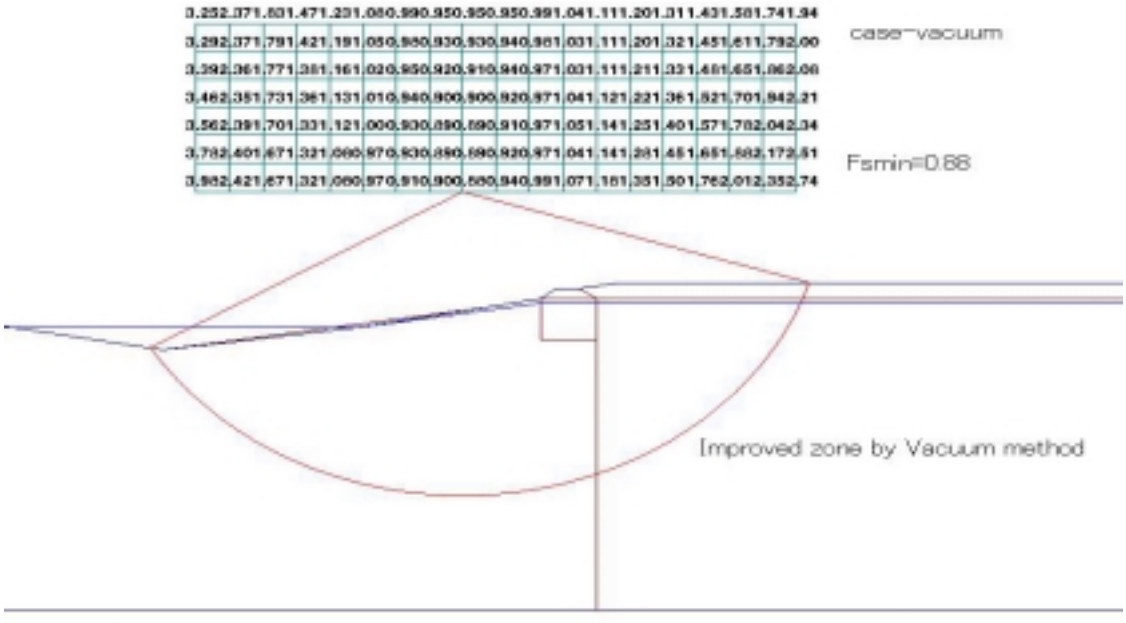


FIG. 8.12 SOIL IMPROVEMENT BY VACUUM PRELOADING METHOD

.

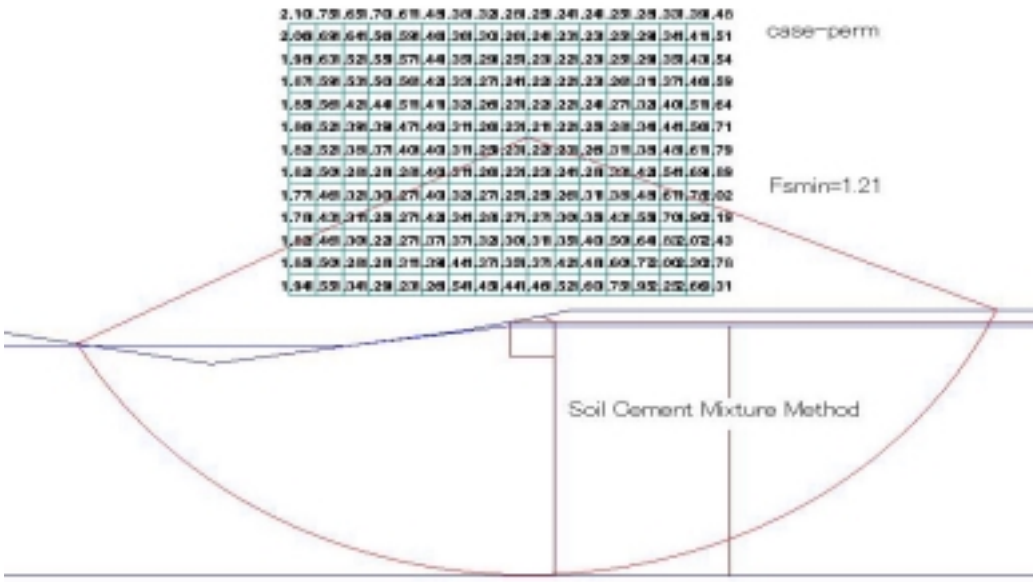
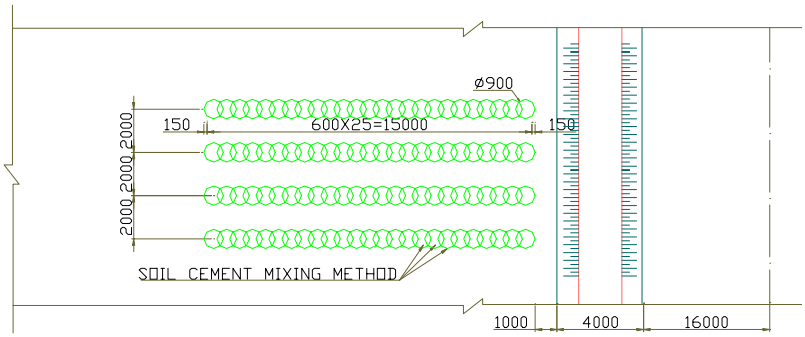


FIG. 8.13 SOIL CEMENT MIXING IMPROVEMENT – OPTION 1



CM COLUMNS LAYOUT

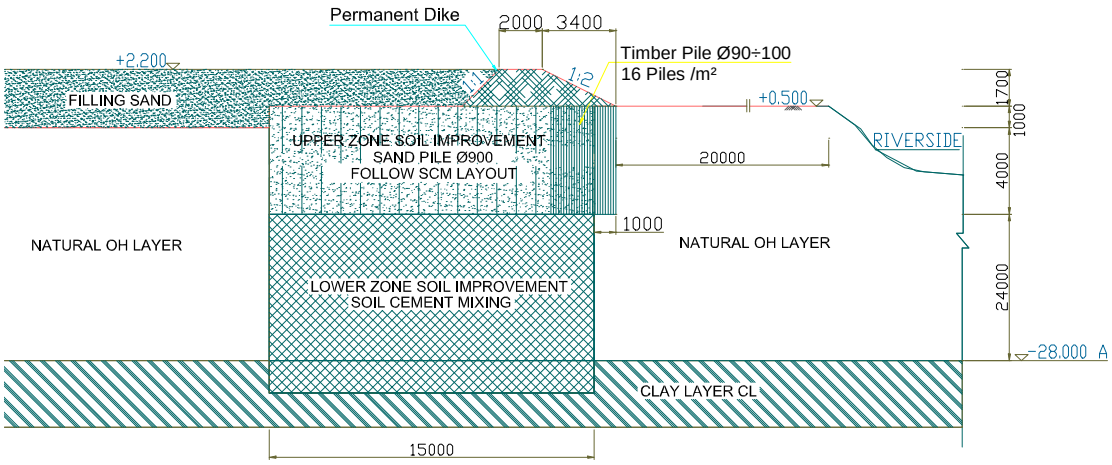
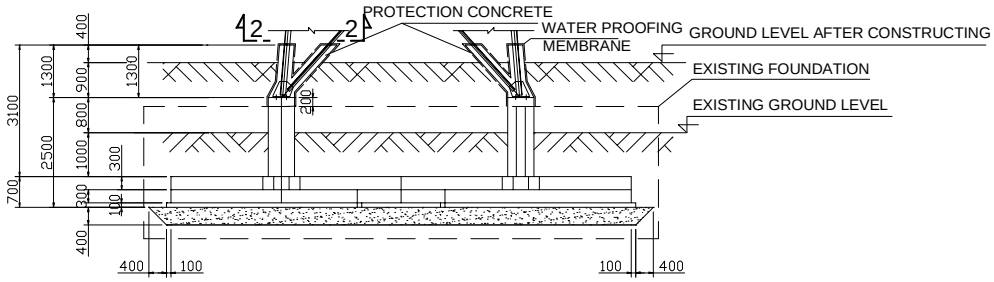
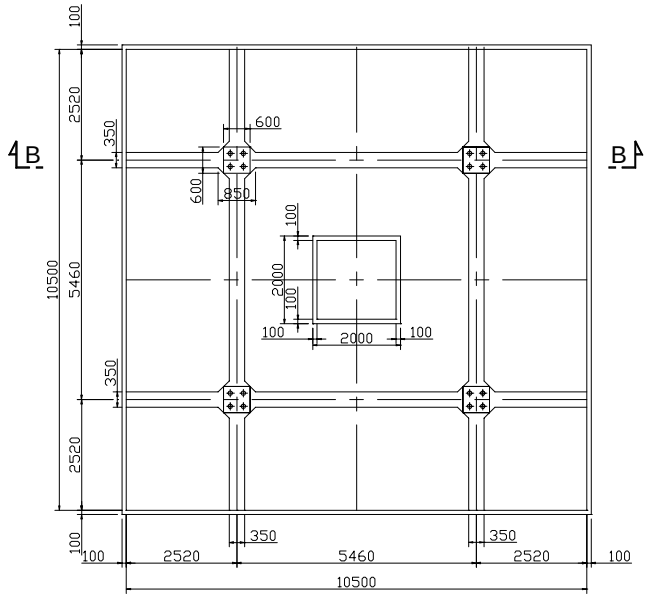


FIG. 8.14 SOIL IMPROVEMENT ALONG CANAL SIDE



SECTION B-B Scale:1/100



LAYOUT OF FOUNDATION No.43 Scale:1/100

FIG. 8.15 EXISTING POWER TOWER PROTECTION

Chapter 9

PROCUREMENT OF SEWER CLEANING EQUIPMENT (PACKAGE C)

CHAPTER 9 PROCUREMENT OF SEWER CLEANING EQUIPMENT (PACKAGE C)

9.1 General

This chapter treats the selection of the required equipment to clean up the existing combined sewer in the Study area. The existing situation of cleaning of the existing sewer is done mainly by manual. To improve the cleaning efficiency of the sewer, mechanical cleaning equipment is proposed.

9.2 Scope of the Project

Scope of the project select the optimum equipments to clean up the sewer and establish their specifications.

The following main equipments are considered;

- Water jet cleaner
- Vacuum cleaner
- Water tanker
- Sludge hauling truck
- Equipment transportation truck

9.3 Design Condition and Criteria

Total length of main sewer is at 78,419 m with a diameter ranging from 500 mm to 2,500mm. Large diameter of sewer more than 1,200mm about 42& of the total length is easily clean up by manual. Remaining sewer length of 45,137m with a diameter ranging of 500mm to 1,100mm is proposed to clean up by mechanical equipments. The length by diameter is shown below;

Sewer diameter (mm)	Length (m)
500	546
600	15,133
800	11,179
900	845
1000	11,243
1100	6,191
1200	20,254
1300	1,255
1400	1,348
1500	6,916
1700	1,596
1800	129
2000	1,185
2500	599
Total length	78,419

Based on the existing sludge deposit condition, sedimentation rate in the pipe is assumed at 5% and once per two (2) years cleaning up is recommended.

9.4 Selection of Sewer Cleaning Equipment

In principle, rather small diameter of sewers are installed in the small road with limited cleaning space. Water jet cleaner and vacuum cleaner should be attached on the truck. Due to the restriction of cleaning condition for large truck, rather smaller diameter of sewers ranging from 500mm to 900mm are proposed to clean up by 4ton truck equipment. And sewer diameter of 1,000mm and 1,100mm should be clean up by water jet cleaner and vacuum truck attached on 8ton truck.

(1) For Sewer Diameter from 500mm to 900mm

1) Equipment

a) 4 tons water jet cleaner 219 L/min
b) 4 tons vacuum cleaner 2,000 L
c) 4 tons water tanker 4,000 L
d) 4 tons sludge hauling dump truck
e) 4 tons truck for equipment transportation

2) Specification of sewer pipe and existing sediment volume

Sewer size(mm)	Sewer length (m)	Sediment volume (m^3)
500	5,46	5.36
600	15,133	213.94
800	11,179	280.96
900	845	26.88
Total volume		527.13

3) Required daily dredging capacity

Dredging time: once per 2 years
Actual working day: 500 days
Dredged capacity per day:

527.13 m3 /500 days = 1.05 m3/day

4) Number of operation cycle for vacuum cleaner

Usually, vacuumed sediment consists of 10% of sludge and 90% of water.

Therefore, in case of 4 tons vacuum cleaner with 2000 liter tank, required number of operation cycle is calculated as follows:

1.05 m3/day / 10% / 2,000 L = 5.27 cycle/day

5) Operation time for vacuum cleaner

Discharge capacity of water jet cleaner is 200 L/min.
Percentage of vacuumed water is estimated to 60%. And allowance of 50% is necessary.

2,000 L / (219 L/min x 60%) x 1.5 = 23 min/cycle

6) Necessary operation time per day

22.83min/cycle x 5.27 cycle/day = 120.35 min/day

7) Necessary nos. of vacuum cleaner

Net working hour per day is estimated to be 5 hours
Accordingly, necessary nos. of vacuum cleaner is calculated as follows;

120.35 min/day / 5 hours / 60 min = 0.40
↓
1 set

8) Necessary nos. of water jet cleaner

No. of water jet cleaner is same as nos. of vacuum cleaner.
1 set

9) Necessary nos. of water tanker

Necessary water for water jet cleaner is calculated as follows;

219 L/min x 300 min = 65.7 m3

From tank capacity of water tanker, operation time of water jet cleaner is ;
4,000 L /219 L/min = 18.2 min

Time required for transportation of water between Site and water supply place is assumed at 30 min.

Accordingly, number of necessary water tanker for each water jet cleaneris estimated as follows;

30 min / 18.26min + 1 set = 2.6
↓
3 sets

10) Necessary nos. of sludge hauling dump truck

Operation time of vacuum cleaner is estimated at 23 min.

Time required for transportation of sludge between Site and dumping place is estimated to be 60 min.
Accordingly, number of necessary dump truck is calculated as follows;

60 min / 23 min + 1 set = 3.6
↓
4 sets

11) Conclusion

Required numbers of sewer cleaning equipment for diameter from 500mm to 900mm are summarized below:

a) 4 tons water jet cleaner 1 set
b) 4 tons vacuum cleaner 1 set
c) 4 tons water tanker 3 sets
d) 4 tons sludge hauling dump truck 4 sets
e) 4 tons truck for equipment transportation 1 set

(2) For sewer diameter of 1,000mm and 1,100mm

1) Equipment

a) 8 tons water jet cleaner 260 L/min
b) 8 tons vacuum cleaner 4,500 L
c) 4 tons water tanker 4,000 L
d) 4 tons sludge hauling dump truck
e) 4 tons truck for equipment transportation

2) Specification of sewer pipe and existing sediment capacity

Sewer size (mm)	Sewer length (m)	Sediment volume (m^3)
1000	11,243	441.51
1100	6,191	294.17
Total Volume		735.69

3) Required daily dredging capacity

Operation time: Once per 2 years
Actual working day: 500 days
Dredged capacity per day:

735.69 m3 /500 days = 1.47 m3/day

4) Number of operation cycle for vacuum cleaner

Usually, vacuumed sediment consists of 10% of sludge and 90% of water.
Therefore, in case of 8 tons vacuum cleaner with 4,500 liter tank, required number of operation cycle is calculated as follows:

1.47 m3/day / 10% / 4,500 L = 3.27 cycle/day

5) Operation time for vacuum cleaner

Discharge capacity of water jet cleaner is 260 L/min.
Percentage of recycled water is estimated to 60%. And allowance of 50% is necessary.

4,500 L / (260 L x 60%) x 1.5 = 43 min/cycle

6) Necessary operation time per day

43 min/cycle x 3.27 cycle/day = 141.48 min/day

7) Necessary nos. of vacuum cleaner

Net working hour per day is estimated to be 5 hours.
Accordingly, necessary nos. of vacuum cleaner is calculated as follows;

141.48 min/day / 5 hours / 60 min = 0.47
↓
1 set

8) Necessary nos. of water jet cleaner

No. of water jet cleaner is same as nos. of vacuum cleaner.

1 set

9) Necessary nos. of water tanker

Necessary water for water jet cleaner is calculated as follows;

260 L/min x 300 min = 78 m3

From tank capacity of water tanker, operation time of water jet cleaner is ;
4,000 L /260 L/min = 15.38 min

Time required for transportation of water between Site and water supply place is assumed at 30 min.
Accordingly, number of necessary water tanker for each water jet cleaner is calculated as follows;

30 min / 15.38 min + 1 set = 2.95
↓
3 sets

10) Necessary nos. of sludge hauling dump truck

Operation time of vacuum cleaner is 43 min

Time required for transportation of sludge between Site and dumping place is estimated to be 60 min.
Accordingly, number of necessary dump truck is calculated as follows;

60 min / 43 min + 1 set = 2.4
↓
3 sets

11) Conclusion

a) 8 tons water jet cleaner 1 set
b) 8 tons vacuum cleaner 1 set
c) 4 tons water tanker 3 sets
d) 4 tons sludge hauling dump truck 3 sets
e) 4 tons truck for equipment transportation 1 set

Chapter 10

CONSULTING SERVICES

CHAPTER 10 CONSULTING SERVICES

10.1 General

Consulting services are required to implement five (5) packages of construction works smoothly. This chapter treats the scope of the consulting services and the required engineer's man/month.

10.2 Scope of Consulting Service

10.2.1 Pre-construction Stage

Stage 1 : Review of the Detailed Design and Finalization of Bidding Documents

The detailed engineering design shall be conducted in the review of the detailed design to cover, among others, the following major works.

- Study of land acquisition and relocation situation with due discussion with agencies and authorities concerned;
- Study of comments raised by the Government agencies and establish design concept to meet the satisfaction of PCHCMC;
- Review of the construction quantity elements and unit prices required for the construction cost estimation.

Based on the result of the above engineering study of the Project, the detailed engineering design shall be performed. The detailed engineering design is to be documented in each contract package and shall include all such investigations, surveys, studies as well as structural design. Cost estimation and finalization of all documents required for bidding and contract shall be included in the detailed engineering design.

The Consultant shall undertake detailed engineering design presenting their findings and recommendations on the following subjects and shall be dealt with separately:

(1) Detailed Investigation

1) Topographic survey
Centerline survey of interceptor sewer, conveyance sewer
Detailed survey of the intermediate pumping station and wastewater treatment plant for the construction works

2) Geological survey
Geological investigation for canal crossing of interceptor sewer and conveyance sewer
Soil investigation for foundation of intermediate sewage pumping station
Soil investigation for foundation design and soil improvement of wastewater

treatment plant

3) Material sources survey
Identification of sources of reclaimed material of wastewater treatment plant site

(2) Preparation/Finalization of Detailed design, Specification and Contract Documents

1) Structural analysis
Temporally works

2) Detailed design of canal improvement
Review of design criteria
Study on temporally works to construct embankment
Study on sludge removal
Preparation of drawings

3) Detailed design of interceptor and conveyance sewers
Review of design criteria
Study on detours during construction
Preparation of drawings

4) Detailed design of intermediate sewage pumping station
Review of design criteria
Study on temporally works
Study on coordination of construction works of vertical shaft for pipe jacking and pumping station
Preparation of drawings

5) Detailed design of wastewater treatment plant
Review of design criteria
Study on soil improvement and protection of land sliding
Study on structure foundation
Study on stepwise construction
Preparation of drawings

6) Cost estimate
Price analysis classified on the basis of labor, materials, equipment, tax, overhead, profit, etc. and Breakdown of foreign and local currency portion

7) Study and proposal of construction execution
Study on construction schedules
Study on the materials and equipment, which will be used for the construction
Study on the construction method

8) Finalization of tender documents
Finalize the pre-qualification documents and tender documents for the whole project, which were prepared by JICA study Team in the detailed design stage

Stage 2 : Assistance in Pre-tendering and Tendering Stage

(1) Assistance in Pre-Tendering Stage (Pre-qualification of Contractors)

1) Assist PMU WEIP if necessary, in the updating of the pre-qualification forms and in the preparation of the pre-qualification advertisement.
2) Assist PMU WEIP to evaluate the pre-qualification documents

(2) Assistance in Tendering Stage

During the tendering stage, the Consultant's work shall include but not necessarily limited to the following tasks:

1) Assist PMU WEIP to conduct pre-bid conference and pre-bid site inspection for interested contractors and furnish any additional information when needed.
2) Assist PMU WEIP to issue the addendum to the bid documents as required.
3) Assist PMU WEIP in the opening of bids, evaluate the bids received, and prepare recommendation for contract awards.
4) Assist PMU WEIP in the contract negotiations with contractors, if necessary.
5) Prepare and compile all documents for the complete construction contract to be submitted to PCHCMC by PMU WEIP for approval.

10.2.2 Construction Supervision Stage

The Consultant shall perform his duties in accordance with acceptable criteria and standards applicable to the construction and shall exercise the power vested in him as "the Engineer". The term "the Engineer" shall mean the Consultant or his authorized representative appointed by PMU WEIP and approved by the JBIC and notified in writing to the Contractors to act as the Engineer for the purpose of completing the Project.

The Consultant shall have full authority to direct, oversee and revise the works as needed and as defined in the General Conditions of Contract. The Consultant shall establish an organization which shall meet PMU WEIP's requirement for the proper execution of the Services.

The Consultant shall provide the following services applying Task Concept:

1) Represent the interest of PMU WEIP vis-à-vis the Contractor in any matters related to the construction contract and the proper execution thereof.

2) Furnish all necessary soil and topographic data for the use of the Contractor to establish the construction method and schedule for each facility.

3) Review and recommend for approval of PMU WEIP the Contractor's working schedule or revisions thereto and any such plans or programs that the Contractor is obliged to furnish for the Engineer's approval. Prepare and submit a disbursement schedule to PMU WEIP.

4) Assess the adequacy of all inputs such as materials, labor and equipment provided by the Contractor and his method of work in relation to the required rate of progress of the work. When required, take appropriate action in order to expedite the work progress. Keep and regularly update a list of the Contractor's equipment (and its condition) to ensure compliance with the list of equipment which the Contractor provided in his bid.

5) Inspect and evaluate all Contractor's installations, housings, shops, warehouses and other accommodations to ensure compliance with the terms and conditions of the contract documents.

6) Examine and make recommendation to PMU WEIP on all claims from the Contractor for time execution, extra compensations, work or expenses or other similar matters.

7) Compute quantities of approved and accepted work and materials. Check, certify and make recommendations to PMU WEIP on the Contractor's monthly and final payment certificates.

8) Prepare and submit reports to PMU WEIP as required on the progress of the work, the Contractor's performance, quality of works, and the financial status and forecasts.

9) Propose and present to PMU WEIP for approval any change in the plans deemed necessary for the completion of the work including information on any effect of changes on the contract amount and the time of completion of the Project, and prepare all necessary change orders including altering plans and specifications and other details. Inform PMU WEIP of any problems or potential problems which may arise in connection with the Contract and make recommendation to PMU WEIP for possible solutions.

10) Station at least one of the Engineer's Representatives at the site at all times when the Contractor is working, to supervise the work and issue instructions as required.

11) Furnish timely assistance and direction to the Contractor on all matters related to

the interpretation of the contract documents, ground survey controls, quality control testing, and any other matters relating to the requirement of the Contract and progress of the Project.

12) Organize supervision of the works with proper allocation of responsibilities to the individual inspectors and supervise their work in order to ensure effective execution of the Services.

13) Prepare Engineering reports including records of inspection, progress and performance of the work.

14) Review all Contractor's drawings, shop drawings, erection drawings, and drawings for temporary works.

15) Verify the Contractor's stakeout surveys for centerline alignment, structure location surveys, and vertical control bench marks.

16) Assure the receipts of, and maintain all warrants for materials accepted and incorporated in the Project, as required under the terms of the contract documents.

17) Assess the adequacy of the soil and materials testing laboratory provided by the Contractor.

18) Monitor and report on the environmental influence during the construction and indicate measures to improve the situation as required.

19) Inspect the safety aspects of the construction and improvement works and construction methods and procedures to ensure that every reasonable measure have been taken to protect life and property.

20) Before the issuance of the Certificate of Completion, the Consultant shall carry out the necessary inspection, specify and supervise any remedial works to be carried out and when completed, recommend PMU WEIP the final inspection and acceptance of the Project.

21) Perform any and all other items of the works not specifically mentioned above but which are necessary and essential to successfully supervise and control the construction activities in accordance with the plans, specifications and terms of contract. The Consultant's responsibility for the works shall continue until the Certificate of Completion has been issued by the State Acceptance Committee.

22) Assist and make recommendations to PCHCMC for setting up an actual maintenance and operation scheme for the Project after completion.

23) Implement environmental monitoring during construction, based on the results of review of environmental impact analysis derived in the detailed design stage by JICA.

(1) Study on Institutional Development

In the detailed design study conducted by JICA 2000, the optimum organization for operation and management of the urban drainage and sewerage system was proposed. The detailed study for operation and management including the sewerage charge collection system will be conducted.

The Study will cover:

1) Preparation of O/M Plan
   (i) Establishment of monitoring system of rain fall, water level and water quality of rivers and canals
   (ii) Preparation of O/M manual of pump drainage and sewerage facilities
   (iii) Preparation of sewer network database

2) Preparation of Financial Plan
   (i) Developing the new sewerage charging system
   (ii) Preparation of financial perspective of the newly establish organization

3) Preparation of Institutional Strengthening Plan
   (i) Sewerage service charge collection system
   (ii) Regulations required for management of the sewerage system
   (iii) Establishment of discharge water quality standard to the sewerage system
   (iv) Preparation of personal training and technology development plan

(2) Transfer of Technology

An effective transfer of knowledge and technology to the counterpart personnel on construction of urban drainage and sewerage facilities will be accomplished by means of both on-the-job training and overseas training. Main fields of overseas training are as follows.

(i) Urban drainage improvement
(ii) Flood prevention by non-structural measures
(iii) Improvement of combined sewer system
(iv) Design of sewer network system and treatment plant
(v) Water quality analysis and management
(vi) Operation and maintenance of pump drainage and sewage treatment plant
(vii) Maintenance of sewer network system
(viii) Construction of sewer system

(ix) Sewerage management

10.3 Work Schedule, Reports and Documents

The Consultant shall commence works in Viet Nam after receiving the Letter of Intent. In accordance with the works requirements, total of 59 calendar months for the completion of the Consulting Services are estimated. In accordance with the volume of works involved in (i) Pre-construction stage and (ii) Construction supervision stage are estimated as follows:

(i) Pre-construction stag : 13 calendar months; and
(ii) Construction supervision Stage : 46 calendar months

The Consultants shall submit the following reports and documents in English and Vietnamese:

(1) Pre-construction Stage

1) Monthly Report
The Consultant shall submit five (5) copies of a Monthly Progress Report briefly and concisely describing all activities and the progress of works including in the Review of the Detailed Design, the problems encountered, remedial measures/solutions and other significant matters which are transpired in the previous month.

2) Interim Report
Within one (1) month after completion of the Review of detailed design stage, a Final Design Report summarizing the Consultant's activities and progress of work, design criteria and design calculations shall be submitted. The number of copies of this report will be agreed before preparation but shall not exceed ten (10).

3) Bill of Quantities and Cost Estimation
Quantity calculations and Bill of Quantities as well as Cost Estimation shall be submitted in ten (10) copies. The detailed cost estimations will be derived from a detailed bill of quantities taken from the detailed design drawings and specifications, and relevant conditions.

- Unit price analysis shall be classified into labor, materials, equipment, tax, tariff and overhead, etc.;
- Breakdown of foreign and local currency portion shall be shown; and
- Financial schedule (annual fund requirement according to the construction schedule) shall be prepared.

4) Tender Documents

In accordance with the implementation schedule agreed by PMU WEIP and the Consultant, Tender Documents shall be submitted for each contract package.

The Consultant shall prepare the following documents to procure a construction firm(s).

- Instruction to Bidders;
- Form of Contract;
- General Condition of Contract;
- Special Provisions of Contract;
- Technical Specifications;
- Bid, Bid Schedule and Schedule of Rates and Prices;
- Drawings; and
- Detailed Work Schedule

5) Pre-qualification Report
The Consultant shall assist the PMU to compile pre-qualification report for each project package.

6) Bid Evaluation Report and Formulation of Contract Documents
The Consultant shall assist the PMU to prepare bid evaluation and contract document for each project package.

(2) Construction Supervision Stage

1) Monthly Report
The Consultant shall submit five (5) copies of a Monthly Progress Report in the accepted form briefly and concisely describing all construction activities and progress for the previous month. Problems encountered and problems anticipated shall be clearly stated, together with steps taken or recommendation for their correction. These reports shall also list the Contractor's equipment and work force.

2) Final Report
Within one (1) month after completion of construction, a Final Design Report summarizing the Consultant's activities and progress of work in relation to construction supervision shall be submitted. The number of copies of this report will be agreed before preparation.

3) Construction Data
Within one (1) month after completion of construction, the Consultant shall provide construction data to PMU WEIP with one (1) full size set of as-built plans on the stable base material plus three (3) printed copies showing final details of the project as completed together with all data, records, field books, etc.,

with a properly indexed catalogue.

4) Final Construction Report
Within three (3) months after completion of construction, a Final Construction Report summarizing the construction activities, total effects of contract changes, claims or disputes and any other substantive matters having an effect on the amount, cost and progress of work shall be submitted.

5) Report on Institutional Development
Within 12 months after commencement of the Engineering service, five (5) copies of Institutional Development Report summarizing operation and maintenance plan, financial plan and institutional strengthening plan shall be submitted.

6) Service Completion Report
A Service Completion Report shall be submitted after completion of all Services stipulated in the contract, giving a summary of the whole period of the Services. This report shall be referred to regarding the issuance of the Statement of Performance for the final payment.

7) Report on the Overseas Training
After finishing the Overseas Training, the Consultant shall submit five (5) copies of report on the Overseas Training describing the training activities.

8) Information to the JBIC
The Consultant shall assist PMU WEIP to compile reports and documents, which will be submitted to the JBIC by PCHCMC. The following reports may be expected.

(i) Progress Report describing status of the Project and Land Acquisition and Resettlement etc
(ii) Tender Documents and Bid Evaluation Reports
(iii) Contract Documents
(iv) Project Completion Report in accordance with the JBIC's form
(v) Post Construction Evaluation Report

10.4 Required Expertise Input

It is estimated that following types and numbers of personnel will be required for the Engineering Services.

10.4.1 Pre-construction Stage

The required experts for pre-construction stage will be consisted of, but not limited to,

the following personnel.

Expatriate	Nos.	Man-month
Project Manager	1	13
Co-Ordinator	1	5
Urban Drainage Engineer	1	8
Sewage Treatment Engineer	1	8
Sewer Line Engineer	1	8
Structure Engineer	1	5
Civil Engineer	1	5
Mechanical Engineer	2	13
Electrical Engineer	1	8
Topographic Survey Engineer	1	1
Soil/Material Engineer	1	5
Cost Estimator	1	5
Document Specialist	1	13
Institutional Expert	1	8
Quantity Engineer	1	3
Total Man-month		108

National Engineer	Nos.	Man-month
Co-Project Manager	1	13
Urban Drainage Engineer	2	16
Sewage Treatment Engineer	1	8
Sewer Line Engineer	2	16
Civil Engineer	2	10
Architect	1	5
Mechanical Engineer	2	16
Electrical Engineer	2	16
Road Engineer	1	5
Bridge Engineer	1	5
Environment Engineer	1	5
Topographic Survey engineer	1	5
Soil/Material Engineer	1	5
Cost Estimator	3	15
Document Specialist	2	31
GIS/Database Processing Specialist	1	5
CAD System Engineer	1	5
Resettlement Specialist	1	5
Resettlement Coordinator	3	9
Social Worker	6	48
Total Man-month		243

The required assignment man/month of both Expatriate and National Engineer are at 108 m/m and 243 m/m respectively.

10.4.2 Construction Supervision Stage

The following Experts and National Engineers will be assigned for the Construction Supervision stage.

Expatriate	Nos.	Man-month
Project Manager	1	46

Resident Engineer (Package A)	1	30
Resident Engineer (Package B)	1	28
Resident Engineer (Package C)	1	36
Resident Engineer (Package D)	1	37
Resident Engineer (Package E)	1	44
Urban Drainage Engineer	1	6
Sewage Treatment Engineer	1	9
Sewer Line Engineer	1	17
Mechanical Engineer	1	9
Electrical Engineer	1	9
Institutional Expert	1	4
Document Specialist	1	18
Quantity Engineer	1	21
Total Man-month		314

National Engineer	Nos.	Man-month
Co-Project Manager	1	46
Assistant Resident Engineer (Package A)	1	30
Assistant Resident Engineer (Package B)	1	28
Assistant Resident Engineer (Package C)	1	36
Assistant Resident Engineer (Package D)	1	37
Assistant Resident Engineer (Package E)	1	44
Urban Drainage Engineer	2	24
Sewage Treatment Engineer	1	9
Sewer Line Engineer	2	78
Architect	1	30
Mechanical Engineer	2	52
Electrical Engineer	2	52
Road Engineer	1	10
Bridge Engineer	1	10
Environmental Engineer	1	16
Soil/Material Engineer	1	23
Institutional Expert	1	12
Economical/Financial Expert	1	12
Quantity Survey Engineer	3	132
CAD System Engineer	1	23
Document Specialist	2	36
Resettlement Specialist	1	1.5
Resettlement Coordinator	3	3
Social Worker	6	24
Assessment Specialist	1	2
Total Man-month		770.5

The total required man/month of both Experts and National engineers are estimated at 314 m/m and 770.5 m/m respectively.

TABLE 10.1 ASSIGNMENT SCHEDULE FOR CONSTRUCTION SERVICES

ASSIGNMENT	Pre-Const. Satge	Const. Satge	Total
Construction Schedule			
Package A			
Package B			
Package C			
Package D			
Package E			
Staffing Schedule			
Expatriate	108	314	422
1 Project Manager	13	46	59
2 Co-ordinater	5	0	5
3 Urban Draianeg Engineer	8	6	14
4 Sewage Treatment engineer	8	9	17
5 Sewer Line Engineer	8	17	25
6 Structural Engineer	5	0	5
7 Civil Engineer	5	0	5
8 Mechanical Engineer I	8	9	17
9 Mechanical Engineer II	5	0	5
10 Electrical Engineer	8	9	17
11 Topographic Survey Engineer	1	0	1
12 Soil/material Engineer	5	0	5
13 Cost Estimator	5	0	5
14 Document Specialist	13	18	31
15 Institutional Expert	8	4	12
16 Quantity Engineer	3	21	24
17 Resident Engineer (Package A)	0	30	30
18 Resident Engineer (Package B)	0	28	28
19 Resident Engineer (Package C)	0	36	36
20 Resident Engineer (Package D)	0	37	37
21 Resident Engineer (Package E)	0	44	44
Local Engineer	243	770.5	1,013.5
1 Co-project Manager	13	46	59
2 Urban Drainage Engineer (I)	8	12	20
3 Urban Drainage Enginner (II)	8	12	20
4 Sewage Treatment Engineer (I)	8	9	17
5 Sewer Line Engineer (I)	8	39	47
6 Sewer Line Engineer (II)	8	39	47
7 Civil Engineer (I)	5	0	5
8 Civil Engineer (II)	5	0	5
9 Architect	5	30	35
10 Mechanical Engineer (I)	8	26	34
11 Mechanical Engineer (II)	8	26	34
12 Electrical Engineer (I)	8	26	34
13 Electrical Engineer (II)	8	26	34
14 Road Engineer	5	10	15
15 Bridge Engineer	5	10	15
16 Environmental Engineer	5	16	21
17 Topographic Survey Engineer	5	0	5
18 Soil/Material Engineer	5	23	28
19 Cost Estimator (I)	5	0	5
20 Cost Estimator (II)	5	0	5
21 Cost Estimator (III)	5	0	5
22 Document Specialist (I)	13	18	31
23 Document Specialist (II)	13	18	31
24 Document Specialist (III)	5	0	5
25 GIS/Database Processing Speci.	5	0	5
26 CAD System Engineer	5	23	28
27 Institutional Expert	0	12	12
28 Economic/Financial Expert	0	12	12
29 Assist. Res. Eng. (Package A)	0	30	30
30 Assist. Res. Eng. (Package B)	0	28	28
31 Assist. Res. Eng. (Package C)	0	36	36
32 Assist. Res. Eng. (Package D)	0	37	37
33 Assist. Res. Eng. (Package E)	0	44	44
34 Quantity Suevry Engineer (I)	0	44	44
35 Quantity Suevry Engineer (II)	0	44	44
36 Quantity Suevry Engineer (III)	0	44	44
37 Resettlemnt Specialist	5	1.5	6.5
38 Resettlemnt Coordinator (I)	3	1	4
39 Resettlemnt Coordinator (II)	3	1	4
40 Resettlemnt Coordinator (III)	3	1	4
41 Social Worker (I-1)	6	3	9
42 Social Worker (I-2)	6	3	9
43 Social Worker (II-1)	6	3	9
44 Social Worker (II-2)	6	3	9
45 Social Worker (III-1)	6	3	9
46 Social Worker (III-2)	6	3	9
47 Social Worker (IV-1)	6	3	9
48 Social Worker (IV-2)	6	3	9
49 Assesment Specialist	0	2	2
	351.0	1,084.5	1,435.5

Note : ━━ 1 M/M ▪▪▪ 0.5 M/M

Chapter 11

ENVIRONMENTAL IMPACT ASSESSMENT

CHAPTER 11 ENVIRONMENTAL IMPACT ASSESSMENT

11.1 Objective

11.1.1 Introduction

Fig. 11.1 shows the steps in environmental impact assessment for this study. The environmental assessment has been carried out in four steps as mentioned below:

Step 1 Initial Environmental Examination (IEE) and Preparation of Terms of Reference (TOR) for Environmental Impact Assessment Survey for the Priority Project, Tau Hu Ben Nghe Doi Te Project,
Step 2 Execution of Environmental Surveys on Tau Hu Ben Nghe Doi Te Project,
Step 3 Environmental Impact Assessment (EIA) on Tau Hu Ben Nghe Doi Te Project,
Step 4 EIA for the Detailed Design Study on HCMC Water Environment Project.

EIA was carried out from August – September 1999 and details are reported in Report "Environmental Impact Assessment" prepared by CENTEMA and approved by MOSTE.

EIA for the Detailed Design Study on HCMC Water Environment Project was carried out from November – December 2000 in order to get the further information in addition to the previous study and details are reported in "Environmental Impact Assessment for the Detailed Design on HCMC Water Environment Improvement Project" Report prepared by CENTEMA and approved by MOSTE. Brief summary of the report is presented in Appendix (EIA) of Data Book Vol 1.

11.1.2 Objectives of the Study

An environmental impact assessment survey shall be carried out in accordance with legal requirements of the Socialist Republic of Viet Nam and Ho Chi Minh City. The objectives of the survey are:

(a) To identify project activities, particularly those which may cause significant environmental impacts;
(b) To describe the status of environmental quality in the project area, particularly those features which may experience impact in the future;
(c) To predict and evaluate the significant environmental impacts whether negative or positive;
(d) To provide the mitigation measures for preventing, minimizing, and eliminating the environmental impacts; and
(e) To recommend countermeasures for environmental management and monitoring.

11.1.3 Project Area

The detailed design study of the phase I consists of:

- Tau Hu - Ben Nghe Canal (Canal improvement of 7.288 km);
- Thanh Da (Pump drainage improvement);
- Ben Me Coc (1) (Pump drainage improvement);
- Ben Me Coc (2)(Drainage improvement);
- Interceptor sewer development (including main and secondary interceptor sewer and diversion chambers);
- Intermediate wastewater-pumping station construction;
- Conveyance sewer construction;
- Wastewater treatment plant construction;

11.1.4 EIA Report Contents

The following contents should be included in the EIA report for the Detailed Design on HCMC Water Environment Improvement Project in the Socialist Republic of Vietnam - Project Phase I.

(1) Introduction;
(2) Project description with major contents of detailed design;
(3) Description on existing environmental condition and socio-economic in the project area;
(4) Assessment of impacts of the projection implementation on environmental quality, socio-economic conditions and living condition of surrounding residential areas:
    - Description of following impact boundary, characteristics and magnitude in comparison with the "no project" scenario:
        - Air environment;
        - Water environment;
        - Soil environment;
        - Ecosystem;
        - Infrastructure;
        - Transportation;
        - Public health;
        - Others impacts.
    - Impact evaluation of project option alternative;
    - Overall evaluation (impact assessment);
(5) Mitigation measures of negative impacts;
(6) Proposing environmental quality monitoring program;
(7) Conclusions and recommendations.

11.2 Law and Regulation

11.2.1 Vietnamese Laws and Requirement for EIA

Environmental concerns and developments of environmental legislation and policies in Vietnam began in the early 1990s. The National Assembly of the Socialist Republic of Vietnam, at its 4th session of the IX Legislature, passed the Environmental Protection Law (EPL) on 27 December 1993. Subsequently, the decree No. 175-CP was issued on the 18th October 1994 to provide guidance for the implementation of the Law on Environmental Protection. Additionally, Circular No.490/1998/TT-BKHCNMT issued on April 29, 1998 by Ministry of Science, Technology and Environment in guidance on making and appraisal of Environmental Impact Assessment Report for investment project. This specifies the requirements of an EIA at different stages of the project development. For the detail design study, it is required to conduct EIA report following the standard as presented in Appendix I.2 of the Government Decree No. 175/CP. The specific chapters include introduction, brief description of the project, environmental status of the project areas, impacts of the project implementation to the environmental and natural resources factors, and recommendations on the alternative for project implementation.

11.2.2 Environmental Standards

All investment projects to be implemented within the territory of Vietnam shall have to apply Vietnamese Environmental Standards issued by the Ministry of Science, Technology and Environment. Those projects to be implemented at provinces where local environmental standards is available, may be adopted, provided that such local standards must be more stringent than those standards issued by MOSTE.
In case that other environmental standards required are not stipulated by the Vietnamese Environmental Standards, the proponents may apply to adopt a set of or any standards developed by other advanced countries provided that the adoption is subject to the permit in writing granted by MOSTE.

11.3 Description of The Project Phase 1

11.3.1 Project Phasing

The priority project will be implemented through two phases, phase I and phase II, as follows:

- Phase I (2000 – 2005): along with the detailed design works of the basic structures relating to this phase to be started firstly, the subjected construction works and the related institution program will be orderly carried out.
- Phase II (2006 – 2010): all the rest of the priority project, the expanded works in the phase II, and prolonged institution programs, will be carried out to achieve completely all components envisaged in the priority project by the end of 2010.

11.3.2 Implementation Program for Phase I Project

The phase I project consisting of detailed design and construction will be implemented within 70 months, from March 2000 to December 2005. The detailed design will be accomplished within 13 months between March 2000 and March 2001. The pre-qualification and tendering of contractor will be done within 6 months from April 2001 to September 2001. The construction works will be conducted within 51 months from October 2001 to December 2005. Implementation program is described in previous chapters or Appendix (EIA) of Data Book Vol 1.

11.4 Significant Environmental Impact

The proposed project will result in improvement of living environment, public health benefits and abatement of pollution to rivers and groundwater. Improper planning and engineering design and the use of inappropriate construction techniques/methods and equipment can be counterproductive and lead to serious negative short term and long term impacts. Potential and significant environmental impacts, both positive and negative are identified and assesses for

a) the pre-construction stage,
b) the construction stage, and
c) operation stage.

Principal impacts are below:

- the social impacts caused by the relocation/resettlement during the pre-construction stage;
- the water and soil contamination caused by the disposal of canal sludge during the construction stage; and
- the water and soil contamination caused by the disposal of sludge from wastewater treatment plant.

Other impacts are shown in Appendix (EIA) of Data Book Vol 1. The impacts related to the relocation/resettlement are described in Appendix (Relocation/Resettlement) of Data Book Vol 1.

11.5 Pollution Prevention and Mitigation Measures

In order to minimize negative impacts and enhance positive impacts to environmental quality, socio-economic condition caused by the activities of the project phase I, mitigation measures applied are shown in Section 5 in Appendix (EIA) of Data Book Vol 1. The mitigation related to the relocation/resettlement is shown in Appendix (Relocation/Resettlement) of Data Book Vol 1.

(1) Mitigation of Impacts Caused by Canal Sludge Dredging

During the dredging, sediments messing and spilling when moving from canal bottom to the barge causes water pollution. Technically, this pollution source can be prevented using the following measures:

- At possible locations (existing street, narrow width of canal), employing excavator, shovel scurf to dredge the supernatant nearby the shore during low tide;
- Employing as tight container as possible to avoid the spilling of water on the street during transportation.

During the dredge, on the way from canal bottom to barge, some sediment is spilled and dissolved into canal water and causes high color and suspended solid concentration. This sediment will be partly settled at downstream of the flow. The settle location depends on the flow direction and velocity. If the velocity and water level is high, sediments will be carried further than the case of low velocity and water level. The spilling and settling of sediments decreases the dredging efficiency. In order to overcome those obstacles, the dredging procedure should be done with considering flow direction and flow rate.

Canal Sludge disposal sites with EIA approved by DOSTE are prepared in Can Gio and Nha Be districts by Waterway Management Office. Canal sludge produced from the project will be disposed into the above disposal sites with following Waterway Management Office's instruction in order to reduce the contamination of water and soil.

(2) Treatment of Sludge from Wastewater Treatment Plant

Sludge generating from wastewater treatment plant (about 106 tons/day, 80%) is proposed to treat by the following two options:

- Sludge generated is composted at wastewater treatment plant before sending to HCMC Waste Disposal Company (HOWADICO) for dumping to municipal landfill (23 tons/day, moisture content of 59%) as regulation.
- Dewatered sludge (moisture content of 80%) may be sent directly to HOWADICO for composting before dumping in municipal landfill if HOWADICO's project will be available.

In all cases, the sludge generating from wastewater treatment plant will be disposed in compost form to the domestic waste disposal sites of HOWADICO.

11.6 Monitoring Program

11.6.1 Monitoring Program during Construction Stage of Phases I

Monitoring shown in Fig. 11.1 shall be conducted during construction and operation

stage under the supervision of the Department of Science, Technology and Environment of Ho Chi Minh City.

(1) Water Quality Monitoring

Periodical Monitoring Program

The whole periodical monitoring program of water quality during construction stage of the project phase I is summarized as follows:

Location	Duration (years)	Frequency (time/year)	Sampling point	Sample per sampling point	Total samples per year	Total sample	Indicator type
Sai Gon River*	2	4	1	4	16	32	A
Tau Hu – Ben Nghe Canal	2	4	6	4	96	192	B
Wastewater treatment plant	4	6	4	4	96	384	B

** Sai Gon River at the junction with Ben Nghe Canal*

Monitoring indicators

- *Type A*: pH, Turbidity, Alkalinity, Acidity, TDS, SS, DO, COD, BOD_5, Cl^-, $N\text{-}NH_3$, $N\text{-}NO_2^-$, $N\text{-}NO_3^-$, N-Org, $P\text{-}PO_4^{3-}$, Phenols, Oil, Cr, Pb, Cd, As, Hg, Fecal Coliform, Total Coliform, Pesticide Cl, Pesticide P.
- *Type B*: pH, Turbidity, Alkalinity, Acidity, TDS, SS, DO, COD, BOD_5, Cl^-, $N\text{-}NH_3$, $N\text{-}NO_2^-$, $N\text{-}NO_3^-$, N-Org, $P\text{-}PO_4^{3-}$.

Sampling methods

- At each cross section, samples will be taken at middle location and at 2 depth levels: 1m from the surface and 1 m from the bottom of the canals. For cross sections of the river, sampling will be done at 1 m and 6 m from the surface.
- Sampling should be taken in the opposite direction of water flow during both low tide and high tide.

Daily Monitoring Program

The whole daily monitoring programs of water quality during construction stage of the project phase I for dredging in Ben-Nghe Canal is presented as follows:

Location	Duration (years)	Frequency (time/year)	Sampling point	Sample per sampling point	Total samples per year	Total sample	Indicator type
Sai Gon River at T-junction with Ben Nghe Canal	2	150	1	8	1,200	2,400	Turbidity

(2) Noise, Vibration and Air Quality Monitoring

Periodical Monitoring Program

The whole periodical monitoring program of noise, vibration, and air quality during construction stage of the project phase I is summarized as follows:

Location	Duration (years)	Frequency (time/year)	Sampling point	Sample per sampling point	Total samples per year	Total sample	Indicator type
Thanh Da pumping station	2.5	4	2	3	24	60	C
Ben Me Coc 1	2.5	4	2	3	24	60	C
Ben Me Coc 2	1.5	4	2	3	24	36	C
Tau Hu – Ben Nghe Canal	2.0	4	5	3	60	120	D
Sewer and Drainage	3.5	6	6	3	108	378	C
Wastewater treatment plant	4.0	4	2	3	24	96	C
Wastewater pumping station	2.5	4	2	3	24	60	C

Monitoring indicators

- *Type C*: Noise, vibration, dust, NO_x, SO_x, and CO.
- *Type D*: Noise, vibration, dust, NO_x, SO_x, CO, NH_3, H_2S, CH_4, and microorganisms.

Sampling methods

- As social activities requirement, sampling time can be divided into the following classes:
  - Rush hours: 6.30 a.m. – 7.30 a.m. and 17.30 a.m. – 18.30 p.m.
  - Official hours: 8.00 a.m. – 12.00 a.m. and 13.30 p.m. – 17.30 p.m.
  - Resting time: 22.00 p.m. – 6.00 a.m.
- Therefore, at each measurement point, noise level, and vibration have to be measured for at least 10 minutes, except for air quality which have to be measured

for at least 1 hour in each case during rush hours, official hours and resting time.

Daily Monitoring Program

Daily monitoring program of impacts from construction activities to air environmental quality will be carried out mainly by observation and traffic control.

11.6.2 Monitoring Program during Operation Stage

(1) Water Quality Monitoring

Monitoring locations, duration, frequency, and number of sample

The whole monitoring program of water quality during operation stage is summarized as follows.

Location	Frequency (time/year)	Sampling point	Sample per sampling point	Total samples per year	Indicator type
Sai Gon River*	4	1	4	16	A
Tau Hu – Ben Nghe Canal	4	6	2	48	B
Wastewater treatment plant	6	4	4	96	B

** Sai Gon River at the junction with Ben Nghe Canal.*

(2) Noise, Vibration and Air Quality Monitoring

Monitoring locations, duration, frequency, and number of sample

The whole monitoring program of noise, vibration and air quality during operation stage are summarized as follows:

Location	Frequency (time/year)	Sampling point	Sample per sampling point	Total samples per year	Indicator type
Thanh Da pumping station*	4	2	3	24	C
Ben Me Coc 1*	4	2	3	24	C
Wastewater pumping station**	4	2	3	24	D
Wastewater treatment plant***	4	2	3	24	D

* from the year 2004
** from the year 2005
*** from the year 2006

11.6.3 Cost Estimate for Monitoring Program

Total cost for monitoring program during construction stage is estimated as follows:

Monitoring type	Survey Type	Cost (million VND)	Cost (USD)
Periodical	***Water Quality***		
	Analysis	297	20,489
	Labor	13	914
	Transportation	27	1,830
	Noise, Vibration, and Air Quality		
	Analysis	270	18,604
	Labor	84	5,280
	Transportation	105	7,216
Daily	***Water Quality***		
	Analysis	30	2,052
	Labor	62	4,283
	Total	**888**	**61,170**

Total cost for monitoring program during operation stage is estimated as follows:

No.	Survey Type	Cost (million VND/year)	Cost (USD/year)
01	***Water Quality***		
	Analysis	91	6,312
	Labor	4	286
	Transportation	8	572
02	***Noise, Vibration, and Air Quality***		
	Analysis	44	3,309
	Labor	10	685
	Transportation	12	857
	Total	**170**	**11,750**

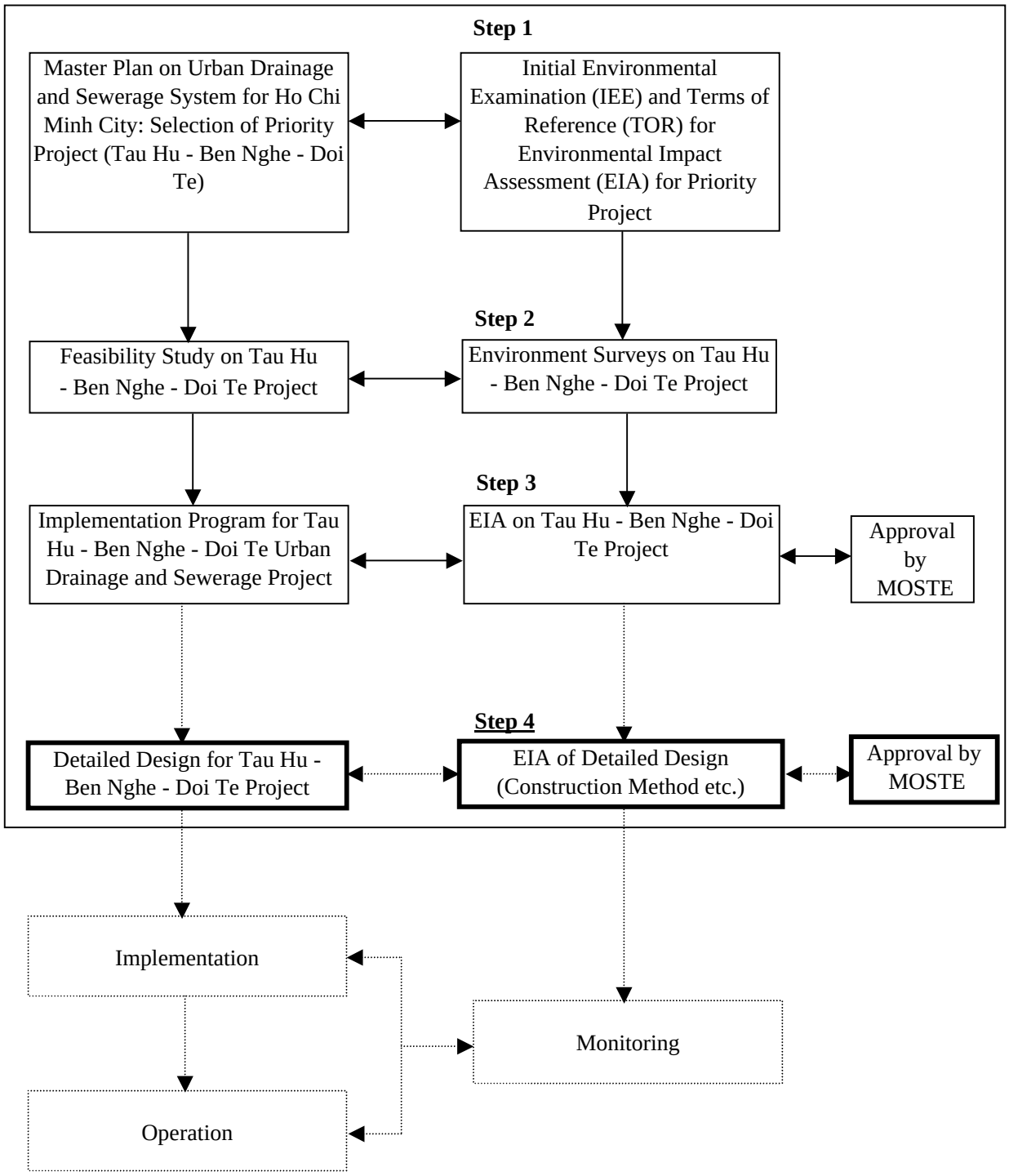


FIG 11.1 STEPS IN ENVIRONMENTAL IMPACT ASSESSMENT

Chapter 12
RELOCATION AND RESETTLEMENT

CHAPTER 12 RELOCATION AND RESETTLEMENT

12.1 Scale of Relocation/Resettlement

12.1.1 Land Area to be Acquired

Area of land to be acquired for the Project is shown in the following table, including one wastewater pumping station, three drainage pumping stations, and one wastewater treatment plant, the southern edge and the northern edge (in ward 16 of district 8) of Ben Nghe – Tau Hu Canal, and the conveyance sewer.

Location	Area (m^2)
Pumping Station at Ben Me Coc 1 (Ward 15 District 8)	20,424
Pumping Station at Ban Me Coc 2 (Ward 15 District 8)	19,746
Pumping Station at Dong Dieu (Ward 4 District 8)	6,000
Pumping Station at Thanh Da (Binh Thanh District)*	1,140
Wastewater Treatment Plant (Binh Chanh District)**	500,000
Road and sewer for Conveyance Sewer**	61,800
Ben Nghe – Tau Hu Canal Renovation (Southern edge: District 4 and District 8, Northern edge: Ward 16 District 8)	126,753
Total	735,863

* including dike (375 m^2), and not including the existing retarding pond

** agricultural land

The area of land to be acquired will be revised by the detailed household survey.

12.1.2 Number of Houses and Households to be Affected

Based on the initial surveyed document of Department of Land and Housing in July 1999 and Topographic Survey conducted by this project team, the number of houses and households to be affected by the Project were surveyed and estimated by PMU in Nov. 2000. The result of the survey is summarized in the following table. These numbers will be revised after the detailed household survey.

Location	Affected Households	Houses to be Removed/relocated
Ben Me Coc (1) Pumping Station	29	29
Ben Me Coc (2) Pumping Station	32	31
Wastewater Pumping Station at Dong Dieu	48	47
Thanh Da Pumping Station	98	96
Conveyance Route (Binh Chanh District)	20	0
Conveyance Route (District 8)	10	0
Wastewater Treatment Station	60	60
Ben Nghe – Tau Hu Canal Renovation		
District 4	850	850
District 8	1,406	1,298
Total	2,553	2,411

12.2 Legal Framework

The national and Ho Chi Minh City's policy for the relocation/resettlement is shown in various regulations. Details are shown in Section 3 of Appendix (Relocation/Resettlement) in Data Book Vol 1.

12.2.1 National Level

- Land Law (Oct., 1993)
- Civil Code (July, 1996)
- Decree No.22/1998/ND-CP (Apr. 24, 1998)
- Circular No.145/1998/TT-BTC (Nov. 4, 1998) of Finance Ministry
- Decree No.87/CP (Aug. 17, 1994) of the Government regulating land price frame.
- Decree No.38/2000/ND-CP (Aug. 23, 2000) of the Government on relocation and resettlement.

12.2.2 City Level

- Decision No. 05/QD-UB-QLDT (Jan. 4, 1995) of HCMC People's Committee issuing land price framework.
- Decision No. 5184/QD-UB-KT (Sep. 11, 1996) of HCMC People's Committee compensating the houses (structures) on standard price of houses to calculate the registration fee multiplying 1.2 coefficient.
- Decision No. 5787/QD-UB-QLDT (Aug. 8, 1998) on managing the apartments to relocate people living on canal.
- Draft regulation on compensation, damage and resettlement assists for HCMC Water Environment Improvement Project, Tau Hu, Ben Nghe – Doi Te basin sent to Departments to get comments and submitted to HCMC People's Committee to get its approval. This draft regulation is based on Draft Proposal of East – West Highway Project and Drainage System Improvement Project – Hang Bang Basin funded by ADB which is a small part of Tau Hu, Ben Nghe – Doi, Te basin.

12.3 Institutional Framework

Following institutions are related to the compensation, relocation and resettlement (Details are shown in Section 4 of Appendix (Relocation/Resettlement) in Data Book Vol 1):

- HCMC People's Committee
- Compensation and Resettlement Council at City Level
- District PC
- Compensation and Resettlement Council at District Level
- Project Management Unit (PMU)
- Specialized Teams of Compensation and Resettlement Council at District Level

and PMU
- Department of Land & Housing
- Others

12.4 Procedure of Relocation and Resettlement

Based on the governmental decree on compensation for lost property in the case where the state recovers land for use in national defense, security, national interest, and public interest in Decree No.22/1998/NC-CP and the HCMC PC's policy and instruction in Document No.2553/1999/CV-UB-QLDT, the following steps are proceeded by relevant agencies.

- Flow of relocation and resettlement procedure is shown in Fig. 12.1.
- Schedule for the land acquisition, compensation, and resettlement is shown in Fig 12.2, 12.3, 12.4, 12.5 and 12.6.

12.5 Compensation

Compensation will be provided in cash, by land or by house according to Decree No. 22. Scope of compensation is;

- Loss of the whole area of confiscated lands stated in Decree No.22
- Loss of properties on confiscated land, including infrastructure
- Subsidizing people and factories that have to be relocated
- Paying fees to confiscated land-owners who have to change their jobs
- Paying the cost of site clearing, moving and allowance

Categories for compensation and unit rates will be shown in a regulation on Compensation and Resettlement in construction investment project items of HCMC Water Environment Improvement Project to be issued by HCMC PC as shown in Data Book (Relocation/Resettlement).

Based on draft regulation on compensation and resettlement in construction investment project items of HCMC Water Environment Improvement Project, the PMU of this project prepared the land acquisition and compensation costs by items with unit costs prescribed by both central and HCMC governments. The results are shown in Table 12.1. After the detailed household survey, the compensation costs will be revised.

12.6 Resettlement Sites Development

Resettlement Sites Developments must be finished before the relocation starts. Based on the HCMC Housing Development Program, HCMC Water Environment Improvement Project proposes to resettle the relocated people into 10 sites in Districts 4, 8, Binh Thanh, 7, Binh Chanh. Locations of the resettlement sites are shown in Table 12.2.

Based on the results of the questionnaire to the housing companies, cost for the resettlement sites and its breakdown for the technical and social infrastructure and housing construction are shown in Table 12.3.

The following procedure is done:

1) Investigate the current situation of the land lot, estimate the scale of construction and agree on location;
2) Preliminary negotiation with households in the proposed area on compensation and land acquisition is taken;
3) Prepare the project to submit to relevant authority for approval, depending on the size of the project;
4) After getting the approval, the compensation and land acquisition is proceeded in accordance with current regulations;
5) Estimate the costs of construction;
6) Organize the bid of construction package;
7) Land leveling and construction of packages; and
8) After the completion of housing construction, the developer coordinates with district PCs, where relocatees come from, to transfer houses.

The present condition of some projects for resettlement sites development is as follows:

- District 4: due to limitation of land fund (high population density is about 54,000 person/km^2). There are 3 apartment sites for 415 households. All apartments are nearly completed and arranged some households lived along canal Ben Nghe from Ong Lanh to Calmette Bridge). Meanwhile, district 4 has 13 ha at Phu My Ward, District 7 (this project has got approval and completed compensation), this is done by exchange land lots available infrastructure.

- Binh Thanh District: there is complete apartment A9 Dinh Bo Linh for resettlement. This apartment has approval for construction of 186 units, in which 80 units were constructed in advance and allocated relocatees in district 1. Remaining about 106 units shall be done at the end of this year to resettle relocatees from Thanh Da area of Ward 27, Binh Thanh District.

- District 8 balances housing and land fund to resettle fully as request. District 8 has construction plan of 5 apartment sites:
  - Binh Hung apartment sites constructed 80 units and 60 units shall be done in year 2000.
  - Bui Minh Truc apartment sites at Ward 6 has been constructing 120 units and will be finished at December/2001.
  - Bui Minh Truc apartment sites at Ward 5 having 544 units is opening bid of construction and completion at year 2002.
  - Ba Dinh Apartment sites being warehouse of 2 ha for resettlement site shall be constructed 350 units and completed at the middle year 2002.

- Resident area at Ward 16 is only constructed infrastructure and exchanged. This project shall be completed at year 2001

- Binh Chanh District: Location has not been determined.

12.7 Mitigation Measures

12.7.1 Public Involvement

(1) Public Hearing Meeting

The public hearing is organized by each district under supervision of the Department of Land and Housing to collect opinions and wishes from relocatees during preparation of detailed compensation plan.

(2) Public Consultation

In general, households to be relocated are not familiar with the compensation and resettlement issues such as purchase of new house in resettlement site, job opportunity after resettlement, and education for children in the resettlement site.

- Therefore, the public consultation service during and after the resettlement will be coordinated by relevant district under supervision of Land and Housing Department.
- Each affected household can express its ideas or opinions on questionnaire which is collected by district People's Committee and is reported to Land and Housing Department.

(3) Grievance Procedure

Opinions and grievance raised by affected households will be timely collected and carefully incorporated into the compensation and resettlement process.

- Opinions and grievances raised by affected households should be resolved directly by district People's Committee under the supervision of the Compensation and Resettlement Council at City Level.
- Mechanisms and manuals for frequent dispute and grievance resolution will be established based on the recent experiences of resettlement in HCMC, and then staff in charge of compensation and resettlement procedures will be trained in advance.

12.7.2 Income Restoration

Importance of income restoration for the relocatees and affected people has recently become an international principle on the resettlement for both intentional donors and personnel in charge of the resettlement issues in developing countries as well as the

requirement described in the JBIC Environmental Guidelines.

- The income restoration means that relocatees can continue previous job or find a new regular job to keep their income levels at least equivalent to their pre-project income levels. And if possible, it is desirable that income levels for the relocatees should be improved at the resettlement through the Project. In addition the income restoration after resettlement can be an important incentive for relocatees to settle down at the resettlement sites.
- The income restoration is not prescribed in the present laws and regulations relevant to the resettlement though equivalent cost of living for six months is subsidized based on the Decree 22/1998/ND-CP.
- To minimize the inconvenience for the relocatees, the land-use-right tax and register fees are exempted in case they purchase houses in the resettlement sites.

Department of Labor, Invalid and Social Affairs, and District People's Committee will be involved in the Compensation and Resettlement Council to implement the following measures:

- Provision of Chance for Continuation of Previous Business and Job
- Provision of New Employment Opportunity
- Introduction of Business Loan
- Poor Alleviation Fund
- Early Provision of Alternative Land for Agriculture

12.7.3 Supervision and Monitoring

HCMC recognizes the importance of the monitoring activity for the resettlement based on the recent experiences of resettlement programs.

- As soon as the procedures for compensation and resettlement start, the Compensation and Resettlement Council at City Level, headed by Vice Chairman of the HCMC People's Committee, supervises the progress of implementation with support of Department of Planning and Investment and Department of Land and Housing.
- Department of Land and Housing has responsibility to collect all the information related to relocation and resettlement, and reports to the Compensation and Resettlement Council at City Level.
- When any problems are found or reported, the PMU gives instructions to the district offices based on the relevant regulations and experiences of the recent resettlement programs.
- After the relocatees move into the resettlement sites, monitoring activity will be implemented periodically by relevant district offices under supervision of the Land and Housing Department to check mainly following items:
  - Settle down at the resettlement sites

- Relocation and rebuilt of facilities
- Relationship in community
- Any grievance and problem

- Monitoring activities are proposed to start from commencement of move to the resettlement site.
- After the completion of the Project, relocatees who are employed in the Project should be monitored whether they find and engage in new job for 3 months.
- Duration of monitoring is supposed to be around 3 years in total to check the above monitoring items and any unexpected things in the resettlement sites.
- The PMU will report JBIC the situation of land acquisition and resettlement for the Project and progress of the Resettlement Action Plan periodically.

12.7.4 Participation of Social Workers

(1) Introduction

Two basic principles for relocation/resettlement should be followed:

(a) after relocation life for the affected people should be the same or better than before; and
(b) there must be discussions with the people, since they are the ones affected by these projects. As a general rule, communities and poor people should be involved in urban planning.

It is possible that a lot of difficulties and problems for the affected people may occur during relocation/resettlement process as shown below:

- Insufficient compensation for some affected people

  The families who live on the land that is earmarked for clearance are mostly very poor. When they are forced to leave their homes, those who have legal ownership of their houses are given compensation, which may or may not be enough to enable them to move into a reasonable house or apartment in a reasonable locality. Those who are tenants and those who brought or put up houses unofficially, receive no compensation at all. That was the risk they took, when they settled in the area, and so they have no ground complaint.

- Insufficient information for some affected people

  Often communities slated for urban development and resettlement are not fully informed about the plans. There should be a limit to the areas slated for urban development and conditions and plans should be made clear to everybody. In some cases, there is insufficient information on supporting program.

- Unstable life in the new resettlement site for some affected people

  It has been reported that following relocation few people continue to live in the new apartment because they are too poor to stay there and must relocate again in order to earn a living. Employment is therefore more important than housing. The poor also often sell their new apartment and return to the slums in order to maintain vital social ties. Relocation should not be driven only by an environmental agenda, but should give equal consideration to poor people's economic and social concerns. There is a need for more research on relocation programs and their impact on poor people in Ho Chi Minh City.

Social workers will be involved during relocation and resettlement process in order to solve above difficulties.

(2) Roles of Social Workers

Social workers participate in several steps during relocation and resettlement. These steps are as follows:

1) Planning

The plan of social workers' involvement is made by high level experts in social field of Ho Chi Minh City (planner) in order to mitigate negative impact of resettlement. The responsibility of the planner is to review plan of detailed household survey, and plan of assessing the problems during appropriate hearing of opinions of project-affected-people in order to implement public involvement by social workers.

2) Implementation

- Announcement of relocation (at detailed household survey)
  - Unofficial announcement on relocation
  - Monitor and assess results induced from unofficial announcement on method of compensation and resettlement sites and schedule.
  - Assist the Compensation, Relocation, and Resettlement Councils at District Level in informing affected people on relevant laws and regulations concerning land acquisition, compensation and resettlement.

- Participatory Rapid Assessment (PRA)

- Updates of Relocation/Resettlement Schedule
  Before land acquisition and relocation/resettlement, social workers shall assist the Compensation, Relocation and Resettlement Council at District Level on the updates of land acquisition and relocation/resettlement schedule.
- Announcement of Land Acquisition
  The social workers shall participate in meeting held by the Compensation,

Relocation and Resettlement Council at Ward Level in order to inform the relocatees on land acquisition, compensation, relocation and resettlement. The social workers shall make the relocatees understand the legal procedures related to the decision on resettlement and land acquisition.

- Public Hearing Meeting
  The social workers shall participate in public hearing meeting in order to collect opinions and wishes from relocatees during preparation of detailed compensation plan and resettlement plan.

- Negotiation of Compensation and Resettlement
  In order to solve problems in negotiation for compensation and resettlement between Compensation, Relocation and Resettlement Council and the project-affected people, the social workers shall input information and counsel them on the justification related to the compensation and resettlement.

- Public Consultation
  Social workers collect opinions from the project-affected people in Public Hearing Meeting, Negotiation, Detailed Household Survey, Participatory Rapid Assessment, Grievance Procedure and so on before, during, and after the resettlement.

- Grievance Procedure
  Social workers shall participate in the grievance procedure to collect opinions and grievance raised by affected households in order to carefully incorporate them into the compensation and resettlement process.

- Community Development
  Based on the results of the PRA and Detailed Survey by the PMU, community development is implemented to ensure the sustainability of resettlement work by educating the affected people the benefits of improving living environment, concept of settle-down, self-management in the new resettlement living quarters.

- Assessment on Resettlement Procedure
  The social workers shall assess resettlement works and living conditions of the new dwellers in the resettlement sites.

3) Recommendation
   The social workers shall submit recommendation on compensation, relocation and resettlement process to PMU and HCMC PC.

TABLE 12.1 COMPENSATION AND RESETTLEMENT COST Unit: million VND

No	Category	Unit	Number	Unit Price	District 4	District 8	B.T.	B.C.	Total
1	House								
	2nd	m2	5,100	1.440	7,344				7,344
			8,430	1.440		12,139			12,139
	3rd	m2	17,000	0.720	12,240				12,240
			28,100	0.720		20,232			20,232
			1920	0.720			1,382		1,382
			1200	0.720				864	864
	4th	m2	42,500	0.420	17,850				17,850
			70,250	0.420		29,505			29,505
			4,608	0.420			1,935		1,935
			2,880	0.420				1,210	1,210
2	Land	m2	51,000	2.600	132,600				132,600
			110,161	2.300		253,370			253,370
			14,338	0.110		1,577			1,577
			1,140	1.700			1,938		1,938
			552,300	0.080				44,184	44,184
3	Electric	No.	425	1.500	638				638
	meter		703	1.500		1,055			1,055
			48	1.500			72		72
			30	1.500				45	45
4	Water	No.	340	2.000	680				680
	meter		562	2.000		1,124			1,124
			19	2.000			38		38
			12	2.000				24	24
5	Telephone	No.	340	1.800	612				612
			422	1.800		760			760
			19	1.800			34		34
6	Relocation	family	850	2.000	1,700				1,700
	allowance		1,405	2.000		2,810			2,810
			96	2.000			192		192
			60	2.000				120	120
	Stabilization	person	4,250	1.000	4,250				4,250
	allowance		7,025	1.000		7,025			7,025
			480	1.000			480		480
			300	1.000				300	300
	Loss of	family	425	8.000	3,400				3,400
	business		703	8.000		5,624			5,624
	Crops and		14,338	0.028		401			401
	trees		552,300	0.025				13,808	13,808
	Reward for	family	850	5.000	4,250				4,250
	family who		1405	5.000		7,025			7,025
	move in time		96	5.000			480		480
			60	5.000				300	300
	Sub-total (I)				185,564	342,647	6,552	60,854	595,617
	Spare cost for house 5% of sub-total (I)				9,278	17,132	328	3,043	29,781
	Cost for removing underground work				1,763	2,914	199	124	5,000
	Sub-total (II)				196,605	362,694	7,079	64,021	630,398
	Service cost for compensation and clearance 2% of Sub-total (II)				3,932	7,254	142	1,280	12,608
	Total				200,537	369,947	7,220	65,301	643,006

TABLE 12.2 HOUSING PROJECTS FOR RELOCATION AND RESETTLEMENT

	Projects	Investors	Area (m2)	Apartments	Exchanged House Foundation
	District 4		**138,382**	**625**	**425**
1	C3 Building, ward 6 District 4	Housing Management & Development of District 4	1,629	105	0
2	B4 and B5 Buildings, Ward 3, district 4	Housing Management & Development of District 4	3,753	310	0
3	Phu My residential Place, District 7	Housing Management & Development of District 4	133,000	210	425
	Binh Chanh District		**50,000**	**0**	**60**
4	Binh Hung Commune Residential	Binh Chanh District	50,000	0	60
	District 8		**183,029**	**1,354**	**300**
5	Binh Dang Residential Place, ward 6, district 8	Housing Developmental & Commercial Company	4,968	140	0
6	Bui Minh Truc Residential Place, ward 5, district 8	Housing Development Service Company/ Dist.8	66,713	544	0
7	Bui Minh Truc Residential Place, ward 6, district 8	Tan Binh Dong Company	9,348	120	0
8	Residential Place, Ward 16, District 8	Housing Development Service Company/ Dist.8	100,000	200	300
9	481 Ben Ba Dinh St., Ward 6, district 8/the storage	General Company of River-Ways	20,000	350	0
	Binh Thanh District		**2,476**	**106**	**0**
10	A9 Building, Dinh Bo Linh	Housing Development Company of Binh Thanh District	2,476	106	0

TABLE 12.3 COST FOR RESETTLEMENT SITES DEVELOPMENT

(Unit: Million VND)

Proposed Resettlement Site	Land Acquisition And Compensation	Technical Infrastructure	Social Infrastructure	Housing Construction	Others	Total
District 4						
C3 Building, ward 6 District 4	2,700	2,392	1,500	9,377	1,027	16,996
B4 and B5 Buildings, Ward 3, district 4	1,488	2,000	1,000	23,923	2,540	30,951
Phu My residential Place, District 7	10,702	40,057	0	13,272	4,315	68,346
Binh Chanh District						
Binh Hung Commune Residential	3,390	11,971	0	0	1,037	16,398
District 8						
Binh Dang Residential Place, ward 6, district 8	1,190	1,700	0	13,332	558	16,780
Bui Minh Truc Residential Place, ward 5, district 8	4,299	8,115	2,292	54,076	5,745	74,527
Bui Minh Truc Residential Place, ward 6, district 8	692	1,300	369	8,706	925	12,000
Residential Place, Ward 16, District 8	2,807	5,299	1,496	38,446	652	48,700
481 Ben Ba Dinh St., Ward 6, district 8/the storage	5,560	4,925	3,090	19,316	2,109	35,000
Binh Thanh District						
A9 Building, Dinh Bo Linh	1,100	1,120	0	8,920	500	11,640
Total	33,928	78,879	9,747	189,356	19,408	331,338

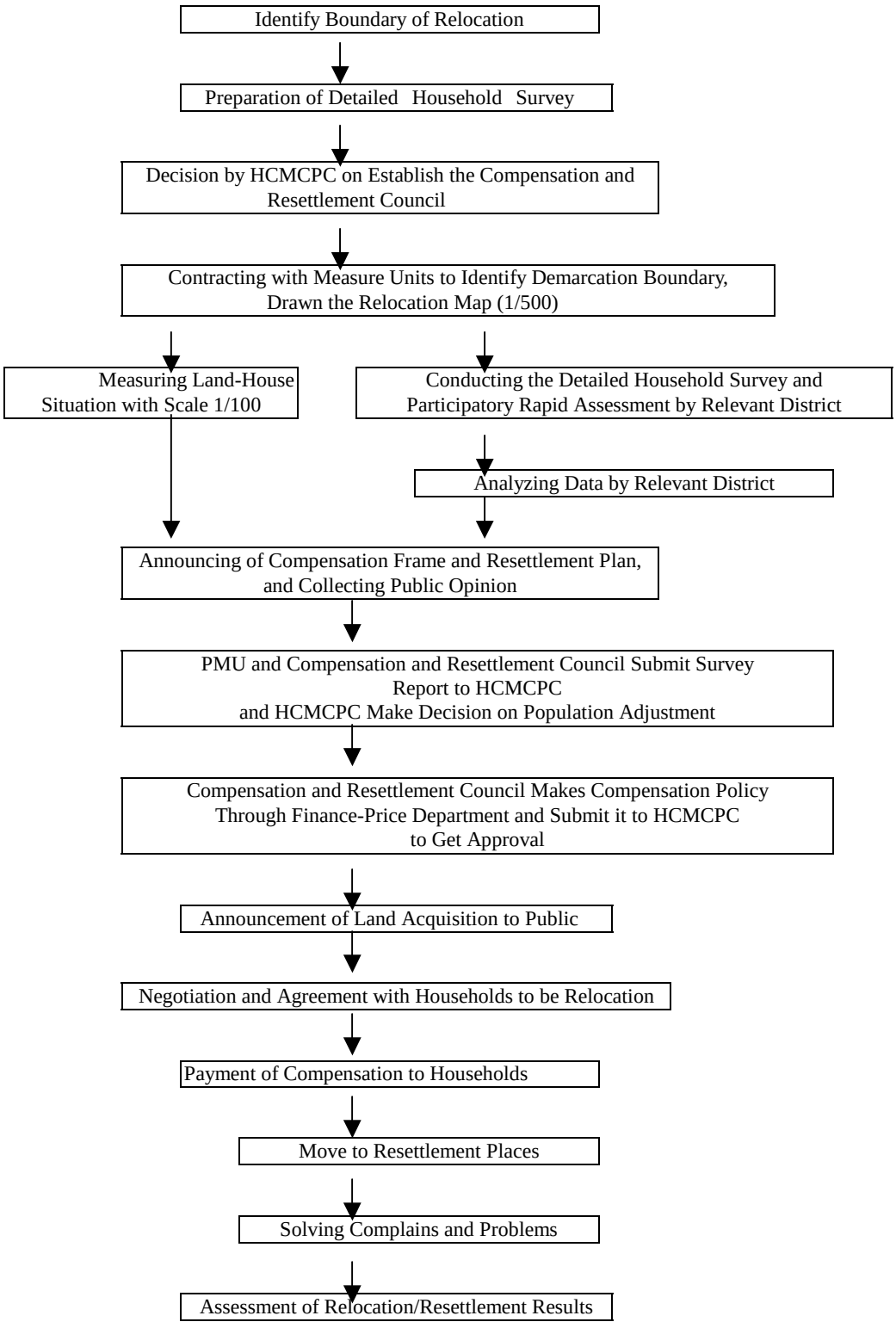


FIG. 12.1 PROCEDURE PROCESS OF RELOCATION/RESETTLEMENT

FIG. 12.2 RELOCATION/RESETTLEMENT SCHEDULE FOR TAU HU - BEN NGHE CANAL IMPROVEMENT

Activity \ Year and month	1999			2000											2001												2002												2003				
	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Relocation and Resettlement Procedure																																												
1. Planning																																												
2. Preparation of detailed survey																																												
3. Conducting the detailed survey																																												
4. Data analysis																																												
5. Compensation and Relocation Council submit to HCMC PC report of resident area																																												
6. HCMC PC issues a decision of adjustment of resident area																																												
7. Preparation of land acquisition map																																												
8. Estimation of compensation cost																																												
9. Application of landuse right																																												
10. Announcement of land acquisition																																												
11. Negociation and signing on relocation schedule																																												
12. Payment to house owners																																												
13. Solving the existing problems																																												
14. Monitoring and evaluation of the resettlement																																												

FIG. 12.3 RELOCATION/RESETTLEMENT SCHEDULE FOR DRAINAGE PUMPING STATIONS

Activity \ Year and month	1999			2000											2001												2002												2003				
	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Relocation and Resettlement Procedure																																												
1. Planning																																												
2. Preparation of detailed survey																																												
3. Conducting the detailed survey																																												
4. Data analysis																																												
5. Compensation and Relocation Council submit to HCMC PC report of resident area																																												
6. HCMC PC issues a decision of adjustment of resident area																																												
7. Preparation of land acquisition map																																												
8. Estimation of compensation cost																																												
9. Application of landuse right																																												
10. Announcement of land acquisition																																												
11. Negociation and signing on relocation schedule																																												
12. Payment to house owners																																												
13. Solving the existing problems																																												
14. Monitoring and evaluation of the resettlement																																												

FIG. 12.4 RELOCATION/RESETTLEMENT SCHEDULE FOR INTERCEPTOR AND INTERMEDIATE PUMPING STATION

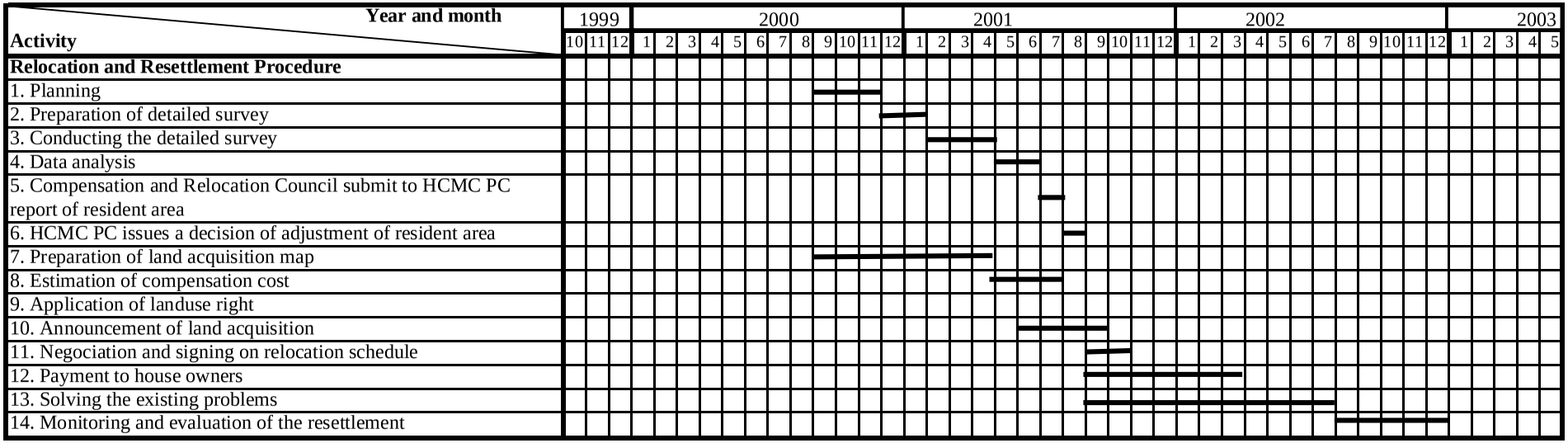


FIG. 12.5 RELOCATION/RESETTLEMENT SCHEDULE FOR CONVEYANCE SEWER

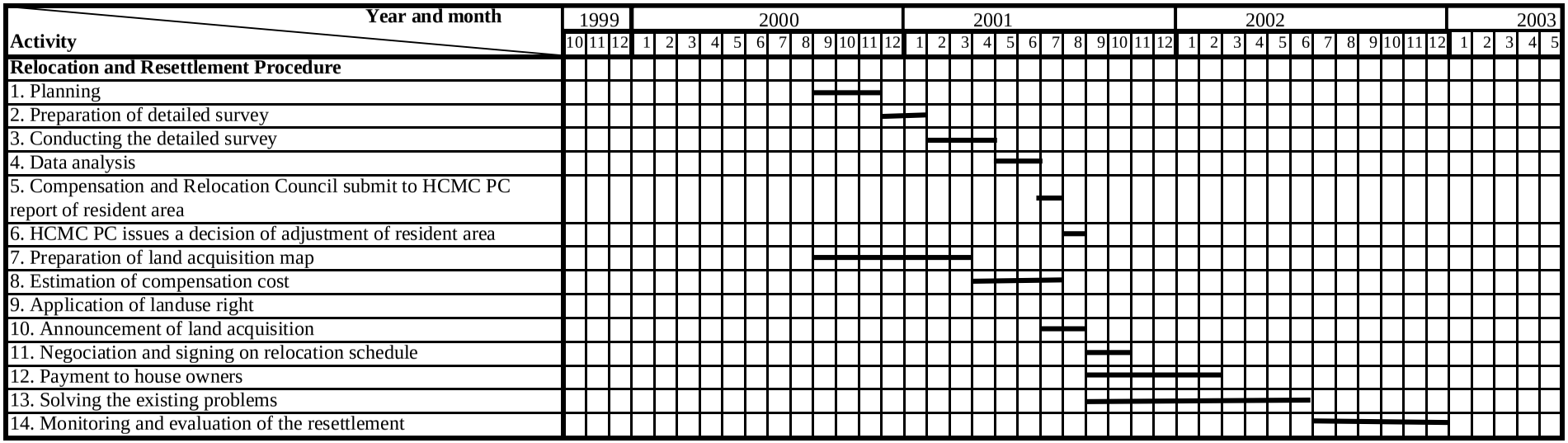
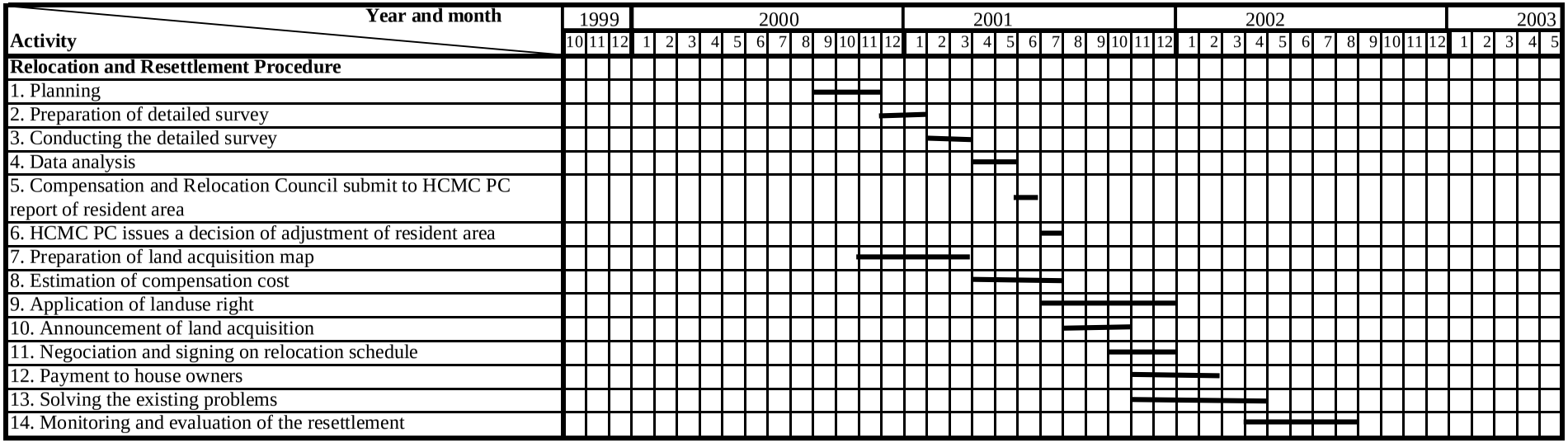


FIG. 12.6 RELOCATION/RESETTLEMENT SCHEDULE FOR WASTEWATER TREATMENT PLANT



Chapter 13
INSTITUTIONAL DEVELOPMENT PROGRAM

CHAPTER 13 INSTITUTIONAL DEVELOPMENT PROGRAM

13.1 Training recommended for the Project

The Wastewater Treatment Plant is the facility that the HCMC people possess at the first time as a large scale of such one while there have been some pumping stations already in HCMC. It is very important to bring up effectively and shortly the staffs for knowledge and capability enough to operate and maintain the plant. This paragraph mentions our recommendation on a package for the training to be optimal to the Project.

(1) Target Organization and Trainees

The following persons are targeted for receiving the training package:

- The plant manager and technical staffs working for the Wastewater Treatment Plant, illustrated in Figure 13.1
  The administrative staffs are not considered as the target trainees because the activities should be performed in a business way according to the Vietnamese custom as well as their organization.

The trainees are classified as follows in view of their training objectives and contents:

(a) Class 1: Plant Manager, to learn the general management of the Wastewater Treatment Plant, related legislation, and practice for controlling the water qualities and taking actions against the abnormal conditions.

(b) Class 2: Technical Deputy Manager, to learn the general management of the Wastewater Treatment Plant, the general knowledge on the operation, the maintenance, control of the water qualities and the sludge treatment in order to assist the Plant Manager.

(c) Class 3: Section Chiefs, to learn the knowledge and technologies required in the management in the operation, the maintenance, or control of the water qualities.

(d) Class 4: Engineers and Specialists, to learn the knowledge and technologies required in implementation of the operation, the maintenance, or control of the water qualities.

(e) Class 5: Technicians and Workers, to learn the knowledge and technologies required in order to assist the operation, the maintenance, or control of the water qualities.

(2) Procedures for Training

The following four-level procedures on the training and the technology transfer are proposed in order that the technology or the knowledge might really and promptly take root in the Wastewater Treatment Plant.

(a) Level 1: Send to the ERTC in Thailand the trainees who will be core members in the plant in the future in order to receive training programs at the ERTC aiming at training systematically them in a short-term period.

(b) Level 2: Make the trainees have practical training of the operation and the maintenance at the existing wastewater treatment plant in Thailand in line with the time of the sending in the Level 1.

(c) Level 3: Make them receive on-job-training at the Wastewater Treatment Plant through calling on some experts to come to the plant site for giving a lecture and on-job-training. The trainees who are sent in the Level 1 and 2 should review the contents and schedule thereof according to the experience.

(d) Level 4: Make the trainees who are sent in the Level 1 and 2 give a lecture to the others in order to perform the technology transfer on timing.

(3) Contents of training programs

This paragraph explains the contents of the training programs.

(a) Level 1: Give fundamental training at the ERTC to the managers or the persons who would be potentially the manager on the environmental introduction, development of water resources and water-treatment technologies that are corresponding to the following training courses supplied by the ERTC:

- Course 4. Environmental Information Management (II)
  : Present environmental conditions and impact of environmental problems in Thailand
- Course 9. Water Resources Development (I)
  : Water situations, floods, and water pollution in Thailand, and water resource management
- Course 16. Water Treatment Technology (II)
  : Technology principles in wastewater treatment

(b) Level 2: Make the trainees have practical training of the analytic technology and of the operation and the maintenance using the equipment to treat activated sludge, at the existing wastewater treatment plant in Thailand. In addition, the water analysis chief and specialists would receive the following training courses supplied by the ERTC:

- Course 17. Water and Wastewater Analysis
  : To perform water analysis both in the laboratory and the field.

(c) Level 3: Candidates of the experts would be of the water treatment and the mechanical and the electrical for the plant, fields of which are not fully developed yet in Vietnam. They would give the lecture and the instruction in English. In addition, they would be in charge of looking for optimal operating conditions in the part-load or full-load operation that is anticipated to take more than a half-year after three weeks of the commissioning. The candidates should understand the principles or basis in designing the plant and system; therefore, the Japanese might have to be selected as the candidate.

- On-job training on the wastewater treatment: The excess sludge would be purchased from the facilities treating the sludge located near HCMC, such as brewery factories. The sludge would be put into the aeration tank in order to increase the activated sludge through increasing the influent of the wastewater. The excess sludge would be stored in the sludge thickening / storage facilities after the activated sludge has sufficiently increased and the thickened sludge would be dewatered. The compost would be produced mixed the dewatered sludge in a cake shape with rice hulls.

- On-job training on operation and maintenance of the mechanical and electrical facilities and equipment: The experts would instruct the trainees in them in the above-mentioned part-load or full-load operation of the Wastewater Treatment Plant.

(4) Training Schedule in Thailand

The trainees are grouped as follows in order to receive smoothly the training course supplied by the ERTC.

- All the staffs of the Class 1 to 3 of five persons would receive the training. There is planned to locate 32 people in total of engineers or specialists on the Class 4 for the Operation Section, the Maintenance and the Water Analysis. The Operation Section is composed of 26 staffs, of four teams of six persons per team and two persons (6 persons x 4 teams + 2 persons). Twelve persons would be selected as the trainee as for the four teams of the 24 persons. The trainees of the Class 4 are composed as follows:

  * Operation Section: 14 persons (12 + 2)
  * Maintenance Section: 4 persons
  * Water Analysis Section: 2 persons

Consequently 25 persons would receive the training courses supplied by the ERTC.

- Training groups would be formed as illustrated in Table 13.1 in consideration of number of the training courses of four; A Group: 6 persons, B Group: 7 persons, C Group: 3 persons, D Group: 6 persons, E Group: 3 persons and then C + E: 6 persons

TABLE 13.1 GROUPING OF TRAINEES

Group of Trainees	Trainee	Class of Trainee	No. of Persons	Level 1			Level 2
				Course 4	Course 9	Course 16	Course 17
A	Plant Manager	1	1	O	O	O	×
B	Technical D. Manager	2	1	O	O	O	×
C	Operation S. Chief	3	1	O	O	O	×
	Operation Engineers	4	2	O	O	O	×
B			6	O	O	O	×
D			6	O	O	O	×
A	Maintenance Chief	3	1	O	O	O	×
	Maintenance Eng'rs	4	4	O	O	O	×
E	Water Analysis Chief	3	1	O	O	O	O
	W. A. Specialists	4	2	O	O	O	O

Table 13.2 illustrates a plan of the training schedule in Thailand, where the training length is assumed as follows:

- Training Course of ERTC: One week
- Field Training at the existing plant: Two weeks

TABLE 13.2 TRAINING SCHEDULE IN THAILAND

Training Group	No. of Persons	Training Weeks							
		1st	2nd	3rd	4th	5th	6th	7th	8th
Group A	6	F. Training		C-4	C-9	C-16			
Group B	7		C-4	F. Training		C-9	C-16		
Group C	3			C-16	C-4	F. Training		C-9	
Group E	3			C-16	C-4	F. Training		C-9	C-17
Group D	6				C-16	C-4	C-9	F. Training	

Note: C-4: Course 4, C-9: Course 9, C-16: Course 16, C-17: Course 17, F. Training: Field Training

(5) Training Schedule of Level-3 in Vietnam

Table 13.3 illustrates a plan on the schedule for the training Level-3 where the Wastewater Treatment Plant would be utilized and the experts would be called as the lecturer. The working procedures would be rationalized under the experts, based on the procedure program that would be prepared for the Project, in order to save the operation and maintenance costs of the Company concurrently improving the performance.

It is considered that all the classes of 67 staffs would be a trainee; however, the English capability and the job performance may differ largely among the trainees. In such a case the target trainees would be restricted in number and such trainees would be a lecturer for the technology transfer in an internal seminar.

13.2 Staffs Required for New machines Supplied for Cleaning Sewers

The following equipment will be newly supplied for cleaning the sewers in the Project:

STAFF REQUIRED FOR SEWER CLEANING MACHINES

Sewer Diameter (mm)	500 to 900	1,000 to 1,200
Jet Cleaner	4 tons × 1 set	8 tons × 1 sets
Vacuum Cleaner	4 tons × 1 set	8 tons × 1 set
Water Tanker	4 tons × 6 sets	
Sludge Hauling Dump Truck	4 tons × 6 sets	4 tons × 9 sets
Truck for Equipment Translation	4 tons × 1 set	4 tons × 2 sets

Equipment	Sets	Required per set			Total Req'd*
		Driver	Operator	Worker	
Jet Cleaner	2	1	1	2	8
Vacuum Cleaner	2	1	1	2	8
Water Tanker	6	1	1	-	12
Sludge Hauling Dump Truck	15	1	-	2	45
Truck for Equipment Translation	3	1	2	1	12
				Total Number Required	85

One hundred (100) persons in total, fifteen (15) persons as the spare in addition to eighty-five (85) persons listed in the table, are required to operate the above-mentioned equipment. The Drainage Enterprises under management of UDC would be in charge of the cleaning activities.

Six hundred (600) workers of the Drainage Enterprises would be classified as follows:

- 85 workers in charge of handling the Sewer Cleaning Machines: Two teams
- 515 workers for manual cleaning including of 15 persons as the spare: Fifty teams (50 teams x 10 persons / team = 500 persons) assumed

Table 13.4 calculates how many times the Drainage Enterprises could maintain the sewers yearly. The following are conditions or assumption in the calculation:

- The sewer of Level 1 ranges 100,000 m to take 40 days for manual maintenance with 50 teams at a cleaning capability of 50 m / team / day (50 m/TD).
- The sewer of Level 2 and 3 at a diameter more than 1,200 mm has a length of 149,111 m to take 30 days for manual maintenance with 50 teams at a cleaning capability of 100 m/TD.
- The sewer of Level 2 and 3 at a diameter smaller than 1,200 mm ranges 201,262 m to take 40 days for manual maintenance with 50 teams at a cleaning capability of 100 m/TD.

As the results the manual maintenance takes 110 days (= 40 + 30 + 40 days), therefore one year could have three times of the maintenance.

As for the sewer of Level 2 and 3 at a diameter smaller than 1,200 mm the above-mentioned cleaning machine could perform the maintenance activity. The length of 201,262 m takes 168 days with 2 teams at a cleaning capability of 600 m/TD; therefore, one year could have two times of the machinery maintenance.

Consequently, annual times of the maintenance are calculated as follows:

- The sewer at a diameter more than 1,200 mm: 3 times of the manual
- The sewer at a diameter smaller than 1,200 mm: 3 times of the manual and two times of the machinery

The results show that the Drainage Enterprises afford to conduct the maintenance of the sewer.

TABLE 13.4 MAINTENANCE TIMES REQUIRED FOR SEWERS

Cleaned By	Sewer	Sewer Length (m)			Cleaning Cap. (m/TD) (b)	Team Days (a) ÷(b) (c)	No. of Teams (d)	Req'd Days (c) ÷(d)
		Existing	Phase I	Phase II (a)				
Manual	Level 1	100,000	100,000	100,000	50	2,000	50	40
	>1,200	100,500	+16,662	+31,940				
	Accum.	100,500	117,171	149,111	100	1,491	50	30
	<1,200	136,310	+17,172	+47,780				
	Accum.	136,310	153,482	201,262	100	2,013	50	40
Machine	<1,200	136,310	153,482	201,262	600	335	2	168

13.3 Number of Staffs Required for SDC

The following offices and facilities constitute SDC:

- Head Office

(As the "New Facilities")
- Wastewater Treatment Plants
- Ben Me Coc1 and Thanh Da Pumping Stations
- THBNTD Wastewater Pumping Station
- Monitoring Huts for controlling the inflow into THBNTD Wastewater Pumping Station

The head office has the following departments: Technical Operation (DOTO), Commercial Operation (DOCO), Planning (DOP), Financial Control (DOFC), and Administration Support (DOAS). Figure 13.2 shows the organization of the head office with numbers of staffs of the departments constituting of the head office.

DOTO would manage the organization for operating and maintaining the New Facilities. Figure 13.3 shows number of the staffs for the New Facilities. Table 13.5 explains the staff works and locations together with number of the staffs required.

TABLE 13.3 TRAINING SCHEDULE OF LEVEL-3 AT NEW WASTEWATER TREATMENT PLANT

Training Program	Month	1st Month				2nd Month				3rd Month				4th Month				5th Month			
	Week	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Loading Run at New Plant																					
(1)Wastewater Treatment																					
- Basic theory																					
- Operation																					
- Maintenance																					
- Water Analysis																					
(2)Dehydration Equipment																					
- Basic theory																					
- Operation																					
- Maintenance																					
(3) Compost Equipment																					
- Basic theory																					
- Operation																					
- Maintenance																					

TABLE 13.5 ORGANIZATION PLAN FOR PHASE I (1/9) SDC Head Office (No.1)

Task	Number of Persons Required		Working Required in		Location of Persons		Note
	Normal	Total	Daytime	Night	Working Place	Desk Location	
Managing Director	1	1	YES	NO	Head Office	Head Office	To manage SDC.
Department Mgr of Technical Operation	1	1	YES	NO	Ditto	Ditto	To manage of Department of Technical Operation (DOTO).
- Operation	3	3	YES	NO	Ditto	Ditto	
- Maintenance and Repair	3	3	YES	NO	Ditto	Ditto	
- Procurement and Storehouse	3	3	YES	NO	Ditto	Ditto	
- Laboratory	3	3	YES	NO	Ditto	Ditto	
- Management of Design and Construction	5	5	YES	NO	Ditto	Ditto	
Department Mgr of Commercial Operation	1	1	YES	NO	Ditto	Ditto	To manage of Department of Commercial Operation (DOCO).
- Marketing	2	2	YES	NO	Ditto	Ditto	
- Customer Registration	3	3	YES	NO	Ditto	Ditto	
- Verifying Transaction	5	5	YES	NO	Ditto	Ditto	To verify the transaction amount and to secure the contents of the database.

Note: Mgr: Manager

TABLE 13.5 ORGANIZATION PLAN FOR PHASE I (2/9) SDC Head Office (No.2)

Task	Number of Persons Required		Working Required in		Location of Persons		Note
	Normal	Total	Daytime	Night	Working Place	Desk Location	
Department Mgr of Planning	1	1	YES	NO	Head Office	Head Office	To manage of Department of Planning (DOP).
- Planning New Facilities	2	2	YES	NO	Ditto	Ditto	
- Planning Level 1 to 3	2	2	YES	NO	Ditto	Ditto	
- Planning Level 4 & smaller	2	2	YES	NO	Ditto	Ditto	
Department Mgr of Financial Control	1	1	YES	NO	Ditto	Ditto	To manage of Department of Financial Control (DOFC).
- Financial Administration and Cost Control	5	5	YES	NO	Ditto	Ditto	
- Accounting	15	15	YES	NO	Ditto	Ditto	
Department Mgr of Administ. Support	1	1	YES	NO	Ditto	Ditto	To manage of Administration Support (DOAS).
- Public and Customer Relations	5	5	YES	NO	Ditto	Ditto	
- Human Resource	5	5	YES	NO	Ditto	Ditto	
- Supply and Asset	3	3	YES	NO	Ditto	Ditto	
- General	3	3	YES	NO	Ditto	Ditto	

Note: Mgr: Manager

TABLE 13.5 ORGANIZATION PLAN FOR PHASE I (3/9)

DRAINAGE GROUP / Ben Me Coc 1 Station

Task	Number of Persons Required		Working Required in		Location of Persons		Note
	Normal	Total	Daytime	Night	Working Place	Desk Location	
Senior Station Manager	1	1	YES	NO	Ben Me Coc 1 Office	Ben Me Coc 1 Office	To manage all the stations.
Operation Team Leader	1	1	YES	NO	Site	Ben Me Coc 1 Office	To be also in charge of mechanical works.
- Electrical Technician	1	1	YES	NO	Site	Ben Me Coc 1 Office	
Maintenance Team Leader	1	1	YES	NO	Site	Ben Me Coc 1 Office	To be also in charge of mechanical works, and conduct the activities for all the stations in a patrol manner.
- Electrical Technician	1	1	YES	NO	Site	Ben Me Coc 1 Office	To conduct the activities for all the stations in a patrol manner.
Assistant Manager	1	1	YES	NO	Ben Me Coc 1 Office	Ben Me Coc 1 Office	To be in charge of administration works.
- Secretaries	2	2	YES	NO	Ben Me Coc 1 Office	Ben Me Coc 1 Office	To report the accounting status to the head office.
- Driver	1	1	YES	NO	Car	-	(Considered by the Third Party on Contract Base)
- Guardians	1	1	YES	NO	Site	-	To be in charge of all the stations. (By the Third Party on Contract Base)
- Janitor	1	1	YES	YES	Site	-	(By the Third Party on Contract Base)

TABLE 13.5 ORGANIZATION PLAN FOR PHASE I (4/9) DRAINAGE GROUP / Thanh Da Station

Task	Number of Persons Required		Working Required in		Location of Persons		Note
	Normal	Total	Daytime	Night	Working Place	Desk Location	
Operation Team Leader	1	1	YES	NO	Site	Thanh Da Office	To be also in charge of mechanical works.
- Electrical Technician	1	1	YES	NO	Site	Thanh Da Office	
- Janitor	1	1	YES	YES	Site	-	(By the Third Party on Contract Base)

TABLE 13.5 ORGANIZATION PLAN FOR PHASE I (5/9)

SEWERAGE GROUP / Wastewater Treatment Plant (No.1)

Task	Number of Persons Required		Working Required in		Location of Persons		Note
	Normal	Total	Daytime	Night	Working Place	Desk Location	
Plant Manager	1	1	YES	NO	Main Office	Main Office	To manage a plant.
Technical Deputy Manager	1	1	YES	NO	Main Office	Main Office	To manage technical groups.
Operation Section Chief	1	1	YES	NO	Main Office	Main Office	
Assistant Chief	0	0	YES	NO	Main Office	Main Office	Only in Phase II
- Sludge Treatment / Centrifugal Thickening Eng'rs	2	8	YES	YES	Dewatering Room	Dewatering Room	2 persons / team x 4 teams = 8 persons
- Dewatering Eng'rs	2	8	YES	YES	Dewatering Room	Dewatering Room	2 persons / team x 4 teams = 8 persons
- Composting Eng'rs	0	0	YES	YES	Compost Control Room	Compost Control Room	Only in Phase II
- Water Treatment Eng'rs	1	1	YES	NO	Control Room	Control Room	To watch and report status.
	1	4	YES	YES	Control Room	Control Room	1 person / team x 4 teams = 4 persons
- Sludge Treatment Eng'rs	1	1	YES	NO	Control Room	Control Room	To watch and report status.
	1	4	YES	YES	Control Room	Control Room	1 persons / team x 4 teams = 4 persons
- Mechanical Technicians	2	2	YES	NO	Site	Main Office	To take measures or action against problems.
- Electrical Technician	2	2	YES	NO	Site	Main Office	To take measures or action against problems.

Note 1: Eng'rs: Engineers, Note 2: Workers of Maintenance Section assist temporarily Operation Section.

TABLE 13.5 ORGANIZATION PLAN FOR PHASE I (6/9) SEWERAGE GROUP / Wastewater Treatment Plant (No.2)

Task	Number of Persons Required		Working Required in		Location of Persons		Note
	Normal	Total	Daytime	Night	Working Place	Desk Location	
Maintenance Section Chief	1	1	YES	NO	Main Office	Main Office	
- Mechanical Technicians	2	2	YES	NO	Site	Main Office	
- Electrical Technician	2	2	YES	NO	Site	Main Office	
- Civil Engineers	2	2	YES	NO	Site	Main Office	
- Architectural Engineers	2	2	YES	NO	Site	Main Office	In charge of Architecture and Facility Design.
- Workers	4	16	YES	YES	Site	Main Office	To assist temporarily Operation Section. 4 persons / team x 4 teams = 16 persons
Water Analysis Section Chief	1	1	YES	NO	Main Office Laboratory	Main Office Laboratory	
- Analytical Specialists	2	2	YES	NO	Main Office Laboratory	Main Office Laboratory	
- Laboratory Workers	3	3	YES	NO	Site	Main Office Laboratory	

TABLE 13.5 ORGANIZATION PLAN FOR PHASE I (7/9)

SEWERAGE GROUP / Wastewater Treatment Plant (No.3)

Task	Number of Persons Required		Working Required in		Location of Persons		Note
	Normal	Total	Daytime	Night	Working Place	Desk Location	
Administration Deputy Manager	1	1	YES	NO	Main Office	Main Office	
- Secretaries	3	3	YES	NO	Main Office	Main Office	
- Drivers	2	2	YES	NO	Car	-	(By the Third Party on Contract Base)
- Guardians	2	2	YES	NO	Site	-	(By the Third Party on Contract Base)
- Janitor	1	1	YES	YES	Site	-	(By the Third Party on Contract Base)

SEWERAGE GROUP / Intermediate Wastewater Pumping Station (No.1)

Task	Number of Persons Required		Working Required in		Location of Persons		Note
	Normal	Total	Daytime	Night	Working Place	Desk Location	
Station Manager	1	1	YES	NO	Station Office	Station Office	To manage Station.
Operation Team Leader	1	1	YES	NO	Site	Station Office	To be also in charge of mechanical works.
- Operators	2	10	YES	YES	Site	Station Office	2 persons / team x 5 teams = 10 persons (3 batches per day), where 2 teams of the five would conduct the activities in the daytime and one team of the two is in charge of operation of the glove bucket and removing the screenings.

TABLE 13.5 ORGANIZATION PLAN FOR PHASE I (8/9)

SEWERAGE GROUP / Intermediate Wastewater Pumping Station (No.2)

Task	Number of Persons Required		Working Required in		Location of Persons		Note
	Normal	Total	Daytime	Night	Working Place	Desk Location	
Maintenance Team Leader	1	1	YES	NO	Site	Station Office	To be also in charge of mechanical works, and conduct the activities in a patrol manner.
- Electrical Technician	1	1	YES	NO	Site	Station Office	
- Civil /Architectural Engineers	1	1	YES	NO	Site	Station Office	
- Workers	3	3	YES	NO	Site	Station Office	
Water Analysis Section Leader	1	1	YES	NO	Site	Station Office	Analyzing for management and distribution of the flow volume and countermeasure against emergency of sanitary sewage.
Administration Section Leader	1	1	YES	NO	Station Office	Station Office	To be in charge of administration works.
- Secretaries	2	2	YES	NO	Station Office	Station Office	To report the accounting status to the head office.
- Driver	1	1	YES	NO	Car	-	(By the Third Party on Contract Base)
- Guardian	1	1	YES	NO	Site	-	(By the Third Party on Contract Base)
- Janitor	1	1	YES	YES	Site	-	(By the Third Party on Contract Base)

TABLE 13.5 ORGANIZATION PLAN FOR PHASE I (9/9)

SEWERAGE GROUP / for controlling Inflow into Intermediate Wastewater Pumping Station

Task	Number of Persons Required		Working Required in		Location of Persons		Note
	Normal	Total	Daytime	Night	Working Place	Desk Location	
Flow Controller (No. 1)	1	3	YES	YES	Site	Monitoring Hut (No.1) in Main Interceptor	To be in charge of controlling the total inflow volume into the station. (1 person x 3 shifts = 3 persons)
Flow Controller (No. 2)	1	3	YES	YES	Site	Monitoring Hut (No.2)	Ditto, but located in the Secondary Interceptor.
Flow Controller (No. 3)	1	3	YES	YES	Site	Monitoring Hut (No.3)	Ditto
Flow Controller (No. 4)	1	3	YES	YES	Site	Monitoring Hut (No.4)	Ditto
Flow Controller (No. 5)	1	3	YES	YES	Site	Monitoring Hut (No.5)	Ditto
Flow Controller (No. 6)	1	3	YES	YES	Site	Monitoring Hut (No.6)	Ditto
Flow Controller (No. 7)	1	3	YES	YES	Site	Monitoring Hut (No.7)	Ditto
Flow Controller (No. 8)	1	3	YES	YES	Site	Monitoring Hut (No.8)	Ditto
Flow Controller (No. 9)	1	3	YES	YES	Site	Monitoring Hut (No.9)	Ditto
Flow Controller (No. 10)	1	3	YES	YES	Site	Monitoring Hut (No.10)	Ditto

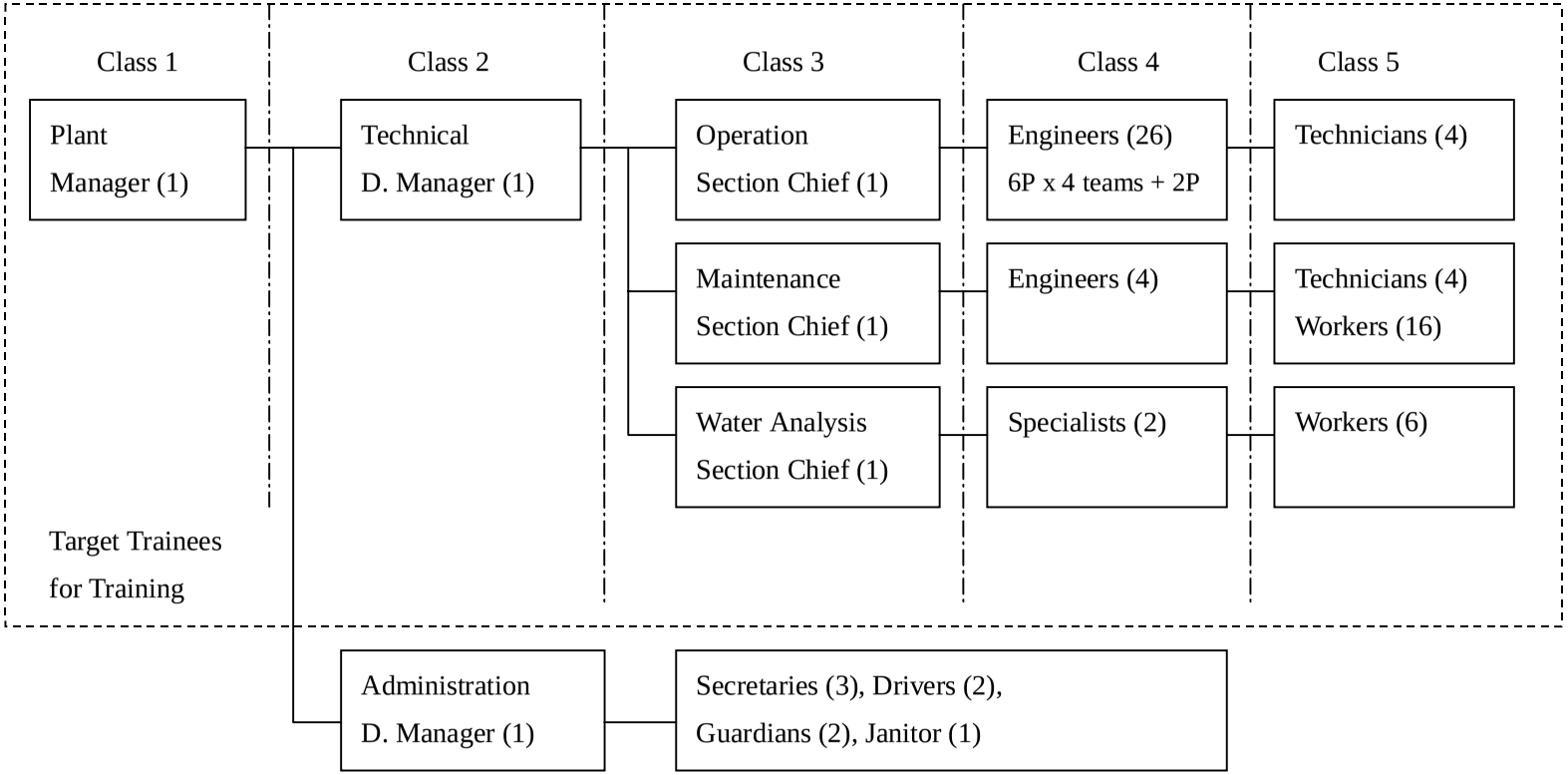


FIGURE 13.1 ORGANIZATION OF WASTEWATER TREATMENT PLANT

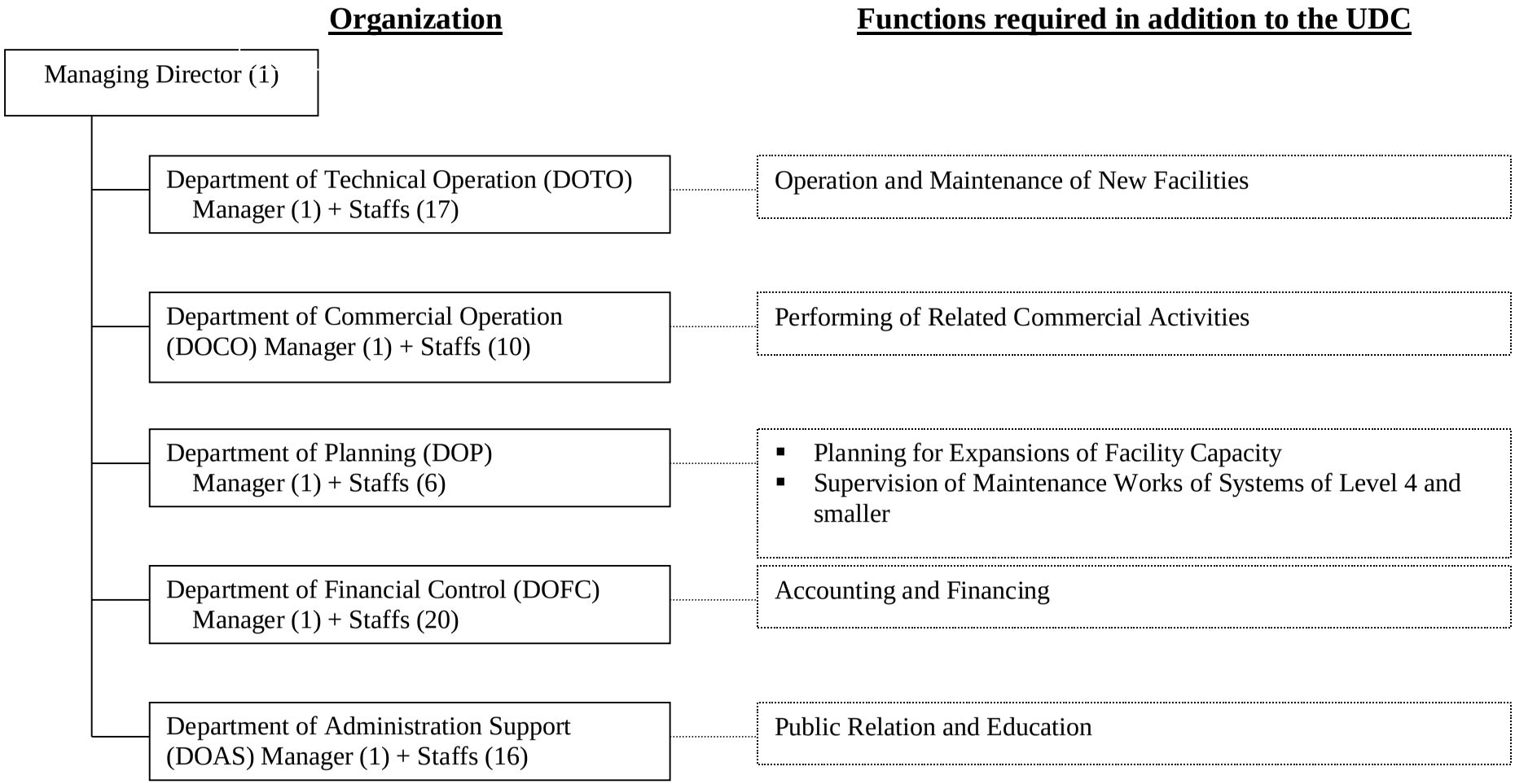


FIGURE 13.2 ORGANIZATION OF SDC HEAD OFFICE (PHASE I)

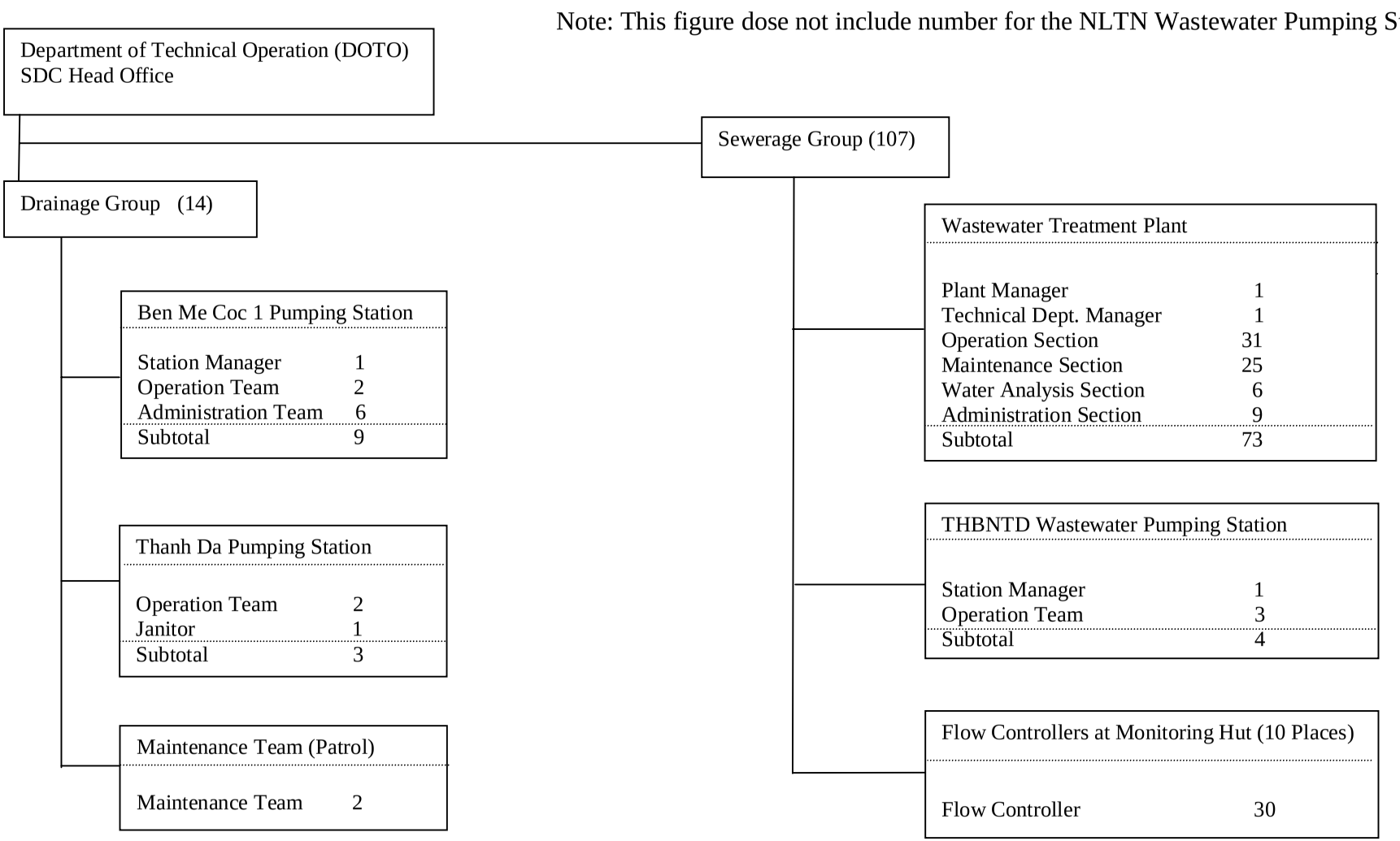


FIGURE 13.3 NUMBER OF STAFFS FOR NEW FACILITIES (PHASE I)

Chapter 14

COST ESTIMATE

CHAPTER 14 COST ESTIMATE

14.1 General

The unit costs of labor, material and equipment have been surveyed and examined for this construction works for this project. The costs are summarized in this chapter.

14.2 Unit Labor Costs

Unit labor costs for normal construction works for this project are listed in Table 14.1.

The conditions described below have been considered to construct unit labor costs for this project.

(1) Labor Law and Regulation

The basic wage of the labor has been set up based on the following law and regulations;

- The Decree No.708/1999/QD-BLDTBXH which stipulates the minimum salary levels of the labor working for enterprises financed by foreign funding,
- The salary classification system which was issued with the Decree No.25/CP dated 23/5/1993 by the Government,
- The Vietnamese Labor Law Clause 149 which stipulates the social insurance level of the employer and employee, and
- The Decree No.58/1998/ND-CP issued by the Government dated 13/8/1992 which stipulates the health insurance level.

(2) Monthly Basic Wage by Labor Grade

According to the regulations of the salary classification system and the minimum salary level mentioned above, basic salary of labors is computed by the following equation by labor grade;

Monthly Basic Salary : $L_1 = K \times Lo$

Where, Lo : Minimum monthly basic salary (= 626,000 VND/month)

K : Coefficient for Labor Grade

Generally, there are seven (7) grades with respective coefficients of for each work. For example, the table below shows the grades of construction labor and its coefficients.

Coefficient of Labor Grade for Construction Work

Grade	I	II	III	IV	V	VI	VII
K	1.57	1.75	1.95	2.17	2.65	3.23	3.94

* No. of grade and coefficient are different depending on work type.

However, in order to simplify the computation of unit basic cost, an average level of labor grade has been set for the cost estimation for this project.

Common labor : K = 2.17 (Grade IV)
Foreman : K = 3.94 (Grade VII)

(3) Allowances

Based on the above regulations, the following allowances are added to the basic salary:

Description	Percentage of Basic Salary (%)
Supplemental salary (for Tet holidays, leave and others etc.)	12
Social Insurance	20
Health insurance	2
Total	34

(4) Income Tax

The income tax has not been added in the labor salary.

(5) Average Working Days per Month

i) Number of approved paid holidays and annual leave per year

- Sunday	52 days
- National holidays and New Year	8 days
- Paid annual leave including moving time	15 days
Total	75 days

ii) Idle days in construction per year

- Weather condition	13 days
- Study and meeting	10 days
- Public activities and military training	4 days
- Illness	5 days
Total	32 days

Working Time Lost due to Weather Condition

Month	1	2	3	4	5	6	7
Lost time (day)	0.5	0.0	0.0	0.8	1.6	1.6	1.6
Month	8	9	10	11	12	Total (1 – 12)	
Lost time (day)	1.6	1.6	1.6	1.0	0.8	12.7	

iii) Average Working days per Month

n = (365 - 75 - 32) / 12 months = 21.5 days

14.3 Unit Material Costs

Unit material costs in HCMC have been surveyed and examined for this project. The unit material costs applied for the cost estimation are listed in Table 14.2.

14.4 Unit Equipment Rental Costs

Firstly, unit equipment rental costs have been estimated based on Japanese standards and they were studied comparing with market rates in HCMC. Based on the comparison, the following coefficients to Japanese Standards have been set up in order to correspond with the market rates. The coefficient has been categorized into five (5) as follows;

Category	Main Equipment	Coefficient
I	Road work machinery group like roller, grader	1.00
II	Air compressor, generator group	0.95
III	Earthwork machinery group like backhoe, bulldozer	0.85
IV	Cranage group and transportation group	0.80
V	Others	0.90

For example, daily rental cost of a mobile crane with a capacity of 10-ton has been computed at 1,776,000 VND/shift applying an equipment rental cost of 2,220,000 VND/shift worked out from Japanese standards and the coefficient 0.80 of Category IV, this rate is corresponding to the market rate. The unit equipment rental costs applied for the cost estimation are listed in Table 14.3.

14.5 Project Cost for Phase I

The project cost for Phase I is estimated at 3,951.0 billion VND under the economic condition in December 2000.

The project cost of each package for construction works consists of (i) construction cost, (ii) price escalation, (iii) physical contingency, (iv) land acquisition cost and (v) administration cost. The consulting service cost consists of (i) consulting service cost, (ii) price escalation, (iii) physical contingency and (iv) administration cost.

The project cost of each package and the consulting service cost are summarized and shown as follows;

Project Cost for Phase I

(Unit : Million VND)

Item	F.C.	L.C.	Total
Package A	100,241.68	707,443.53	807,685.20
Package B	42,595.65	220,744.18	263,339.83
Package C	345,301.50	219,262.25	564,563.75
Package D	69,306.90	186292.70	255,599.59
Package E	1,026,336.22	773,335.35	1,799,671.57
Consulting Services	191,726.22	68,404.20	260,131.02
Total	1,775,508.77	2,175,482.21	3,950,990.98

Note : Exchange rate : US$ 1.0 = VND 14,500 = ¥ 110.0
Administration cost : 5% of construction cost and consulting service cost including price escalation, physical contingency and land acquisition cost
Physical contingency : 10% of construction cost and consulting service cost
Price escalation : Foreign Currency (F.C.) = 0.8 % per annum, Local Currency (L.C.) = 0.1 % per annum

TABLE 14.1 UNIT LABOR COST FOR NORMAL CONSTRUCTION WORKS

Lo = 626,000VND

1. Normal construction work

USD1.0 = 14,500 VND = 110.0 Yen

Code	Labor	Grade	Grade Wage		Allowance	Total Wage (Per Month) Tax Excluded		Unit Cost (Per Day) Tax Excluded	
			Coefficient K	Basic salary L1= K x Lo	0.34 x L1 (VND)	USD	VND	USD	VND
L1	Foreman	VII	3.94	2,466,440	838,590	227.9	3,305,030	10.6	153,722
L2	Common Labor	IV	2.17	1,358,420	461,863	125.5	1,820,283	5.8	84,664
L3	Mechanic	IV	1.92	1,201,920	408,653	111.1	1,610,573	5.2	74,910
L4	Electrician	IV	1.92	1,201,920	408,653	111.1	1,610,573	5.2	74,910
L5	Welder	IV	1.92	1,201,920	408,653	111.1	1,610,573	5.2	74,910
L6	Rigger	VI	2.84	1,777,840	604,466	164.3	2,382,306	7.6	110,805
L6B	Skilled Labor	IV	2.84	1,777,840	604,466	164.3	2,382,306	7.6	110,805
L7	Carpenter/Block Worker	IV	2.17	1,358,420	461,863	125.5	1,820,283	5.8	84,664
L8	Block Worker	IV	2.17	1,358,420	461,863	125.5	1,820,283	5.8	84,664
L9	Steel Worker	IV	2.17	1,358,420	461,863	125.5	1,820,283	5.8	84,664
L10	Concrete Worker	IV	2.17	1,358,420	461,863	125.5	1,820,283	5.8	84,664
L11	Equipment Operator	IV	1.92	1,201,920	408,653	111.1	1,610,573	5.2	74,910
L12	Truck Driver	IV	2.44	1,527,440	519,330	141.2	2,046,770	6.6	95,199
L13	Driver	IV	2.16	1,352,160	459,734	125.0	1,811,894	5.8	84,274
L14	Ship Officer	IV	2.44	1,527,440	519,330	141.2	2,046,770	6.6	95,199
L15	Sailor	IV	2.16	1,352,160	459,734	125.0	1,811,894	5.8	84,274
L16	Assistant Operator	IV	1.55	970,300	329,902	89.7	1,300,202	4.2	60,475
L17	Yardman	IV	1.55	970,300	329,902	89.7	1,300,202	4.2	60,475
L18	Engineer (junior)	IV	2.50	1,565,000	532,100	144.6	2,097,100	6.7	97,540
L19	Engineer (Senior)	IV	4.38	2,741,880	932,239	253.4	3,674,119	11.8	170,889
L7	Engineer (Specialist)	IV	6.67	4,175,420	1,419,643	385.9	5,595,063	17.9	260,235

2. Pipe jacking work

USD1.0 = 14,500 VND = 110.0 Yen

Code	Labor	Grade Wage		Allowance	Total Wage (Per Month) Tax Excluded		Unit Cost (Per Day) Tax Excluded	
		Coefficient K	Basic salary L1= K x Lo	0.34 x L1 (VND)	USD	VND	USD	VND
S1	Special labor	5.91	3,699,660	1,257,884	341.9	4,957,544	15.9	230,583
S2	Common Labor	3.26	2,037,630	692,794	188.3	2,730,424	8.8	126,996
S3	Mechanic	2.88	1,802,880	612,979	166.6	2,415,859	7.7	112,366
S4	Electrician	2.88	1,802,880	612,979	166.6	2,415,859	7.7	112,366
S5	Welder	2.88	1,802,880	612,979	166.6	2,415,859	7.7	112,366
S6	Rigger	4.26	2,666,760	906,698	246.4	3,573,458	11.5	166,207
S7	Steel Worker	3.26	2,037,630	692,794	188.3	2,730,424	8.8	126,996
S8	Concrete Worker	3.26	2,037,630	692,794	188.3	2,730,424	8.8	126,996
S9	Equipment Operator	2.88	1,802,880	612,979	166.6	2,415,859	7.7	112,366
S10	Assistant Operator	2.33	1,455,450	494,853	134.5	1,950,303	6.3	90,712

Note : Basic salary of labor for pipe jacking work is assumed at 1.5 times of the basic salary of labor for normal construction work

TABLE 14.2(1/5) LIST OF UNIT MATERIAL COST

Code	Material	Specification	Unit	Unit Cost	
				Foreign	Local
				(Yen)	(VND)
1. Steel					
M1	Anchor bolt	M20 x 600mm	each	-	17,000
M2	Anchor bolt	with 2 nut ; M24 x 600 mm	each	-	25,000
M3	Bolt	D16 x 150	each	-	2,520
M4	Bolt	D12 x 75	each	-	1,682
M5	Bolt nut	M12 x 250	each	-	2,860
M6	Bolt nut	M27 x 80	each	-	12,000
M7	Bolt nut	M12 x 250	each	-	2,860
M8	Bolt+nut	D16 - L = 60mm with washer	pcs	-	1,456
M9	Flat steel		kg	-	3,400
M10	H steel		ton	-	4,200,000
M10a	H steel (Rent for 10 months)	50% buy back	ton	-	2,100,000
M11	I steel section		ton	-	4,200,000
M12	Reinforcing steel bar		ton	-	4,400,000
M13	Round bar		kg	-	3,950
M14	Shaped steel	C250 x 90 x 9	kg	-	4,200
M15	shaped steel	C300:65 x 100 x 10	kg	-	4,200
M16	Shaped steel	C380 x 100 x 10.5	kg	-	4,200
M17	shaped steel	L125 x 80 x 10~125 x 125 x 10	kg	-	4,200
M18	shaped steel	L50 x 50 x 6~75 x 75 x 9	kg	-	4,200
M19	Steel channel	65 mm~120 mm	kg	-	4,300
M20	Steel pipe	D48.6	kg	-	7,513
M21	Steel sheet pile	type II; III; IV	ton	42,000	-
M21a	Steel sheet pile (Rent for 10 months)	type II; III; IV (50% buy back)	ton	21,000	-
M22	Steel sheet pile	type V	ton	47,300	-
M23	Wire rope	D16	m	-	73,091
M23a	Galvanized steel portion including fabrication and installation		kg		14,500
2. Concrete					
M24	Box sewer	1.0 m x 1.0 m	m	-	1,245,455
M25	Box sewer	1.2 m x 1.2 m	m	-	1,532,727
M26	Box sewer	1.6 m x 1.6 m	m	-	2,289,091
M27	Box sewer	1.6 m x 2.0 m	m	-	2,947,273
M28	Box sewer	1.8 m x 2.0 m	m	-	3,264,545
M29	Box sewer	2.0 m x 2.0 m	m	-	3,627,273
M30	Box sewer	2.5 m x 2.5 m	m	-	5,628,182
M31	Box sewer	2 x 1.6 m x 1.6 m	m	-	3,929,091
M32	Box sewer	2 x 1.6 m x 2.0 m	m	-	5,320,000
M33	Box sewer	2 x 2.0 m x 2.0 m	m	-	6,535,455
M34	Box sewer	2 x 2.3 m x 2.3 m	m	-	9,037,745
M35	Box sewer	2 x 2.5 m x 2.5 m	m	-	9,823,636
M36	Box sewer	2 x 30 x 3.0 m	m	-	12,882,727
M37	Box sewer	3.0 m x 3.0 m	m	-	7,628,182
M38	Box sewer	1.5 m x 1.5 m	m		2,178,191
M39	Box sewer	2.8 m x 2.4 m	m		6,705,168
M40	Box sewer	3.0 m x 1.5 m	m		3,929,091
M40a	Box sewer	2.0 m x 1.0 m	m	-	2,046,000
M40b	Box sewer	2.5 m x 2.0 m	m	-	3,864,000
M41	Brick	Hollow-40 x 80 x 180	pcs	-	368
M42	Brick	Hollow-45 x 90 x 190	pcs	-	396
M43	Brick	Hollow-70 x 70 x 170	pcs	-	267
M44	Brick	Hollow-35 x 70 x 170	pcs	-	267
M45	Brick	Hollow-80 x 80 x 180	pcs	-	368
M46	Brick	Hollow-90 x 90 x 190	pcs	-	396
M47	Bridge PC beam	Length = 24.54 m	no	-	35,618,700
M48	Bridge PC beam	Length = 24.7 m	no	-	26,355,500
M49	Bridge PC beam	Length = 33 m	no	-	75,000,000
M50	Cement	Ha tien	kg	-	860
M51	RC pipe	D1000 mm	m	-	568,182
M52	RC pipe	D1200 mm	m	-	1,058,182
M53	RC pipe	D1500 mm	m	-	1,281,818
M54	RC pipe	D1800 mm	m	-	1,895,455
M55	RC pipe	D2000 mm	m	-	2,176,364

TABLE 14.2(2/5) LIST OF UNIT MATERIAL COST

Code	Material	Specification	Unit	Unit Cost	
				Foreign	Local
				(Yen)	(VND)
M56	RC pipe	D200 mm	m	-	109,091
M57	RC pipe	D300 mm	m	-	140,909
M58	RC pipe	D400 mm	m	-	180,909
M59	RC pipe	D500 mm	m	-	233,636
M60	RC pipe	D600 mm	m	-	317,273
M61	RC pipe	D700 mm	m	-	377,273
M62	RC pipe	D800 mm	m	-	405,455
M63	RC pipe	D900 mm	m	-	520,000
M63a	RC pipe	D2500 mm	m	-	3,398,000
M64	Ready mixed concrete	Normal 10 mpa	m^3	-	445,455
M65	Ready mixed concrete	Normal 18 mpa	m^3	-	509,091
M66	Ready mixed concrete	Normal 21 mpa	m^3	-	536,364
M67	Ready mixed concrete	Normal 30 mpa -For Diaphram wall	m^3	-	672,727
M68	Reinforced concrete pile	350 x 350 without connection	m	-	254,167
M69	Reinforced concrete pile	400 x 400 without connection	m	-	400,000
M69a	Reinforced concrete pile	250 x 250 without connection	m	-	130,000
M69b	Reinforced concrete pile	300 x 300 without connection	m	-	148,000
3. Others				-	
M70	Soil (red)	Laterite	m^3	-	52,000
M71	Sand (black)	for filling	m^3	-	26,000
M72	Sand (yellow)	for sand pile	m^3	-	58,000
M73	Coble Stone (200 x 300)		m^3	-	75,000
M74	Crushed stone	0.5 x 1	m^3	-	118,000
M75	Crushed stone	1 x 2	m^3	-	118,000
M76	Crushed stone	2 x 4	m^3	-	108,000
M77	Crushed stone	4 x 6	m^3	-	94,000
M78	Crushed stone	5 x 7 with clay	m^3	-	111,400
M79	Crushed stone	0 x 4	m^3	-	66,000
M80	Fine stone (0-5)	for base course under leveling concrete	m^3	-	58,000
M81	Gravel	2 x 4	m^3	-	108,000
M82	Asphalt ready mix	Coarse	ton	-	305,000
M83	Asphalt ready mix	Fine	ton	-	318,000
M84	Addmixture	for concrete	litre	-	50,000
M85	Mortar (epoxy resin)	Sikadur 731	kg	-	100,900
M86	Mortar (non-shrink)		kg	-	9,810
M87	Geotextile sheet	Tensile strength > 40 kN/m	m^2	-	19,182
M87a	Geotextile sheet	TS40	m^2		9,570
M88	Geotextile sheet	Thickness = 0.2 mm	m^2	-	2,900
M89	Electrode		kg	-	7,000
M90	Plastic wick	w = 98 mm ; t = 3 mm	m	-	3,950
M91	Plywood (Water proofing)	18 x 1220 x 2440	m^2	-	80,000
M92	Diesel		litre	-	3,518
M93	Oil (heavy)		litre	-	3,273
M94	Gasoline(petrol)		litre	-	4,909
M95	Manhole cover 900x900	In walkway	set	-	1,545,455
M96	Manhole cover F740	In street	set	-	2,727,273
M97	PVC pipe	D114 - 3.2 mm	m	-	28,500
M98	PVC pipe	D34	m	-	5,200
M99	PVC pipe	D50	m	-	8,800
M100	Terracotta	300 x 300 x 2.5	pcs	-	3,109
M101	Timber	Group IV	m^3	-	3,600,000
M102	Timber pile	D = 80 mm to 100mm ; 4.5 m Long	no	-	13,500
M103	Timber pile	D80~100, L = 3 m	no	-	7,500
M104	Water hose	D19mm	m	-	4,000
M105	Cat ladder	for manhole (Installation included)	m	-	150,000
M106	Bag		each	-	2,000
M107	Scaffold (Rental)	VF-50198 : 2 frame sets	set	-	2,000

TABLE 14.2(3/5) LIST OF UNIT MATERIAL COST

Code	Material	Specification	Unit	Unit Cost	
				Foreign	Local
				(Yen)	(VND)
M108	Joint filler for Asphalt Mixture	t = 10 mm	m^2	-	230
M109	Waterbar	SikaV20(G)	m	-	109,500
M110	Waterbar	SikaO20(Y)	m	-	115,340
M111	Elastic sealant	SikaFlex Pro 2HP	litre	-	265,200
M112	Concrete paving block 60mm thick	200 kg/cm^2 - natural cement color	m^2	-	66,364
M113	Concrete paving block 60mm thick	200 kg/cm^2 - color	m^2	-	70,909
M114	Bitument	Bitument-Singapore	litre	-	3,100
M115	Cat ladder	Single step, R22 galvanized, installation incd.	No	-	47,450
M116	Elastic material for expansion joint	Formed Polyurethene 20mm thick	m^2	-	1,450
M117	Hot filling sealant	Sika Igas Mastic N	kg	-	73,000
M118	Water	for concreting	m^3	-	4,000
M119	Electricity	Transformer excluded	Kw	-	1,400
M120a	Flap Gate	Pipe F600	no	425,000	-
M120b	Flap Gate	Pipe F800	no	505,000	-
M120	Flap Gate	Pipe F900	no	550,000	-
M121	Flap Gate	Pipe F1000	no	630,000	-
M122	Flap Gate	Pipe F1200	no	700,000	-
M123	Flap Gate	Pipe F1500	no	955,000	-
M124	Flap Gate	Pipe F1800	no	1,290,000	-
M121a	Flap Gate	Pipe F2000	no	1,580,000	-
M123a	Flap Gate	1500 x 1500	no	1,050,000	-
M124a	Flap Gate	2000 x 2000	no	1,750,000	-
M124b	Flap Gate	2200 x 2200	no	2,110,000	-
M124c	Flap Gate	2500 x 2000	no	2,750,000	
M125	Pit cover	Synthetic wood 1130 mm x 1130 mm	no	82,500	-
M126	Pit cover	Synthetic wood 980 mm x 2630 mm	no	166,500	-
M127	Pit cover	Synthetic wood 930 mm x 2130 mm	no	127,750	-
M128	Jacking Pipe	D1200 mm (incld.collar, seal)	m	23,640	-
M129	Jacking Pipe	D1500 mm (incld.collar, seal)	m	36,310	-
M130	Jacking Pipe	D2200 mm (incld.collar, seal)	m	74,470	-
M131a	Sky light	Poly carbonate 2000 mm x 2000 mm - 14 nos	no	12,825,000	-
M132	Steel pipe	D2500 mm	m	270,270	-
M133	Flexible joint		Unit	4,092,000	-
M134	Manhole cover	Type A - Circular	no	-	3,400,000
M135	Manhole cover	Type B - Rectangular	no	-	3,500,000
M136	Manhole cover	Type C - Grid	no	-	3,500,000
M137	Manhole cover	Type D - Concrete	no	-	1,800,000
M138	Manhole cover	Type E - Cast iron	no	-	2,800,000
M139	Manhole cover	Type F - Rectangular	no	-	6,600,000
M140	Manhole cover	Type G - Rectangular	no	-	9,600,000
M141	Manhole cover	Type H - Rectangular	no	-	1,500,000
M142	Joint sealant	Bitument-Rubber (Igas Mastic N - Sika)	litre	-	104,000
M145	Hanging hook	1 ton capacity	no	-	38,300
M146	Tar Epoxy	Sika - including installation	m2	-	159,000
M147	Local hardwood	for stop log	m3		6,500,000
4. Wood					
MT1	Aglaia duperreana		no.		18,182
MT2	Averhoa carambola		no.		77,273
MT3	Caesalpina pulcherrima		no.		13,636
MT5	Casuarina equsentifolia	1.5 m (H) x 2.0 cm dia.	no.		36,364
MT6	Chrysophyllum cainito		no.		113,636
MT7	Cynometra caulifolia		no.		7,273
MT8	Cochlospermum gossypium		no.		140,909
MT9	Dalbergia cochinchinensis	1 m (H)			45,455
MT10	Delonix regia				204,545
MT11	Delonix regia-1	2.0 m (H) x 3.0 cm dia.			86,364
MT12	Delonix regia-2	3.0 m (H) x 6.0 cm dia.			186,364
MT13	Dillenia indica				77,273
MT14	Dipterocarpus alatus	2.5 m (H) x 3.0 cm dia.			113,636
MT15	Ficus elastica				168,182
MT16	Ficus religiosa				168,182

TABLE 14.2(4/5) LIST OF UNIT MATERIAL COST

Code	Material	Specification	Unit	Unit Cost	
				Foreign	Local
				(Yen)	(VND)
MT17	Gustavia superba				77,273
MT19	Hopia odrata	2.5 m (H) x 3.0 cm dia.			113,636
MT20	Khaya senegalensis-1	2.0 m (H) x 5.0 cm dia.			204,545
MT21	Khaya senegalensis-2	1.5 m (H) x 2.0 cm dia.			45,455
MT22	Lagerstroemia tomentosa	2.0 m (H) x 2.0 cm dia.			45,455
MT23	Lagerstroemia reginae	1.5 m (H)			131,818
MT24	Mangifera indica				86,364
MT25	Magnolia coco-1	2.0 m (H) x 3.0 cm dia.			168,182
MT26	Magnolia coco-2	3.0 m (H) x 5.0 cm dia.			259,091
MT28	Melaleuca leucadendra	2.0 m (H) x 1.0 cm dia.			22,727
MT29	Melaleuca leucadendra	2.0 m (H) x 2.0 cm dia.			22,727
MT30	Mimusops elengi-1	3.0 m (H) x 3.0 cm dia.			204,545
MT31	Mimusops elengi-2	4.0 m (H) x 4.0 cm dia.			259,091
MT32	Plumeria obtusifolia	2.5 m (H) x 6.0 cm dia.			168,182
MT33	Plumeria rubra	2.0 m (H) x 6.0 cm dia.			186,364
MT34	Plumeria alba	2.0 m (H) x 6.0 cm dia.			186,364
MT35	Peltophorum pterocarpum	1.5 m (H) x 2.0 cm dia.			68,182
MT36	Polyalthia longifolia	2.0 m (H) x 3.0 cm dia.			140,909
MT37	Psidium guajava				8,182
MT38	Tamarindus indica	1.0 m (H) x 1.0 cm dia.			22,727
MT39	Terminalia catapa	2.0 m (H) x 3.0 cm dia.			95,455
MT40	Tectoma grandis (teak)				140,909
MT41	Tectoma grandis-1 (White palm-1)	2.5 m (H) x 15.0 cm dia.			168,182
MT42	Tectoma grandis-2 (White palm-2)	2.5 m (H) x 20.0 cm dia.			231,818
MT43	Areca catechu				
MT44	Areca champan -1	1.5 m (H) x 40.0 cm dia.			550,000

TABLE 14.2(5/5) LIST OF UNIT MATERIAL COST

Code	Material	Specification	Unit	Unit Cost	
				Foreign	Local
				(Yen)	(VND)
MT45	Areca champan -2 (Green areca)	3.0 m (H) x 15.0 cm dia.			140,909
MT46	Cocos nucifera	3.0 m (H)			95,455
MT47	Crysalidocarpus lutenscens	3.0 m (H) x 10.0 cm dia.			186,364
MT48	Cycus revoluta	1.0 m (H) x 18.0 cm dia.			459,091
MT49	Livistona rotandiflora	0.5 m (H)			18,182
MT50	Roystonea regia	2.0 m (H) x 15.0 cm dia.			186,364
MT51	Ravenale (Big)				277,273
MT52	Ravenale (Small)				140,909
MT53	Ravenale adamson-1	2.5 m (H)			295,455
MT54	Ravenale adamson-2	1.5 m (H)			186,364
MT56	Bauhinia purpurea				77,273
MT58	Calliandra haematocephata				140,909
MT59	Cananga odorata	1.0 m (H) x 2.0 cm dia.			31,818
MT61	Cupressus funebris	1.5 m (H) x 4.0 cm dia.			113,636
MT62	Duranta repens				31,818
MT63	Gardenia jasminoides-1				59,091
MT64	Gardenia jasminoides-2	0.5 m (H) x 1.0 cm dia.			27,273
MT65	Hibiscus rosa -sinensis				9,091
MT66	Ixora coccina				9,091
MT67	Kopsia fruticosa	0.3-0.5 m (H)			9,091
MT69	Musa				9,091
MT70	Musaenda pubescens	0.4 m (H)			10,909
MT73	Nelium oleander	1.5 m (H) x 2.0 cm dia.			27,273
MT74	Ochna	1.0 m (H) x 1.0 cm dia.			50,000
MT75	Ochna integerrima	2.0 m (H) x 4.0 cm dia.			95,455
MT76	Tabernaemontana divaicatum	0.4 m (H)			27,273
MT77	Tamarix chinensis	1.5 m (H)			1,818
MT78	Thevetia peruviana	1.0 m (H) x 1.0 cm dia.			22,727
MT79	Buogainvillea spectabilis	0.7 m (H) x 1.0 cm dia.			18,182
MT80	Phyllostachis	2.0 m (H) x 4.0 cm dia.			86,364
MT81	Phyllostachis-1				140,909
MT82	Phyllostachis-2				277,273
MT84	Sinocalamus gigantenus	0.2 m (H)			5,455
MT85	Japenese grass				40,909
MT86	American grass				50,000
MT87	Axnopus compressus (Cow grass)				14,545
MT88	Axnopus compressus (Golf grass)				81,818
MT90	Polianthes tuberosa	0.5/1.0 m (H)			81,818
MT91	Catharanthus roseus	0.3/0.5 m (H)			14,545

TABLE 14.3(1/3) LIST OF UNIT EQUIPMENT RENTAL COST

Code	Equipment	Specification	Unit	Unit Cost	
				Foreign	Local
				(Yen)	(VND)
E001	Air compressor	3.5~3.7 m^3/min	Day	1,890	147,100
E002	Air compressor	7.5 m^3/min	Day	4,005	336,700
E003	Air compressor	10.5~11.0m^3/min	Day	6,237	464,400
E004	Air compressor	17 m^3/min	Day	7,029	657,900
E005	Generator	2 kVA	Day	304	45,400
E006	Generator	5 kVA	Day	727	31,800
E007	Generator	10 kVA	Day	1,521	62,000
E008	Generator	15 kVA	Day	1,917	81,300
E009	Generator	20 kVA	Day	2,286	89,100
E010	Generator	35 kVA	Day	2,673	154,800
E011	Generator	60 kVA	Day	3,717	267,100
E012	Generator	75 kVA	Day	4,824	325,100
E013	Generator	100 kVA	Day	4,905	425,700
E014	Generator	125 kVA	Day	6,192	541,800
E015	Generator	150 kVA	Day	8,550	619,200
E016	Generator	200 kVA	Day	9,720	928,800
E017	Generator	350 kVA	Day	16,020	1,548,000
E018	Welding machine	250 A	Day	1,071	73,600
E019	Back hoe (hydraulic type)	0.2 m^3	Hr.	1,479	43,300
E020	Back hoe (hydraulic type)	0.35 m^3	Hr.	2,049	56,100
E021	Back hoe (hydraulic type)	0.6 m^3	Hr.	3,613	90,900
E022	Back hoe (hydraulic type)	1.0 m^3	Hr.	5,619	133,500
E023	Bulldozer	3 ton	Hr.	1,666	35,600
E024	Bulldozer	6 ton	Hr.	2,737	52,800
E025	Bulldozer	9 ton	Hr.	3,655	64,600
E026	Bulldozer	11 ton	Hr.	4,327	72,300
E027	Bulldozer	15 ton	Hr.	4,794	87,800
E028	Clamshell	0.6 m^3	Hr.	4,632	58,700
E028b	Clamshell (1.2 m^3) per day (on Barge) x 300 m^3/day		day	25,900	367,200
E029	Swamp bulldozer	16 ton	Hr.	4,998	87,800
E030	Tractor shovel	0.8 m^3	Hr.	1,726	42,100
E031	Tractor shovel	1.2 m^3	Hr.	2,253	54,100
E032	Tractor shovel	1.4 m^3	Hr.	2,559	54,500
E033	Crawler crane (hydraulic type)	40 ton	Hr.	6,272	54,600
E033'	Crawler crane (40 ton) - Fabrication & Dismantle		Ls	43,956	1,388,900
E034	Crawler crane (hydraulic type)	60 ton	Hr.	11,040	62,300
E034'	Crawler crane (60 ton) - Fabrication & Dismantle		Ls	69,472	2,182,700
E035	Tower crane	Fixed type 60 t.m ; h = 50 m	Day	15,024	54,000
E036	Truck crane	4.8~4.9 ton	Hr.	1,576	38,100
E037	Truck crane	10~11 ton	Hr.	2,848	38,100
E038	Truck crane	15~16 ton	Hr.	3,888	41,600
E039	Truck crane	20~22 ton	Hr.	4,440	42,300
E040	Truck crane	25 ton	Hr.	5,344	48,500
E041	Truck crane	40~45 ton	Hr.	9,200	63,600
E042	Truck crane	120 ton	Hr.	30,880	98,500
E043	Truck with crane (2 ton, 2 ton hanging load)		Hr.	880	37,700
E044	Truck with crane (4 ton truck, 2.9 ton hanging load)		Hr.	1,360	44,700
E045	Dump truck	4 ton	Hr.	824	43,500
E046	Dump truck	10 ton	Hr.	2,184	65,600
E047	Dump truck	6~7 ton	Hr.	1,552	49,700
E048	Truck	2 ton	Hr.	611	41,500

TABLE 14.3(2/3) LIST OF UNIT EQUIPMENT RENTAL COST

Code	Equipment	Specification	Unit	Unit Cost	
				Foreign	Local
				(Yen)	(VND)
E049	Truck	4~4.5 ton	Hr.	1,096	49,600
E050	Truck	11 ton	Hr.	2,712	75,200
E051	Trailer	28 ton	Hr.	4,048	85,900
E052	Trailer	32 ton	Hr.	4,352	85,900
E053	Wagon	3 x 17 m	Day	25,392	-
E054	Asphalt distributor	2000 liter	Day	8,500	184,300
E055	Asphalt finisher	1.6~3.0 m	Hr.	5,290	34,600
E056	Asphalt finisher	2.4~5.0 m	Hr.	13,900	38,100
E057	Line marker	Hand guided type	Hr.	205	-
E058	Motor grader	3.1 m	Hr.	4,490	54,500
E059	Road sprinkler	3800 liter	Hr.	1,720	38,600
E060	Road sprinkler	5500~6500 liter	Hr.	2,280	40,900
E061	Road sweeper	brush type	Hr.	5,690	50,100
E062	Road roller	10~12 ton	Hr.	3,010	43,300
E063	Tired roller	8~20 ton	Hr.	3,240	42,900
E064	Tired roller	21~30 ton	Hr.	3,960	46,400
E065	Tamper	60~100 kg	Day	568	146,000
E066	Vibrating roller	0.8~1.1 ton	Hr.	503	18,200
E067	Vibrating roller	3~4 ton	Hr.	2,090	28,600
E068	Barge	Steel 100 ton	Day	10,800	179,500
E069	Barge	Steel 300 ton	Day	28,080	179,500
E070	Barge with crane (crane 25 ton, barge 200 ton)		Day	42,660	326,300
E071	Barge with crane (crawler crane 40 ton, barge 300 ton)		Day	67,680	349,500
E072	Barge with engine	100 m^3	Day	20,608	1,417,900
E073	Tug boat	Steel 150 pcs	Day	9,540	830,500
E074	Tug boat	Steel 250 pcs	Day	15,480	1,417,900
E075	Concrete pump	55 ~60 m^3/Hr	Hr.	5,400	53,100
E076	Concrete pump	pipe setting type 90~100 m^3/	Hr.	7,101	76,300
E077	Concrete pump	90~110m^3/hr.	Hr.	8,127	57,700
E078	Concrete mixer	0.3~0.6 m^3	Day	13,410	-
E079	Concrete plant	45 m^3/hr.	Hr.	12,870	-
E080	Truck mixer	3.0~3.2 m^3	Hr.	1,566	56,600
E081	Grout mixer	100 liter x 1 unit	Day	388	-
E082	Grout mixer	200 liter x 1 unit	Day	866	-
E083	Grout mixer	200 liter x 2 units	Day	1,233	-
E084	Grout pump	15~30 liter/min.	Day	1,107	-
E085	Diesel hammer (1.3 ton)	1.3 ton	Hr.	2,488	50,700
E085a	Diesel hammer (2.5 ton)	2.5 ton	Hr.	3,856	66,200
E085b	Piling machine-Diesel hammer (1.3 ton)		Hr.	10,800	55,400
E085b'	Piling machine-Diesel hammer (1.3 ton) - Fabrication & Dismantle		Ls	23,638	719,600
E085c	Piling machine-Diesel hammer (2.5 ton)		Hr.	13,120	70,800
E085c'	Piling machine-Diesel hammer (2.5 ton) - Fabrication & Dismantle		Ls	77,700	2,445,800
E086	Guard rail post driving machine		Hr.	3,500	37,600
E087	Plastic board driver per hour		Hr.	9,016	73,000
E088	Sand pile driver	leader length 30 m	Hr.	31,280	40,600
E089	Sand pile driver	leader length 45 m	Hr.	50,800	49,200
E090	Vibrohammer	45 kW	Hr.	3,357	11,300
E091	Vibrohammer	60 kW	Hr.	4,491	11,300
E092	Vibrohammer pile driver with crane 40T	60 kW	Hr.	10,763	69,300
E092b	Vibrohammer pile driver with crane	45 kW	Hr.	9,629	61,600
E093	Water jet for vibrohammer	55 kW	Hr.	3,663	-
E094	Boring machine (F86)		Day	3,699	-

TABLE 14.3(3/3) LIST OF UNIT EQUIPMENT RENTAL COST

Code	Equipment	Specification	Unit	Unit Cost	
				Foreign	Local
				(Yen)	(VND)
E095	Boring pump	30 liter/min.	Day	2,709	-
E096	Chain block	5 ton	Day	157	-
E097	Concrete breaker	30 kA	Day	158	-
E098	Electric hoist	5 ton	Day	1,959	-
E099	Gantry crane	3 ton	Day	3,416	-
E100	Hammer grab	D1000 mm	Day	11,880	-
E101	Hammer grab	D1200 mm	Day	12,420	-
E102	Hammer grab	D2000 mm	Day	26,910	-
E103	Hammer crown	less than D1200 mm	Day	2,889	-
E104	Hammer crown	less than D1300 mm	Day	3,807	-
E105	Hammer drill	38 mm	Day	105	-
E106	Large-sized breaker	600~800 kg	Day	4,896	-
E107	Large-sized breaker (1300 kg)	1300 kg	Day	8,334	-
E109	Reverse circulation drill		Hr.	5,470	-
E110	Slush tank	10 m^3	Day	543	-
E111	Slush tank	20 m^3	Day	963	-
E112	Slush tank	30 m^3	Day	1,368	-
E113	Submersible pump	D30 mm, pump head 15 m	Day	238	-
E114	Submersible pump	D50 mm, pump head 15 m	Day	361	-
E115	Submersible pump	D100 mm, pump head 15 m	Day	543	-
E116	Submersible pump	D150 mm, pump head 15 m	Day	572	-
E117	Submersible pump	D200 mm, pump head 15 m	Day	1,320	-
E118	Submersible pump	D200 mm, pump head 20 m	Day	1,640	-
E119	Generator (100 kVA) for Pipe Jacking - D1200 mm		Day	4,905	1,238,400
E120	Generator (150 kVA) for Pipe Jacking - D1500 mm		Day	8,550	1,780,200
E121	Generator (250 kVA) for Pipe Jacking - D2200 mm		Day	15,840	3,134,700

Chapter 15

FINANCIAL ANALYSIS

CHAPTER 15 FINANCIAL ANALYSIS

15.1 Basis of Sewerage Charge

15.1.1 Introduction of Sewerage Charge

(1) Basic Policy of Sewerage Charge

In order to operate and maintain the facilities to be constructed under the JICA Project, the NLTN Project and the Hang Bang Project for drainage and sewerage system improvement together with the existing drainage system in HCMC and also to improve the drainage system in HCMC, sewerage charge to cover the costs for the above operation and maintenance has to be introduced and levied on the people living in HCMC because they are the beneficiaries of such drainage and sewerage system improvement.

It is the People's Committee of HCMC (PCHCMC)'s idea that sewerage charge will be levied all over HCMC. On the 9th, February 2001, PCHCMC promulgated the Decision No. 10/2001/QD-UB to collect sewerage charge from the 1st, July 2001. In the Decision, it is stated that sewerage charge will be collected from those who use public water supplied by the Water Supply Company (hereinafter referred to as "WSC").

Therefore, in this financial analysis, sewerage charge from those who do not use public water but are using wells is not considered.

According to the Decision, Sewerage Tariff is set at the rate of 264 VND/m^3 for used public water. This means that the amount of sewerage charge to be paid by the people will be calculated multiplying this unit rate of 264 VND/m^3 by volume of public water to be consumed.

Above Sewerage Tariff are kept at the same level until the year of 2003, then reviewed and will be revised in 2004 and thereafter but not annually.

(2) Public Water Volume to be supplied in the Future

The amount of sewerage charge due to be collected depends on the volume of public water to be consumed. Therefore, for the purpose of estimating the total amount of sewerage charge to be collected, it is necessary at first to make assumptions on public water to be consumed in HCMC in the coming years. As like the way mentioned herein-before, total amount of sewerage charge to be collected can be estimated multiplying the Sewerage Tariff of each sector, namely domestic, industrial, commercial and public institution, by such total volume of public water to be consumed respectively.

Based on the information from WSC, volume of public water supplied by WSC in the year of 2000 is assumed as follows:

- Domestic (total of the sector) 131,284,636 m^3
- Industrial (total of the sector) 28,182,925 m3
- Commercial (total of the sector) 8,512,021 m3
- Public institution (total of the sector) 19,384,314 m3

WSC has quite a big expansion plan to increase its public water supply capacity by constructing water purification plants (BOT 1, 2 and 3) and extending its water supply networks. BOT 1 plant started operation in 2000 and BOT 2 is expected to commission in 2004 and BOT 3 in 2005. With this expansion plan, WSC would be able to have the capacity to supply public water to nearly most of the households in HCMC. It is assumed that the water connection growth rate will increase as follows:

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Domestic	2%	2%	5%	14%	17%	10%	3%	2%	2%
Industrial	2%	2%	5%	14%	17%	10%	3%	2%	2%
Commercial	2%	2%	2%	2%	2%	2%	2%	2%	2%
Public Institution	1%	1%	1%	1%	1%	1%	1%	1%	1%

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
2%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
2%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
1%	1%	1%	1%	3%	1%	1%	1%	1%	1%	1%

Above water connection growth rate has a great influence to the total amount of sewerage charge to be collected because it can be said that the total amount of sewerage charge to be collected increases in proportion to the water supply connection growth.

With the water supply connection growth increasing, WSC's expansion plan with large budget accompanies the Water Tariff increase. It is assumed that the Water Tariff will increase as follows:

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Domestic	29%	24%	24%	24%	24%	3%	3%	0%	0%
Industrial	29%	24%	24%	24%	24%	3%	3%	0%	0%
Commercial	29%	24%	24%	24%	24%	3%	3%	0%	0%
Public Institution	29%	24%	24%	24%	24%	3%	3%	0%	0%

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
3%	0%	0%	3%	0%	0%	2%	2%	2%	2%	2%
3%	0%	0%	3%	0%	0%	2%	2%	2%	2%	2%
3%	0%	0%	3%	0%	0%	2%	2%	2%	2%	2%
3%	0%	0%	3%	0%	0%	2%	2%	2%	2%	2%

Above Water Tariff increase has a great influence to the HCMC inhabitant's affordability for water related utility cost including sewerage charge as studied in sub-clause 14.7 of this chapter.

15.1.2 Sewerage and Drainage Company as Operator of Drainage and Sewerage Service

It is the intention of PCHCMC that existing Urban Drainage Company (hereinafter referred to as "UDC") should operate and maintain the facilities to be constructed under the JICA Project, the NLTN Project and the Hang Bang Project together with the existing facilities owned by HCMC using UDC's equipment with reorganized and called as Sewerage and Drainage Company (SDC) as mentioned in Chapter 13. It is the PCHCMC's idea that SDC should operate and maintain all such facilities and all costs incurred by SDC therewith should be covered by sewerage charge to be collected. This means, from an accounting point of view, that SDC will be a company with incoming of sewerage charge as revenue and with outgoing of operation and maintenance costs including replacement cost (hereinafter referred to as "OM/R cost") as expenditure.

However, at present when sewerage charge is not yet introduced and until the near future of time when the SDC's income of sewerage charge is enough to cover the SDC's OM/R cost, SDC has to continue to be subsidized by HCMC. But it is PCHCMC's idea that such subsidy should be decreased according to the increase of incoming of sewerage charge to be collected except the year 2001, 2002 and 2003 as mentioned in the clause of 14.7.1 of this Chapter. In this way, SDC is to be an independent company self-financing with sewerage charge as revenue and OM/R cost as expenditure probably with some net profit.

Pursuant to the Government Decree No.90/1998, SDC should bear only OM/R cost for facilities to be constructed by ODA loans. The loan of the JICA Project by Japan Bank of International Cooperation (JBIC) for drainage and sewerage works, the loan of the NLTN Project by the World Bank for only drainage work and the loan of the Hang Bang Project by Asian Development Bank (ADB) for drainage work will be financed to the Government of Viet Nam by respective donors and then granted to HCMC. Therefore, these facilities to be constructed by the loans so financed will be HCMC's assets as public infrastructure and the depreciation costs of these assets will not be born by SDC as its cost to be covered by sewerage charge to be collected. SDC will administrate these facilities on behalf of HCMC. However, according to the Memorandum of Understandings dated 3rd, November 2000 between PCHCMC and the World Bank, it was agreed that the loan amount of the sewerage portion of the NLTN Project will at first be financed by the World Bank to the Government of Viet Nam and then will be lent to SDC as subsidiary loan. It means that the sewerage facility of the NLTN Project will be

the asset of SDC, and not only the cost of depreciation of such facility but also the cost of interest for the said subsidiary loan will be born by SDC as its cost to be covered by incoming of sewerage charge to be collected. This is considered as a preliminary case of ODA loan taking into account of the future socio-economic development of HCMC.

15.1.3 WSC as Collector of Sewerage Charge

According to the PCHCMC's Decision No.10/2001 dated 9th, February 2001, it was decided that the collection of sewerage charge due to the said Tariff will be made by means of consigning to WSC. It is not a method of surcharge to the public water bill, but a method of separate collection of sewerage charge using the public water bill. WSC has a complete list of consumers of public water, so that it is considered that to use the experiences of WSC would be a great convenience for sewerage charge collection.

In PCHCMC's idea, the fee for the collection of sewerage charge to be paid to WSC will be 1.5% of total amount of sewerage charge so collected.

15.2 Financial Arrangements of the JICA Project and Other Project

15.2.1 Financial Arrangements of the JICA Project

As already mentioned hereinbefore, JBIC will finance for the JICA Project as an ODA. JBIC will make loan to the Government of Viet Nam at first, and then the Government of Viet Nam will grant the whole amount of JBIC loan to HCMC both for drainage and sewerage portion. This means that the responsibility for the repayment of principal and interest of the JBIC loan will be born by the Government of Viet Nam.

The JICA Project comprises of two phases (Phase I and II) and financial arrangements of Phase I of the Project are now considered under this sub-section of 14.3.1.

The components of Phase I of the JICA Project comprise of the following items (excluding contingencies):

- Package A (Tau Hu- Ben Nghe Canal Improvement)
- Package B (Pump Drainage Improvement)
- Package C (Interceptor Sewer Construction, Intermediate Sewerage Pumping Station Construction and Procurement of Sewer Cleaning Equipment)
- Package D (Conveyance Sewer Construction and Existing Combined Sewer Improvement)
- Package E (Wastewater Treatment Plant)

- Engineering service
- Land acquisition and compensation
- Administration

JBIC will loan for the whole amount of above Package A, B, C, D, E and Engineering Service while the project costs for Land acquisition and compensation, and Administration will be financed locally by HCMC.

The JBIC loan will be divided into two categories as General Environmental Project for Package A, B, C, D and Special Environmental Project for Package E and Engineering Service. Conditions of each category are assumed as follows:

General Environmental Project (Package A, B, C and D)

i) an interest rate of 1.3%
ii) repayment period of the loan is 30 years from the start year of the loan financing including the grace period of 10 years

Special Environmental Project (Package E and Engineering Service)

iii) an interest rate of 0.75%
iv) repayment period of the loan is 40 years from the start year of the loan financing including grace period of 10 years

15.2.2 Financial Arrangements of Other Projects

(1) Financial Arrangements of the NLTN Project

The NLTN Project comprises of three phases (Phase I, II and III), and Phase II of the NLTN Project is a supplemental part of Phase I and will be implemented at the same time of Phase I. The donor of Phase I and Phase II is the World Bank, but the donor of Phase III is not fixed yet. For the purpose of financial analysis, it is assumed that the same kind of financial arrangements will be applied for both Phase I and II, and Phase III.

As mentioned herein-before, the World Bank will make loan to the Government of Viet Nam at first. Then, drainage portion of the loan so financed will be granted to HCMC, but sewerage portion of the loan so financed will be on lent to SDC from the Government of Viet Nam directly as a subsidiary loan. This means that SDC will have to repay the principal and interest of the said subsidiary loan to the Government of Viet Nam. The sewerage facility of NLTN project to be so financed and constructed under the subsidiary loan will be the asset of SDC. Therefore, the cost of depreciation of the NLTN sewerage facility and interest of the subsidiary loan will be the cost of SDC to be covered by sewerage charge to be collected.

The conditions of the subsidiary loan are as follows:

- currency to be loaned is Viet Nam Dong, so the exchange risk will be born by the Government of Viet Nam
- interest rate to be negotiated (For the purpose of financial analysis, interest rate of 6.5% p.a. is assumed which is the rate temporarily used by the World Bank for their calculation.)
- repayment period of loan is 25 years from the start of loan financing including grace period of 6 years

(2) Financial Arrangements of the Hang Bang Project

The donor of the Hang Bang Project is ADB. As also mentioned hereinbefore, ADB will make loan to the Government of Viet Nam at first, then all amount of the loan so financed will be granted to HCMC. This means that the responsibility for the repayment of principal and interest of the ADB loan will be born by the Government of Viet Nam.

15.3 Identification of Cost to be Covered by Sewerage Charge

As aforementioned, all costs that incur within SDC will have to be covered by sewerage charge to be collected, so that SDC could be an independent and self-financing company to operate and maintain the drainage and sewerage facilities to be constructed by the three Projects and the existing drainage facilities owned by HCMC. This means that total amount of sewerage charge to be collected will have to be equal or a little bit more than the costs of SDC because it is the intention of PCHCMC not only that the amount of subsidy to SDC should gradually be decreased depending on increase of it revenue of sewerage charge but also that SDC should have the role to improve the drainage systems in HCMC.

The costs that incur within SDC will be as follows:

(1) SDC's own operation and maintenance cost for HCMC's existing facilities using SDC's equipment (this cost has been being subsidized by HCMC.)
(2) The JICA Project's OM/R cost for drainage
(3) The JICA Project's OM/R cost for sewerage
(4) The NLTN Project's OM/R cost for drainage
(5) The NLTN Project's OM/R cost for sewerage
(6) The Hang Bang Project's OM/R cost for drainage
(7) Depreciation cost of SDC's existing equipment
(8) Depreciation cost of the sewerage facilities to be constructed by NLTN Project

(Phase I and II, and Phase III)

(9) Interest of the NLTN Project's subsidiary loan for the sewerage facilities (Phase I and II, and Phase III)

15.4 Financial Cost and OM/R Cost of the JICA Project

15.4.1 Financial Cost of the JICA Project

First of all, direct construction cost, engineering service cost, cost for land acquisition and compensation for relocation are to be estimated by JICA Study Team. Then, the following assumptions are applied to estimate the total Project cost:

- Physical contingency: 10% of total amount of the direct construction cost and engineering service cost,
- Administration cost: 3% of the total cost of the direct construction cost, the engineering service cost and cost for land acquisition and compensation for relocation,
- Price contingency: For estimating price contingency, following price escalation rates are applied based on a direction issued by JBIC on 12th, October 2000:

  - For foreign currency portion (FC portion): 0.8% per annum
  - For local currency portion: 0.1% per annum

  These rates are applied by means of compound rates to the above-mentioned total cost in each year during the construction period. In this case, the base year is 2000.

15.4.2 OM/R Cost of the Project

OM/R cost for Phase-I and Phase-II of the JICA Project will be born by SDC as its cost to be covered by sewerage charge to be collected. The OM/R cost will be a burden to SDC until the end of the project life of 50 years after completion of the construction works.

Operation and maintenance cost consists of the followings:

(1) Tau Hu Ben Nghe canal cleaning cost
(2) Pumping drainage improvement cost
(3) Sewer (Interceptor sewer, Conveyance sewer and Combined sewer improvement) cost
(4) Intermediate pumping station cost

(5) Wastewater treatment plant cost
(6) Head office cost

Above each cost should be separated into drainage portion and sewerage portion. In this case, above (1) Tau Hu Ben Nghe canal cleaning cost and (2) Pumping drainage improvement cost are direct costs and separated as drainage portion, while (4) Intermediate pumping station cost and (5) Wastewater treatment plant cost are direct costs and separated into sewerage portion. As far as above (3) Sewer is concerned, this direct cost should be divided into drainage portion and sewerage portion.

As next step, Head office cost are indirect cost to be allocated above each cost, so, Head office cost are calculated separately and then allocated above costs from (1) to (5).

Calculation of operation and maintenance costs is shown in Table 14.1 (1) to 14.1 (17) and summarized as shown in the next page.

Replacement cost should also be collected as a part of sewerage charge. Replacing some plant or equipment after use of their respective life requires quite a huge amount of money, therefore, such amount should be divided according to the respective life of plant or equipment and such divided amount should be collected in advance yearly as a reserve.

Annualized replacement cost for the Phase I and II of the JICA Project is calculated as also shown in the Table hereunder.

OM Cost of the Project

(Million VND/year)

Cost categories	Annual OM/R cost	
	Phase I	Phase II
Drainage		
1. Tau Hu Ben Nghe Canal	1,276	1,907
2. Pump drainage improvement	3,049	3,043
3. Sewer	538	844
Sub-total	4,863	5,794
Sewerage		
4. Sewer	1,143	2,298
5. Intermediate pumping station	3,686	8,113
6. Wastewater treatment plant	24,691	50,194
Sub-total	29,521	60,605
Total	34,384	66,399

(Note) The amount of OM cost for Phase II includes that for Phase I.

Annualized Replacement Cost of the Project

(Million VND/year)

	Phase I	Phase II
Drainage	588	1,119
Sewerage	32,441	71,420
Total	33,029	72,539

(Note) The amount of OM cost for Phase II includes that for Phase I.

15.5 Methodology of Financial Analysis

Financial analysis include the following 4 items:

(1) Financial analysis of the SDC
(2) Sewerage Tariff
(3) Affordability analysis
(4) Repayment ability analysis of the JBIC loan

For the purpose of taking into consideration of inflation of costs, the price factor is set to be 2% being the year of 2000 as the base year. This means that the price factor is applied as means of compound rate to OM/R cost in each year, however, for such costs as depreciation and interest, price factor is not applied because these amounts will be fixed by the cost of construction and the amount of loan financed. Also, price factor is not applied to sewerage charge because it will increase reflecting the inflation of OM/R cost.

Following methodologies are applied for analyzing each of the above items:

(1) Financial analysis of SDC

The purposes of financial analysis of SDC are to make projections of the financial situations of SDC in the years ahead, and consider on which conditions SDC would be a financially sound company. For these objectives, the profit and loss statement of SDC will be used until the year of 2020.

As aforementioned, the annual revenue of SDC is the amount of sewerage charge to be collected in each year which is obtained by multiplying the Sewerage Tariff of each sector, namely, domestic, industrial, commercial and public institution by total volume of public water consumed by respective sector. In this case, following two deductible items are to be considered:

- Bad debt provision: 2% of revenue so obtained, and
- Collection fee to WSC: 1.5% of net revenue after deduction of the above bad debt provision.

As accounting classification, revenues of SDC are not only limited to sewerage charge to be collected but also includes the subsidy from HCMC. Such subsidy will be entered in the profit and loss statement as revenue. Until the time when SDC will have enough amount of sewerage charge as its revenue to cover its costs, SDC will have to be subsidized.

As mentioned herein-before, costs of SDC comprise of cost for SDC own operation, the JICA Project's OM/R cost for drainage and sewerage, the NLTN Project's OM/R for drainage and sewerage, the Hang Bang Project's OM/R cost for drainage, depreciation cost for the equipment owned by SDC and the sewerage facility of the NLTN Project and the interest for the subsidiary loan for the sewerage facility of the NLTN Project. These costs are entered in the profit and loss statement of SDC as costs.

When such revenues are more than such costs, the balance will be the profit before tax. Income tax rate is assumed to be 25%. The net profit of SDC is gained deducting such income tax from the amount of profit before tax.

(2) Sewerage Tariff

Sewerage charge will have to cover all the costs of SDC so that SDC could be a self-financing company without subsidy from HCMC. Sewerage Tariff is set as aforementioned, but such Tariff should be revised according to the changes of the costs of SDC so that sewerage charge will cover fully the all costs of SDC.

However, covering all the costs of SDC by sewerage charge to be collected will not be enough to satisfy the entire required fund needed by SDC because of the adoption of subsidiary loan for the sewerage portion of the NLTN Project. Interest of such subsidiary loan as cost of SDC will be covered by the sewerage charge to be collected. But the repayment of principal of such loan requires additional fund of money not as cost of SDC and such additional fund will have to be filled by collecting further sewerage charge.

For the purpose of analyzing this additional fund being not as a cost of SDC, yearly analysis of fund flow of SDC will be necessary. Fund flow comprises of two parts, namely, the source of fund and the application of fund.

Source of fund is made up of the following items:

- Internal fund generation (depreciation and net profit)
- Loan amount to be financed
- HCMC counterpart contribution

Application of fund is made up the following items:

- Investment
- Debt retirement
- Working capital

The above working capital represents balance between the source of fund, and investment and debt retirement. Therefore, the amount of source of fund and the amount of application of fund are always the same each year. When working capital is positive, available cash of SDC increases by that amount. And when working capital is negative, available cash of SDC decreases by that amount. Using this available cash as fund for debt retirement will make repayment of principal for the subsidiary loan.

Therefore, when analyzing the revision of the Sewerage Tariff, not only the profit and loss statement of SDC but also the fund flow of SDC should be considered together. This means that sewerage charge to be collected according to the Sewerage Tariff will cover the all costs as entered in the profit and loss statement of SDC and also fill the required fund for debt retirement as shown in the fund flow of SDC.

(3) Affordability Analysis

Affordability analysis is needed to make clear whether the people living in HCMC have ability or not to pay from their income water related utility charges, namely, public water charge, sewerage charge and solid waste charge. PCHCMC suggested that the share rate of these three charges should be within 5% of income of each household.

When analyzing this affordability, followings should be taken into account:

- Tariff of Public Water increase: as aforementioned in sub-clause 14.2.1(2), public water charge is expected to increase considerably because of WSC's expansion plan.

- Sewerage Charge increase: Sewerage Charge will also increase mainly because of the start of the operation of the three Projects.

(4) Repayment Ability Analysis of JBIC Loan

As mentioned hereinbefore, the responsibility of repayment of the JBIC loan is born by the Government of Viet Nam. When analyzing the repayment ability of the Government of Viet Nam, following two points will be considered:

1. The ratio of the amount of the Government securities against the GDP of Viet Nam
2. The growth ratio of the GDP of Viet Nam

The amount of the Government securities represents the net ODA expenditure (repayment of principal and interest minus borrowings) less the net balance of the revenue and expenditure of the Government of Viet Nam. It is expected that the growth of the GDP of Viet Nam would accompany the increase of revenue of the Government of Viet Nam. If the ratio of the amount of the Government securities against the GDP of Viet Nam in these years is enough small, say 1% or around that, and the growth ratio of the GDP of Viet Nam is satisfactorily, it can be judged that the Government of Viet Nam has the repayment ability of JBIC loan.

15.6 Financial Analysis

15.6.1 Financial Analysis of UDC and Sewerage Tariff

According to the idea of PCHCMC, SDC will operate and maintain the facilities to be constructed by the three Projects and continue to operate and maintain the existing drainage facilities which HCMC owns and will improve the drainage systems of HCMC. And this is also the idea of PCHCMC that all cost that incur with the above purposes will have to be born by SDC with the appropriating revenue of sewerage charge to be collected.

Financial analysis of SDC and that of Sewerage Tariff have an inseparable relation each other because SDC's revenue of sewerage charge to be collected will be decided based on Sewerage Tariff being adjusted accordingly. That means, without analyzing Sewerage Tariff, the appropriate level of revenue of sewerage charge to be collected that covers the costs of SDC could not be analyzed. Therefore, in this sub-clause, financial analysis of both SDC and Sewerage Tariff will be carried out together.

For the purpose of financial analysis of SDC and Sewerage Tariff, the expenditure and

revenue of SDC and Sewerage Tariff to be considered are those until the year of 2020 because such period covers enough time in the years ahead and the years beyond such period would not be considered as realistic taking into consideration of future changes in socio-economic conditions.

As the first step and as already mentioned hereinbefore, costs incurs within SDC should be made clear. The costs to be covered by sewerage charge to be collected are as follows:

(1) SDC own operation and maintenance cost for HCMC's existing facilities using SDC's equipment (This cost has been being subsidized by HCMC.)
(2) The JICA Project's OM/R cost for drainage
(3) The JICA Project's OM/R cost for sewerage
(4) The NLTN Project's OM/R cost for drainage
(5) The NLTN Project's OM/R cost for sewerage
(6) The Hang Bang Project's OM/R cost for drainage
(7) Depreciation cost of SDC's existing equipment
(8) Depreciation cost of the sewerage facility to be constructed by NLTN Project (Phase I and II, and Phase III)
(9) Interest of the NLTN Project's subsidiary loan for the sewerage facilities (Phase I and II, and Phase III)

Regarding the above (1), this cost is now subsidized from HCMC. The currently required amount of such cost is estimated to be 76 billion VND p.a., however, the actual amount being subsidized by HCMC is 33billion VND yearly. Without any incoming of sewerage charge at present, SDC's own operation and maintenance works of existing drainage facilities owned by HCMC are under-budgeted and satisfactory works can not have been done by SDC. With the introduction of sewerage charge and such sewerage charge as revenue of SDC being adjusted upwards in the years ahead, SDC would be able to perform such works satisfactorily with appropriate budget and without receiving subsidy from HCMC that will gradually be decreased to be nil. The SDC's own operation and maintenance costs are assumed to increase to be the full amount of 76 billion VND by the year of 2006 (before inflation).

Regarding the above (2) and (3), details of which are described in the previous sub-clause 14.5.3 as OM/R cost of the Project.

Regarding the above (8), among five facilities in total, namely, the JICA Project's drainage and sewerage facilities, the NLTN Project's drainage and sewerage facilities and the Hang Bang Project's drainage facility, only the NLTN Project's sewerage facility is to be depreciated. The reason why the NLTN sewerage facility is only be the one to be owned by SDC as an asset because of the subsidiary loan as aforementioned. (SDC owns

no drainage facility at present.)

Total costs of SDC is shown in the Table 14.2 and summarized bellow:

(Million VND)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
32,957	45,363	54,417	74,295	101,010	132,518	235,543	291,170	293,219	297,074	301,002

2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
427,206	487,957	552,186	655,952	660,758	658,699	648,803	643,783	638,298	632,309

Current yearly subsidy amount to SDC from HCMC is about 33,000 billion VND. As such amount will be increased in the year 2002 and 2003 because of the cost for NNLTN Project without revision of such rate of charge according to the said Decision of PCHCMC. After the starting of revision of the sewerage charge, the subsidy will be decreased according to the increase of the total amount of sewerage charge to be collected. Such amounts to be subsidized are assumed to be as follows:

(Million VND)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
33,000	33,000	33,317	53,313	30,000	25,000	25,000	25,000	0	0

Based on the figures of public water consumed in the year of 2000 as stated in sub-clause 14.2.1(2), total volume of public water consumed in each year is calculated in proportion to the water connection growth rates as stated in sub-clause 14.2.1(2) too with multiplying the price-demand elasticity assumed to be at 20%.

Then, total amount of sewerage charge to be collected in each year will be got by summing up the respective yearly total amounts of sewerage charge which is calculated multiplying unit sewerage charge by the volume of public water consumed as above-mentioned in each year. In this case, the amounts of sewerage charge in each year as calculated using Sewerage Tariff as above-mentioned after deducting bad debt collection and collection fee to WSC, together with the amount of subsidy from HCMC as also mentioned above have to cover all the costs of SDC. And it must be considered that Sewerage Tariff are kept at the same rate from 2001 to 2003 as mentioned above and then reviewed and revised after the year of 2004 but not annually.

In this way, Sewerage Tariff to be recommended is acquired as follows (the figures in the year of 2001 are the rates decided by PCHCMC in VND/m^3 and the percentages thereafter show the rates of increase which are recommended.):

(VND/m^3)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sewerage charge	264	264	264	837	1,163	2,094	2,513	2,714	2,714

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
2,714	3,691	4,097	4,547	5,229	5,229	5,229	5,229	5,229	5,229	5,229

Based on the above-recommended Sewerage Tariff, the revenue of sewerage charge is calculated as follows:

(Million VND)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	22,533	21,853	21,736	73,593	111,970	218,394	276,312	304,174	310,044	314,133

2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
443,790	506,557	574,746	679,710	699,011	716,003	733,426	751,290	769,609	788,392

From the above table, it is understood that although Sewerage Tariff remains the same after the year of 2014, the revenue of sewerage charge increases yearly and rather considerably. This is solely because water connection growth rates as mentioned in sub-clause 14.2.1(2) are assumed to increase also in these years.

From the above mentioned revenue and cost of SDC and other related matters also mentioned herein-before, the profit and loss statement of SDC from 2000 to 2020 is made and shown in Table 14.2.

Fund flow analysis was also made to ascertain whether SDC will have enough available cash or not to repay the principal of NLTN subsidiary loan for sewerage facility as aforementioned. As a result of such analysis, it can be said that SDC will have enough available cash to repay the principal of such loan. However, after the year of 2015 when the repayment of principal of subsidiary loan for Phase III of NLTN Project starts, working capital of SDC will become negative. In spite of that, because SDC will have a considerably large amount of available cash by that time, SDC will be able to repay such principal from the available cash at that time. As far as the repayment of the principal of the subsidiary loan for sewerage facility of NLTN Phase I and II is concerned, mainly because of the reason that the World Bank is planning an accelerated depreciation for such facility (being 25 years although Phase III facility will be depreciated in 50 years as normal depreciation) while net repayment period is 19 years (repayment period being 25 years with grace period being 6 years), SDC will be able to make repayment of principal of subsidiary loan for Phase I and II sewerage facility by using only the sewerage charge to be collected which covers all the costs of SDC without collecting additional fund by

further sewerage charge.

Fund Flow of SDC is shown in Table 14.3 and working capital and available cash are summarized as follows:

(Million VND)

Year	2000	2001	2002	2003	2004	2005	2006
Working capital	4,914	9,998	2,957	2,957	2,979	3,382	3,161
Available cash	17,506	27,504	30,461	33,418	36,397	39,780	42,941

Year	2007	2008	2009	2010	2011	2012	2013
Working capital	1,175	1,060	8,376	565,628	870,548	900,555	622,756
Available cash	44,116	45,176	53,551	619,180	1,489,728	2,390,284	3,013,040

Year	2014	2015	2016	2017	2018	2019	2020
Working capital	67,707	-52,046	-46,168	-39,930	-32,269	-24,519	-16,680
Available cash	3,080,746	3,028,700	2,982,532	2,942,603	2,910,333	2,885,814	2,869,134

From the above financial analysis, it can be concluded that as far as Sewerage Tariff will be adjusted upwards properly and at appropriate times in order to cover all the costs of SDC, it could be a financially sound as self-financing company with its revenue of sewerage charge to be collected. Regarding the Sewerage Tariff, it should be adjusted accordingly as aforementioned.

15.6.2 Affordability Analysis

Affordability analysis is made to clear whether the people living in HCMC have ability to pay the water related utility charges consisting of public water charge, sewerage charge and solid waste charge. PCHCMC suggests that the total amount of these three charges should be the same with or less than 5% of the average income of each household.

When analyzing the affordability, following assumptions are made:

(1) Income of each household is to be 1,947,893 VND/month as of 1998 based on the interview survey made by JICA Study Team at the Feasibility Study Stage. Such amount of income is also assumed to increase with a rate of 4.5% yearly. As mentioned in the sub-clause 14.7.3 hereunder, GDP in Viet Nam grew out ranging from 4.8 % to 9.5 % since 1993. Generally speaking, per capita income of the people reflects the growth rate of GDP. From this viewpoint, the increasing rate of income of 4.5 % may be rather conservative one.

(2) Tariff of Public Water will increase as a result of WSC expansion plan according to the rates as stated in sub-clause 14.2.1(2) of this chapter.

(3) Basic sewerage charge at the starting time is assumed at 204 VND/m^3 based on the

said Decision of PCHCMC and present water charge for domestic users. The Decision says that unit sewerage tariff should be at 12 % of the unit water charge, and the present water charge is applying at 1,700 VND/m^3 as the WSC's existing water tariff system.

(4) Sewerage Tariff will be revised according to the rate as recommended in sub-clause 14.7.1.

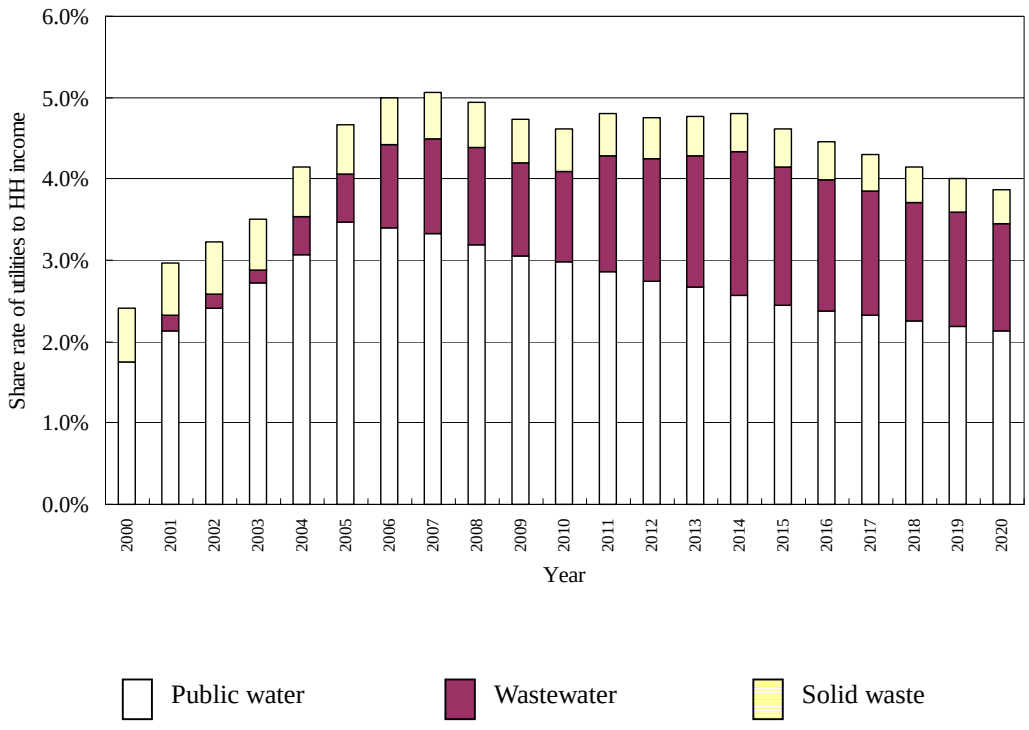
(5) Solid waste charge is assumed to be 14,000 VND/month/household.

(6) Public water to be consumed by each person per month is to be 4 m^3.

(7) Family size of each household is to be 5.71 persons that is also the result of interview survey conducted by JICA Study Team at the stage of Feasibility Study.

Based on the above, affordability analysis is carried out and the result is shown in Table 14.4 and illustrated bellow:

Share Rate of Water Related Utility Charges to Household Income



According to the said table and illustration above, the share rate of expenditures for water related utilities to the household income is almost the same or under the limitation of 5% as suggested by PCHCMC according to the recommendation from the World Bank. As it is clear from the above illustration, most of the utilities' charge is occupied by public water charge. This is because of the Tariff of Public Water increase as a result of WSC's

expansion plan as already mentioned. Share rates of sewerage charge and solid waste are rather small comparing to that of public water charge. It can be said from the above analysis that people living in HCMC have the ability to pay water-related utilities charge from their income.

15.6.3 Repayment Ability Analysis of JBIC Loan by the Government of Viet Nam

JBIC loans for the General Environmental Project and Special Environmental Project both for the Phase I of the JICA Project are made based on the conditions that are already explained in the previous sub-clause in 14.5.1.

The Repayment ability analysis of JBIC loan by the Government of Viet Nam is made by the ratio of the Government securities against the GDP of Viet Nam. In this case, it is assumed that the ratio of the Government securities against the GDP of Viet Nam represents how the burden of the repayment of ODA loans depends on the economy of Viet Nam and the growth rate of GDP of Viet Nam represents how the economy of Viet Nam will be. And it is expected that the growth of GDP of Viet Nam would accompany the increase of revenue of the Government of Viet Nam.

The revenue and expenditure of the Government of Viet Nam was gotten as follows from the web-site homepage of the World Bank:

(Billion VND)

	1993	1994	1995	1996	1997
A. Revenue and grant	30,696	42,125	53,370	62,387	66,310
B. Expenditure	35,226	42,836	51,694	60,189	65,944
C. Balance (A-B)	-4,530	-711	1,676	2,198	366
D. Interest	1,710	1,094	2,895	2,700	2,166
E. Overall balance (C-D)	- 6,240	-1,805	-1,219	-502	-1,800
F. Foreign loans (G-H)	3,726	240	-1,490	-50	-953
G. Utilization	5,184	1,500	1,470	2,400	2,161
H. Amortization	1,458	1,260	2,960	2,450	3,114
I. Government Securities ((E+F) x (-1))	2,514	1,565	2,709	552	2,753

According to the above table, the amount of the Government securities represents the net expenditure relating to the foreign loan (repayment of principal and interest minus borrowings). Namely, the Government securities are most of which are estimated to be the net ODA expenditure, less the net balance of the revenue and expenditure of the Government of Viet Nam.

According to the Statistical Yearbook 2000, the GDPs of Viet Nam during the year from 1993 to 1997 are as follows:

GDP of Viet Nam 1993 – 1997 (at Constant 1994 Price)

(Billion VND)

1993	1994	1995	1996	1997
164,043	178,534	195,567	213,833	231,264

The ratios of amount of the Government securities against the GDP of Viet Nam are calculated as follows:

1993	1994	1995	1996	1997
1.5%	0.9%	1.4%	0.3%	1.2%

From the above figures, it can be said that the ratios of the amount of the Government securities against the GDPs of Viet Nam, namely, the dependency of the burden of the repayment of ODA loans to the economy of Viet Nam, are almost at around 1%.

Also, according to the Statistical Yearbook 2000, the GDPs of Viet Nam and their respective growth rate to the previous years are as follows:

GDP of Viet Nam (at Constant 1994 Price)

Year	1993	1994	1995	1996	1997	1998	1999	2000
GDP (Trillion VND)	164.0	178.5	195.6	213.8	231.3	244.6	256.3	273.4
Growth ratio	8.1%	8.8%	9.5%	9.3%	8.2%	5.8%	4.8%	6.7%

The growth ratio of GDP of Viet Nam fell to 4.8% at 1999, but it gained to 6.7% at 2000. In these three years from 1998 to 2000, growth ratios of GDP of Viet Nam are almost 5% or more than 5%. From the above table, it can be said that economic activities of Viet Nam are growing highly and expected to continue to grow steadily.

As a result of financial analysis, from the reasons that the ratios of the amount of the Government securities against GDP are almost at around 1% and the GDP of Viet Nam is growing highly at the level of almost or more than 5% in these years and can be expected to continue to grow steadily in the years ahead, it can be concluded that the Government of Viet Nam has the repayment ability of JBIC loan.

15.7 Conclusion

From the above analyses, it is concluded as follows:

(1) Financial Soundness of SDC

On the condition that Sewerage Tariff will be adjusted upwards properly and at appropriate times, SDC could be a financially sound company as self-financing one without subsidized from HCMC.

(2) Recommended Revision of Sewerage Tariff

It is recommended that Sewerage Tariff should be revised as a way as stated in sub-clause 14.7.1 in order to cover all the costs of SDC.

(3) Affordability of People in HCMC for Water Related Utility Charges

The share rate of the total amount of public water charge, sewerage charge and solid waste charge against the each household income will be expected always to be almost 5% or less than 5% in each year ahead, it can be concluded that people in HCMC have enough ability to pay for such charges of water related utilities from their income.

(4) Repayment Ability of the JBIC Loan by the Government of Viet Nam

From the viewpoint of the ratios of the Government securities against the GDP of Viet Nam, namely, around within 1% in these years, and that the GDP of Viet Nam has been growing steadily and highly at around the rate of 5% in these years, it can be said that the Government of Viet Nam has the ability to repay fully the JBIC loan for Phase I to be financed.

Table 15.1 (1) Summary of Operation and Maintenance Cost

1. Summary of Operation and Maintenance Cost

(Million VND)

	Annual operating and maintenance cost					
	Phase I			Phase II		
	Direct cost	H.O. cost allocation	Total	Direct cost	H.O. cost allocation	Total
Drainage						
Tau Hu - Ben Nghe Canal	1,189	87	1,276	1,840	67	1,907
Pump drainage improvement	2,841	208	3,049	2,935	107	3,043
Sewer	502	37	538	815	30	844
Sub-total	4,532	331	4,863	5,590	204	5,794
Sewerage						
Sewer	1,066	78	1,143	2,217	81	2,298
Intermediate pumping station	3,435	251	3,686	7,827	286	8,113
Wastewater treatment plant	23,009	1,682	24,691	48,423	1,771	50,194
Sub-total	27,510	2,011	29,521	58,467	2,138	60,605
Total	32,041	2,343	34,384	64,057	2,343	66,399

1.1 Proportion of Each Direct Cost against the total Direct Operation and Maintenance Cost

	Phase I			Phase II		
	Annual cost Million VND	Reference	Share rate	Annual cost Million VND	Reference	Share rate
Tau Hu Ben Nghe Canal	1,189	Table 14.1 (2)	3.71%	1,840	Table 14.1 (2)	2.87%
Pump drainage improvement	2,841	Table 14.1 (3)	8.87%	2,935	Table 14.1 (3)	4.58%
Sewer (Drainage)	502	Table 14.2.4 (7)	1.57%	815	Table 14.2.4 (7)	1.27%
Sewer (Sewerage)	1,066	Table 14.2.4 (7)	3.33%	2,217	Table 14.2.4 (7)	3.46%
Intermediate pumping station	3,435	Table 14.2.4 (11	10.72%	7,827	Table 14.2.4 (11	12.22%
Wastewater treatment plant	23,009	Table 14.2.4 (14	71.81%	48,423	Table 14.2.4 (14	75.59%
	32,041		100.00%	64,057		100.00%

1.2 Head Office Indirect Cost

(Million VND/year)

	Phase I	Phase II
Head office indirect cost	2,343	2,343

1.3 Head Office Indirect Cost Allocation to Each Direct Cost

(Million VND/year)

	Phase I			Phase II		
(Head Office cost)	2,343		Annual cost	2,343		Annual cost
Tau Hu Ben Nghe Canal	2,343	x 3.71%	87	2,343	x 2.87%	67
Pump drainage improvement	2,343	x 8.87%	208	2,343	x 4.58%	107
Sewer (Drainage)	2,343	x 1.57%	37	2,343	x 1.27%	30
Sewer (Sewerage)	2,343	x 3.33%	78	2,343	x 3.46%	81
Intermediate pumping station	2,343	x 10.72%	251	2,343	x 12.22%	286
Wastewater treatment plant	2,343	x 71.81%	1,682	2,343	x 75.59%	1,771

Table 15.1 (2) Operation and Maintenance Direct Cost for Tau Hu Ben Nghe Canal

(Million VND/year)

Phase I	Phase II
1,189	1,840

Table 15.1 (3) Operation and Maintenance Direct Cost for Pump Drainage Improvement Direct (1/4

Item	Annual cost	
	Phase I	Phase II
1. Personnel cost	350	422
2. Utility	2,318	2,319
3. Monitoring	25	18
4. Mechanical and electrical maintenanc	58	68
5. Civil and architectural maintenance	47	58
6. Main furniture and fixture	8	8
7. Miscellaneous	35	42
Total	2,841	2,935

Table 15.1 (4) Pump Drainage Improvement Direct Cost (2/4)

1. Annual Personnel Cost

(1,000VND)

Job Title	Phase I			Phase II		
	Number	Monthly Salary	Annual Cost	Number	Monthly Salary	Annual Cost
Ben Me Coc 1						
Senior Station Manager	1	3,000	36,000	1	3,000	36,000
Operation Team Leader	1	2,500	30,000	1	2,500	30,000
- Electrical Technitian	1	2,000	24,000	1	2,000	24,000
Maintenance Team Leader	1	2,500	30,000	1	2,500	30,000
- Electrical Technician	1	2,000	24,000	1	2,000	24,000
Assistant Manager	1	2,500	30,000	1	2,500	30,000
- Secretaries	2	2,000	48,000	2	2,000	48,000
- Driver	1	2,000	24,000	1	2,000	24,000
- Guardian	1	1,200	14,400	1	1,200	14,400
- Janitor	1	1,500	18,000	1	1,500	18,000
Ben Me Coc 2						
Operation Team Leader	0	2,500	0	1	2,500	30,000
- Electrical Technitian	0	2,000	0	1	2,000	24,000
- Janitor	0	1,500	0	1	1,500	18,000
Thanh Da						
Operation Team Leader	1	2,500	30,000	1	2,500	30,000
- Electrical Technitian	1	2,000	24,000	1	2,000	24,000
- Janitor	1	1,500	18,000	1	1,500	18,000
Total	14		350,400	17		422,400

Table 15.1 (5) Pump Drainage Improvement Direct Cost (3/4)

2.Utility (Million VND/year)

	Phase I				Phase II			
	B.M.C.1	B.M.C.2	Thanh Da	Sub-total	B.M.C.1	B.M.C.2	Thanh Da	Sub-total
Electricity	1,347	0	968	2,315	1,347	0	968	2,315
Water	2	0	1	3	2	1	1	4
Total	1,349	0	969	2,318	1,349	1	969	2,319

3.Monitoring (Million VND/year)

	Phase I				Phase II			
	B.M.C.1	B.M.C.2	Thanh Da	Sub-total	B.M.C.1	B.M.C.2	Thanh Da	Sub-total
Monitoring	-	-	-	25	-	-	-	18
Total	-	-	-	25	-	-	-	18

4.Mechanical and Electrical Maintenance (Million VND/year)

	Phase I				Phase II			
	B.M.C.1	B.M.C.2	Thanh Da	Sub-total	B.M.C.1	B.M.C.2	Thanh Da	Sub-total
Machinery*[1]	29	0	29	58	5	34	29	68
Electricity*[2]	6	0	6	12	9	8	6	23
	35	0	35	70	14	42	35	91

5.Civil and Architectural Maintenance (Million VND/year)

	Phase I				Phase II			
	B.M.C.1	B.M.C.2	Thanh Da	Sub-total	B.M.C.1	B.M.C.2	Thanh Da	Sub-total
Civil Structure*[1]	24	14	9	47	27	22	9	58
Architecural*[2]	0	0	0	0	0	0	0	0
Total	24	14	9	47	27	22	9	58

Table 15.1 (6) Pump Drainage Improvement Direct Cost (4/4)

6. Main Furniture and Fixture (Both for Phase I and Phase II)

(Million VND/year)

Item	Number	Unit Price	Cost	Life of Equip.(yrs)	Annualized Cost
Computor	2	13	26	5	5
Printer	2	6	12	5	2
Total			38		8

7. Miscellaneous Cost

(10% of personnel cost)

(Million VND/year)

	Phase I	Phase II
Miscellasneous cost	0	0

Table 15.1 (7) Sewer Direct Cost (1/4)

Summary

(Million VND/year)

		Phase I		Phase II	
		Drainage	Sewerage	Drainage	Sewerage
1.	Newly introduced equipm	1,500,000	3	54,000,000	0
2.	Manpower cleaning	0	0	0	0
3.	Flow control	-	0	-	0
4.	Civil maintenance	-	0	-	0
5.	Miscellaneous	0	0	0	0
Total		1,500,000	3	54,000,000	0

Table 15.1 (8) Sewer Direct Cost (2/4)

1. Newly Introduced Equipment for Sewer < 1,200 mm

1.1 Summary

(Million VND/year)

	Phase I		Phase II	
	Drainage	Sewerage	Drainage	Sewerage
Personnel cost	1,800 x 3.54% = 64	1,800 x 7.65% = 138	1,800 x 3.41% = 61	1,800 x 28.89% = 520
Fuel and maintenance	3,017 x 3.54% = 107	3,017 x 7.65% = 231	3,017 x 3.41% = 103	3,017 x 28.89% = 872
Total	170	369	164	1,392

1.2 Personnel Cost

(VND)

	Phase I			Phase II		
Job title	Number	Monthly sala	Annual cost	Number	Monthly salary	Annual cost
(Jet cleaner)						
Driver	2	1,500,000	36,000,000	2	1,500,000	36,000,000
Operator	2	1,500,000	36,000,000	2	1,500,000	36,000,000
Worker	4	1,500,000	72,000,000	4	1,500,000	72,000,000
(Vacume cleaner)						
Driver	2	1,500,000	36,000,000	2	1,500,000	36,000,000
Operator	2	1,500,000	36,000,000	2	1,500,000	36,000,000
Worker	4	1,500,000	72,000,000	4	1,500,000	72,000,000
(Water Tanker)						
Driver	6	1,500,000	108,000,000	6	1,500,000	108,000,000
Operator	6	1,500,000	108,000,000	6	1,500,000	108,000,000
(Sludge Truck)						
Driver	18	1,500,000	324,000,000	18	1,500,000	324,000,000
Worker	37	1,500,000	666,000,000	37	1,500,000	666,000,000
(Truck for equip.)						
Driver	3	1,500,000	54,000,000	3	1,500,000	54,000,000
Operator	11	1,500,000	198,000,000	11	1,500,000	198,000,000
Worker	3	1,500,000	54,000,000	3	1,500,000	54,000,000
Total	100		1,800,000,000	100		1,800,000,000

1.3 Fuel Cost and Maintenance Cost

(Million VND)

Item	Phase I			Phase II		
	Annual fuel cost	Annual haintenance*	Total	Annual fuel cost	Annual maintenance*	Total
Jet cleaner	60			60		
Vacume cleaner	54			54		
Water tanker	98			98		
Sludge truck	244			244		
Track for equip.	49			49		
Total	504	2,513	3,017	504	2,513	3,017

1.4 Operation and Maintenance Ratio of above 1.2 and 1.3 according to the Length of Sewer

		Length (m)	Ratio	
Phase I	Existing	136,310	88.81%	
	Constructed by Phase I drainage	5,431	3.54%	3.54%
	Constructed by Phase I sewerage	11,741	7.65%	7.65%
Total		153,482	100.00%	
Phase II	Existing	136,310	67.70%	
	Constructed by Phase I drainage	5,431	2.70%	
	Constructed by Phase II drainage	1,437	0.71%	3.41%
	Constructed by Phase I sewerage	11,741	5.83%	
	Constructed by Phase II sewerage	46,434	23.06%	28.89%
Total		201,353	100.00%	

Table 15.1 (9) Sewer Direct Cost (3/4)

2. Manpower Cleaning for Newly Constructed Sewer for = and > 1200 mm

2.1 Summary

(Million VND/year)

	Phase I		Phase II	
	Drainage	Sewerage	Drainage	Sewerage
Personnel cost	372 x 79.41%	372 x 20.59%	744 x 78.71%	744 x 21.29%
	295	77	586	158

2.2 Personnel Cost

(VND)

	Phase I			Phase II		
Job title	Number	Monthly salary	Annual cost	Number	Monthly salary	Annual cost
Technician	2	2,000,000	48,000,000	4	2,000,000	96,000,000
Worker	16	1,500,000	288,000,000	32	1,500,000	576,000,000
Driver	2	1,500,000	36,000,000	4	1,500,000	72,000,000
Total	20		372,000,000	40		744,000,000

2.3 Operation and Maintenance Ratio of above 2.2 according to the Length of Sewer

		Length (m)	Ratio	
Phase I	Constructed by Phase I drainage	13,231	79.41%	
	Constructed by Phase I sewerage	3,431	20.59%	
Total		16,662	100.00%	
Phase II	Constructed by Phase I drainage	13,231	27.22%	}
	Constructed by Phase II drainage	25,023	51.49%	} 78.71%
	Constructed by Phase I sewerage	3,431	7.06%	}
	Constructed by Phase II sewerage	6,917	14.23%	} 21.29%
Total		48,602	100.00%	100.00%

3. Flow Control

(VND)

	Phase I			Phase II		
Job title	Number	Monthly salary	Annual amount	Number	Monthly salary	Annual amount
Flow controller	30	1,500,000	540,000,000	30	1,500,000	540,000,000

4. Civil Maintenance of Conveyance Maintenance Road

(Million VND/year)

	Phase I	Phase II
Maintenance cost*	5	5

Table 15.1 (10) Sewer Direct Cost (4/4)

5. Miscellaneous Cost

(10% of personnel cost)

5.1 Summary of Personnel Cost

(Million VND/year)

	Phase I		Phase II	
	Drainage	Sewerage	Drainage	Sewerage
Newly introduced equipment	64	138	61	520
Manpower cleaning	295	77	586	158
Flow control	-	540	-	540
Total	359	754	647	1,218

5.2 Miscellaneous Cost

(Million VND/year)

Phase I		Phase II	
Drainage	Sewerage	Drainage	Sewerage
36	75	65	122

Table 15.1 (11) Intermediate Pumping Station Direct Cost (1/3)

Summary

(Million VND/year)

Item	Annual cost	
	Phase I	Phase II
1. Personnel cost	410	470
2. Utility	2,453	6,163
3. Monitoring	21	21
4. Waste disposal	87	287
5. Mechanical and electrical maintenance	400	792
6. Civil and architectural maintenance	19	43
7. Main furniture and fixture	4	4
8. Miscellaneous	41	47
Total	3,435	7,827

Table 15.1 (12) Intermediate Pumping Station Direct Cost (2/3)

1. Annual Personnel Cost

(VND)

Job Title	Phase I			Phase II		
	Number	Monthly Salary	Annual Cost	Number	Monthly Salary	Annual Cost
Station Mgr.	1	3,000,000	36,000,000	1	3,000,000	36,000,000
Operation Team Leader	1	2,500,000	30,000,000	1	2,500,000	30,000,000
-Operators	2	2,000,000	48,000,000	3	2,000,000	72,000,000
Maintenance Team Leader	1	2,500,000	30,000,000	1	2,500,000	30,000,000
- Electrical Technician	1	2,000,000	24,000,000	1	2,000,000	24,000,000
- Civil/Architectural Engineer	1	2,000,000	24,000,000	1	2,000,000	24,000,000
- Workers	3	1,500,000	54,000,000	5	1,500,000	90,000,000
Survey & Investigation Section Ldr.	1	2,500,000	30,000,000	1	2,500,000	30,000,000
Administration Section Ldr.	1	2,500,000	30,000,000	1	2,500,000	30,000,000
- Secretaries	2	2,000,000	48,000,000	2	2,000,000	48,000,000
- Driver	1	2,000,000	24,000,000	1	2,000,000	24,000,000
- Guardian	1	1,200,000	14,400,000	1	1,200,000	14,400,000
- Janitor	1	1,500,000	18,000,000	1	1,500,000	18,000,000
Total	17		410,400,000	20		470,400,000

Table 15.1 (13) Intermediate Pumping Station Direct Cost (3/3)

2. Utility

(Million VND/year)

	Phase I	Phase II
Electricity	2,450	6,160
Water	3	3
Total	2,453	6,163

3. Monitoring

(Million VND/year)

	Phase I	Phase II
Monitoring	21	21

4. Waste Disposal

(Million VND/year)

	Phase I	Phase II
Waste disposal	87	287

5. Mechanical and Electrical Maintenance

(Million VND/year)

	Phase I	Phase II
Machinery*[1]	311	635
Electricity*[2]	89	157
Total	400	792

6. Civil and Architectural Maintenance

(Million VND/year)

	Phase I	Phase II
Civil structure*[1]	14	24
Architectural*[2]	5	19
Total	19	43

7. Main Furniture and Fixture (Both for Phase I and Phase II)

(Million VND/year)

Item	Number	Unit price	Cost	Life of equipment(yrs)	Annualized cost
Computor	1	13	13	5	3
Printer	1	6	6	5	1
			19		4

8. Miscellaneous Cost

(10% of personnel cost)

(Million VND/year)

	Phase I	Phase II
Miscellasneous cost	41	47

Table 15.1 (14) Wastewater Treatment Plant (1/3)

Summary

(Million VND/year)

Item	Annual cost	
	Phase I	Phase II
1. Personnel cost	1,439	1,637
2. Utility	17,769	38,607
3. Monitoring	21	21
4. Waste disposal	537	1,787
5. Laboratory	72	72
6. Mechanical and electrical maintenance	2,606	5,248
7. Civil and architectural maintenance	415	881
8. Main furniture and fixture	6	6
9. Miscellaneous	144	164
Total	23,009	48,423

Table 15.1 (15) Wastewater Treatment Plant (2/3)

1. Annual Personnel Cost

(VND)

Job Title	Phase I			Phase II		
	Number	Monthly Salary	Annual Cost	Number	Monthly Salary	Annual Cost
Plant Mgr.	1	4,500,000	54,000,000	1	4,500,000	54,000,000
Technical Deputy Mgr.	1	3,500,000	42,000,000	1	3,500,000	42,000,000
Operation Section Chief	1	3,000,000	36,000,000	1	3,000,000	36,000,000
Assistant Chief	0	2,500,000	0	1	2,500,000	30,000,000
- Sludge Treat./Centrifugal Thickening Eng.	2	2,000,000	48,000,000	3	2,000,000	72,000,000
- Dewatering Eng.	2	2,000,000	48,000,000	3	2,000,000	72,000,000
- Composting Eng.	0	2,000,000	0	2	2,000,000	48,000,000
- Water Treatment Eng.	5	2,000,000	120,000,000	5	2,000,000	120,000,000
- Sludge Treatment Eng.	5	2,000,000	120,000,000	5	2,000,000	120,000,000
- Mechanical Technician	2	2,000,000	48,000,000	2	2,000,000	48,000,000
- Electrical Technician	2	2,000,000	48,000,000	2	2,000,000	48,000,000
Maintenance Section Chief	1	2,500,000	30,000,000	1	2,500,000	30,000,000
- Mechanical Technicians	2	2,000,000	48,000,000	2	2,000,000	48,000,000
- Electrical Technicians	2	2,000,000	48,000,000	2	2,000,000	48,000,000
- Civil Eng.	2	2,000,000	48,000,000	2	2,000,000	48,000,000
- Architectural Eng.	2	2,000,000	48,000,000	2	2,000,000	48,000,000
- Workers	16	1,500,000	288,000,000	16	1,500,000	288,000,000
Survey & Investigation Section Chief	1	3,000,000	36,000,000	1	3,000,000	36,000,000
- Analytical Specialists	2	2,000,000	48,000,000	2	2,000,000	48,000,000
- Laboratory Workers	3	2,000,000	72,000,000	6	2,000,000	144,000,000
Administration Deputy Mgr.	1	3,500,000	42,000,000	1	3,500,000	42,000,000
- Secretaries	3	2,000,000	72,000,000	3	2,000,000	72,000,000
- Drivers	2	2,000,000	48,000,000	2	2,000,000	48,000,000
- Guardians	2	1,200,000	28,800,000	2	1,200,000	28,800,000
- Janitor	1	1,500,000	18,000,000	1	1,500,000	18,000,000
Total	61		1,438,800,000	69		1,636,800,000

Table 15.1 (16) Wastewater Treatment Plant (3/3)

2. Utility

(Million VND/year)

	Phase I	Phase II
Electricity	14,835	28,874
Chemical	2,925	9,722
Water	9	11
Total	17,769	38,607

3. Monitoring

(Million VND/year)

	Phase I	Phase II
Monitoring	21	21

4. Waste Disposal

(Million VND/year)

	Phase I	Phase II
Waste disposal	537	1,787

5. Laboratory

(Million VND/year)

	Phase I	Phase II
Laboratory	72	72

6. Mechanical and Electrical Maintenance

(Million VND/year)

	Phase I	Phase II
Machinery*[1]	2,045	3,600
Electricity*[2]	561	1,648
Total	2,606	5,248

7. Civil and Architectural Maintenance

(Million VND/year)

	Phase I	Phase II
Civil structure*[1]	299	661
Architectural*[2]	116	220
Total	415	881

8. Main Furniture and Fixture (Both for Phase I and Phase II)

Million VND/year)

Item	Number	Unit price	Cost	Life of equipment(yrs)	Annualized cost
Computor	2	13	26	5	5
Printer	1	6	6	5	1
			32		6

9. Miscellaneous Cost

(10% of personnel cost)

(Million VND/year)

	Phase I	Phase II
Miscellasneous cost	144	164

Table 15.1 (17) Head Office Indirect Cost

1. Summary of Head Office Annual Cost

(million VND/year)

Item	Phase I	Phase II
Personnel Cost	2,082	2,082
Main Furniture and Fixture	52	52
Miscellaneous cost	208	208
Total	2,343	2,343

1.1 Annual Personnel Cost (Head Office)

(VND)

Job Title	Phase I			Phase II		
	Number	Monthly Salary	Annual Cost	Number	Monthly Salary	Annual Cost
Managing Director	1	4,500,000	54,000,000	1	4,500,000	54,000,000
Dept. Mgr. of Technical Operation	1	3,500,000	42,000,000	1	3,500,000	42,000,000
- Operation	3	2,500,000	90,000,000	3	2,500,000	90,000,000
- Maintenance and Repair	3	2,000,000	72,000,000	3	2,000,000	72,000,000
- Procurement and Storehouse	3	2,000,000	72,000,000	3	2,000,000	72,000,000
- Laboratory	3	2,000,000	72,000,000	3	2,000,000	72,000,000
- Management of Design and Const.	5	2,000,000	120,000,000	5	2,000,000	120,000,000
Dept. Mgr. of Commercial Operation	1	3,500,000	42,000,000	1	3,500,000	42,000,000
- Marketing	2	3,000,000	72,000,000	2	3,000,000	72,000,000
- Customer Registration	3	2,000,000	72,000,000	3	2,000,000	72,000,000
- Billing and Collection	5	2,000,000	120,000,000	5	2,000,000	120,000,000
Dept. Mgr. of Planning	1	3,500,000	42,000,000	1	3,500,000	42,000,000
- Planning New Facilities	2	3,000,000	72,000,000	2	3,000,000	72,000,000
- Planning Level 1 to 3	2	2,500,000	60,000,000	2	2,500,000	60,000,000
- Planing Level 4 & smaller	2	2,000,000	48,000,000	2	2,000,000	48,000,000
Dept. Mgr. of Financial Control	1	3,500,000	42,000,000	1	3,500,000	42,000,000
- Financial Admin. and Cost Control	5	2,500,000	150,000,000	5	2,500,000	150,000,000
- Accounting	15	2,000,000	360,000,000	15	2,000,000	360,000,000
Dept. Mgr. of Admin. Support	1	3,500,000	42,000,000	1	3,500,000	42,000,000
- Public and Customer Relations	5	2,500,000	150,000,000	5	2,500,000	150,000,000
- Human Resources	5	2,000,000	120,000,000	5	2,000,000	120,000,000
- Supply and Asset	3	2,000,000	72,000,000	3	2,000,000	72,000,000
- General	3	2,000,000	72,000,000	3	2,000,000	72,000,000
- Driver	1	2,000,000	24,000,000	1	2,000,000	24,000,000
Total	76		2,082,000,000	76		2,082,000,000

1.2 Main Furniture and Fixture (Head Office both for Phase I and Phase II)

(Million VND/year)

Item	Number	Unit Price	Cost	Life of Equip.(yrs)	Annualized Cost
Computor	3	13	39	5	8
Printer	1	6	6	5	1
Car	1	435	435	10	44
			480		52

1.3 . Miscellaneous Cost

(10% of Personnel Cost)

(Million VND/year)

	Phase I	Phase II
Miscellaneous cost	208	208

Table 15.2 UDC Profit and Loss Projection (Current Price)

(million VND) (million VND)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A. Revenue of wastewater charge	0	22,533	21,858	21,736	73,593	111,970	218,394	276,312	304,174	310,044	314,133	443,790	506,557	574,746	679,710	699,011	716,003	733,426	751,290	769,609	788,392
B. WSC collection fee (1.5%)		331	321	320	1,082	1,646	3,210	4,062	4,471	4,558	4,618	6,524	7,446	8,449	9,992	10,275	10,525	10,781	11,044	11,313	11,589
C. Bad debt provision (2%)		451	437	435	1,472	2,239	4,368	5,526	6,083	6,201	6,283	8,876	10,131	11,495	13,594	13,980	14,320	14,669	15,026	15,392	15,768
D. HCMC subsidy	33,000	33,000	33,317	53,313	30,000	25,000	25,000	25,000	0	0	0	0	0	0	0	0	0	0	0	0	0
E. Subtotal (A -B -C +D)	33,000	54,751	54,417	74,295	101,039	133,085	235,816	291,724	293,619	299,286	303,233	428,391	488,979	554,802	656,124	674,755	691,157	707,976	725,221	742,903	761,035
F. OM cost for UDC own operation	30,000	38,420	47,165	56,244	65,668	75,446	85,588	87,300	89,046	90,827	92,644	94,496	96,386	98,314	100,280	102,286	104,332	106,418	108,547	110,718	112,932
G. OM/R cost for The JICA Project operation	0	0	0	0	0	0	75,918	77,436	78,985	82,312	83,958	172,752	176,207	179,731	183,326	186,992	190,732	194,547	198,438	202,406	206,455
Drainage	0	0	0	0	0	0	6,139	6,261	6,387	8,262	8,427	8,595	8,767	8,943	9,122	9,304	9,490	9,680	9,873	10,071	10,272
Sewerage	0	0	0	0	0	0	69,779	71,175	72,598	74,050	75,531	164,156	167,440	170,788	174,204	177,688	181,242	184,867	188,564	192,335	196,182
H. OM/R cost for the NLTN Project operation	0	3,986	4,184	4,474	5,553	8,826	12,451	22,028	23,605	25,176	28,077	29,850	31,603	34,766	36,199	37,667	40,615	41,439	42,261	43,085	43,909
Drainage	0	2,847	2,989	3,196	3,416	3,647	3,892	4,111	4,339	4,577	4,826	5,086	5,304	5,530	5,762	6,001	6,248	6,375	6,501	6,628	6,755
Sewerage	0	1,139	1,195	1,278	2,137	5,179	8,559	17,917	19,266	20,599	23,251	24,764	26,299	29,236	30,437	31,666	34,367	35,064	35,760	36,457	37,154
I. OM/R cost for the Hang Bang Project operat	0	0	0	0	0	1,682	3,453	3,540	3,628	3,716	3,804	3,892	3,979	4,067	4,155	4,243	4,330	4,418	4,506	4,594	4,682
J. Depreciation of UDC existing plant	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
K. Depreciation of NLTG sewerage phase I and	0	0	0	0	0	0	0	42,593	42,593	42,593	42,593	42,593	42,593	42,593	42,593	42,593	42,593	37,283	37,283	37,283	37,283
L. Depreciation of NLTG sewerage phase III	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59,293	59,293	59,293	59,293	59,293	59,293	59,293
M. Interest on NLTN sewerage facility phase I a	0	0	111	10,620	26,832	43,607	55,176	55,316	52,405	49,493	46,582	43,671	40,759	37,848	34,937	32,025	29,114	26,202	23,291	20,380	17,468
N. Interest on NLTN sewerage facility phase III	0	0	0	0	0	0	0	0	0	0	387	36,995	93,473	151,910	192,212	192,702	184,733	176,246	167,208	157,582	147,330
O. Subtotal (F+G+H+I+J+K+L+M+N)	32,957	45,363	54,417	74,295	101,010	132,518	235,543	291,170	293,219	297,074	301,002	427,206	487,957	552,186	655,952	660,758	658,699	648,803	643,783	638,298	632,309
P. Profit before Tax (E - O)	43	9,388	0	0	29	567	273	553	400	2,212	2,231	1,185	1,022	2,616	172	13,997	32,459	59,173	81,437	104,605	128,726
Q. Income tax (P x 25%)	11	2,347	0	0	7	142	68	138	100	553	558	296	255	654	43	3,499	8,115	14,793	20,359	26,151	32,182
Net Profit (P - Q)	32	7,041	0	0	22	425	204	415	300	1,659	1,673	888	766	1,962	129	10,498	24,344	44,379	61,078	78,454	96,545

Table 15.3 UDC Fund Flow Projection (Current Price)

(million VNĐ

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A. **Source of Fund** (B+G+H+I)	2,989	11,898	182,589	280,094	289,726	201,143	5,561	45,965	45,850	53,166	610,418	915,338	945,345	667,546	112,497	115,341	129,187	143,912	160,611	177,987	196,078
B. Internal fund generation (C+D+E+F)	2,989	9,998	2,957	2,957	2,979	3,382	3,161	45,965	45,850	47,209	47,223	46,438	46,316	47,512	104,972	115,341	129,187	143,912	160,611	177,987	196,078
C. Depreciation of UDC existing equipment	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957	2,957
D. Depreciation of NLTN sewerage facility Phase I and II								42,593	42,593	42,593	42,593	42,593	42,593	42,593	42,593	42,593	42,593	37,283	37,283	37,283	37,283
E. Depreciation of NLTN sewerage facility Phase III															59,293	59,293	59,293	59,293	59,293	59,293	59,293
F. Net profit	32	7,041	0	0	22	425	204	415	300	1,659	1,673	888	766	1,962	129	10,498	24,344	44,379	61,078	78,454	96,545
G. World Bank Credit for NLTN sewerage facility (Phase I and II)		1,600	151,250	233,350	241,441	166,515	2,021														
H. Other Credit (NLTN sewerage phase III)										5,063	478,716	738,565	764,175	527,029	6,396						
I. Counterpart contribution by HCMC		300	28,382	43,787	45,306	31,246	379			894	84,479	130,335	134,854	93,005	1,129						
J. **Application of fund** (K+L+M)		11,898	182,589	280,094	289,726	201,143	5,561	45,965	45,850	53,166	610,418	915,338	945,345	667,546	112,497	115,341	129,187	143,912	160,611	177,987	196,078
K. NLTN Investment for sewerage		1,900	179,632	277,137	286,747	197,761	2,400														
L. Debt retirement								44,790	44,790	44,790	44,790	44,790	44,790	44,790	44,790	167,387	175,355	183,842	192,880	202,506	212,758
- NLTN Phase I								44,790	44,790	44,790	44,790	44,790	44,790	44,790	44,790	44,790	44,790	44,790	44,790	44,790	44,790
- NLTN Phase III																122,597	130,565	139,052	148,090	157,716	167,968
M. Working capital	4,914	9,998	2,957	2,957	2,979	3,382	3,161	1,175	1,060	8,376	565,628	870,548	900,555	622,756	67,707	-52,046	-46,168	-39,930	-32,269	-24,519	-16,680

Available cash	17,506	27,504	30,461	33,418	36,397	39,780	42,941	44,116	45,176	53,551	619,180	1,489,728	2,390,284	3,013,040	3,080,746	3,028,700	2,982,532	2,942,603	2,910,333	2,885,814	2,869,134

Chapter 16

RECOMMENDATIONS