2.6.2 Design Fundamentals and Facility Specifications

Table 2.6.2.1 Pump Station

(1) Design Fundamentals

No.	Sewer No.	Design Flow		Invert Level		Water Level		Actual Head	G.L	
		P/D	M/P	Inlet	Outlet	Inlet	Outlet		Present	Plan
		(M3/S)	(M3/S)	(M)	(M)	(M)	(M)	(M)	(M)	(M)
1	1−3A	1.484	1.774	−3.095	−0.650	−2.74	0.31	3.05	2.00	2.50
2	1−7A	1.525	2.070	−2.801	0.230	−1.73	1.31	3.04	2.88	3.00
3	4−4A	0.040	0.066	−2.794	1.380	−2.54	1.64	4.18	2.85	2.90
5	6−8A	0.187	0.766	−0.094	0.255	−1.81	0.55	2.36	2.38	2.50
6	6−12A	0.280	0.867	−3.999	0.530	−3.20	1.33	4.53	2.63	2.70
7	6−13A	0.280	1.129	−1.731	0.500	−0.90	1.34	2.24	2.00	2.80
11	102A	0.236	0.236	−2.762	0.900	−2.30	1.37	3.67	2.63	2.70
12	305A	0.377	0.377	−2.975	0.500	−2.43	1.05	3.48	2.48	2.50

(2) Design Flow

No.	Sewer No.	Preliminary Design				M/P			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
		(M3/m)	(M3/m)	(M3/m)	(M3/m)	(M3/m)	(M3/m)	(M3/m)	(M3/m)
1	1−3A	18.02	20.89	29.66	89.04	21.74	25.35	35.48	106.44
2	1−7A	18.55	21.52	30.50	91.50	25.54	29.91	41.40	124.20
3	4−4A	0.52	0.62	0.80	2.40	0.85	1.02	1.32	3.96
5	6−8A	2.40	2.88	3.74	11.22	9.83	11.80	15.32	45.96
6	6−12A	3.60	4.31	5.60	16.80	11.13	13.35	17.34	52.02
7	6−13A	3.60	4.31	5.60	16.80	14.01	16.46	22.58	67.74
11	102A	3.03	3.63	4.72	14.16	3.03	3.63	4.72	14.16
12	305A	4.84	5.81	7.54	22.62	4.84	5.81	7.54	22.62

Note: Q1 Daily Ave.
Q2 Daily Max.
Q3 Hourly Max.
Q4 3xHourly Max.

(3) Pump Specification

No.	Sewer No.	Pump Type	No. of Units by Diameter							
			150(mm)	200(mm)	250(mm)	300(mm)	350(mm)	400(mm)	450(mm)	600(mm)
1	1−3A	C						2		2
2	1−7A	C							2	2
3	4−4A	M	2							
5	6−8A	C				2		2		
6	6−12A	C				2		2		
7	6−13A	C					2		2	
11	102A	C		2	2					
12	305A	C		2		2				

Note: C Common Type
M Manhole type

(4) Pump Head and HP

No.	Sewer No.	Pump Head			HP by Diameter						
		Actual Head	Loss	Total	200(mm)	250(mm)	300(mm)	350(mm)	400(mm)	450(mm)	600(m)
		(M)	(M)	(M)	(kw/unit)	(kw/unit)	(kw/unit)	(kw/unit)	(kw/unit)	(kw/unit)	(kw/unit)
1	1−3A	3.05	1.50	4.55							45.00
2	1−7A	3.04	1.50	4.54						30	45.00
3	4−4A	4.18	1.50	5.68							
5	6−8A	2.36	1.50	3.86			7.50		15.00		
6	6−12A	4.53	1.50	6.03			15.00		30.00		
7	6−13A	2.24	1.50	3.74				11.00		22	
11	102A	3.67	1.50	4.17	3.70	7.50					
12	305A	3.48	1.50	4.98	5.50		11.00				

(5) Pump Head and H.P required by Design Flow

No.	Pump Dia.	Preliminary Design (P/O)				M/P			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	
	(mm)	(unit)	(unit)	(unit)	(unit)	(unit)	(unit)	(unit)	(unit)
1	(m3/m)	18.02	20.89	29.66	89.04	21.74	25.35	35.48	106.44
	400				1.00	2.00	2.00	2.00	2.00
	600	1.00	1.00	1.00	2.00				2.00
2	(m3/m)	18.55	21.63	30.50	91.50	25.54	29.91	41.40	124.20
	450				1.00	2.00	2.00	2.00	2.00
	600	1.00	1.00	1.00	2.00				2.00
3	(m3/m)	0.51	0.62	0.80	2.40	0.85	1.20	1.32	3.96
	100								
	150	1	1	1	2	1	1	1	2
5	(m3/m)	2.401	2.88	3.74	11.22	9.834	11.796	15.32	45.96
	300	1	1	1	2	2	2	2	2
	400								2
6	(m3/m)	3.595	4.312	506	16.8	11.131	13.351	17.34	52.02
	300	1	1	1	2	2	2	2	2
	400								2
7	(m3/m)	3.595	4.312	5.6	16.8	14.008	16.459	22.58	67.74
	350	1	1	1	2	2	2	2	2
	450								2
11	(m3/m)	3.03	3634	4.72	14.16	3.03	3.634	4.72	14.16
	200	2	2	2	2	2	2	2	2
	250				2				2
12	(m3/m)	4.84	5.805	7.45	22.62	4.84	5.805	7.54	22.62
	200	2	2	2	2	2	2	2	2
	300				2				2

Table 2.6.2.2 Inverted Siphon

No.	Sewer No.	Design Flow		Inlet		Siphon				Outlet	
		P/D	M/P	Dia	Invert L.	Dia.	Velocity	Length	Loss	Invert L.	W.L
		(M3/S)	(M3/S)	(MM)	(M)	(MM)	(M/S)	(M)	(M)	(M)	(M)
1	1−5	1.48	1.88	1500	−1.33	1,000x2line	1.39	71	0.44	−2.04	−1.07
2	6−13	0.28	1.15	1200	0.5	8000x2line	1.19	57	0.33	0.1	0.96
3	6−16	0.28	1.19	1200	−0.24	800x2line	1.19	43	0.31	−0.6	0.28
4	7−3	0.14	0.14	500	−0.41	300x2line	0.77	54	0.39	−1.65	−1.27

2.6.2.3 Overflow Chamber

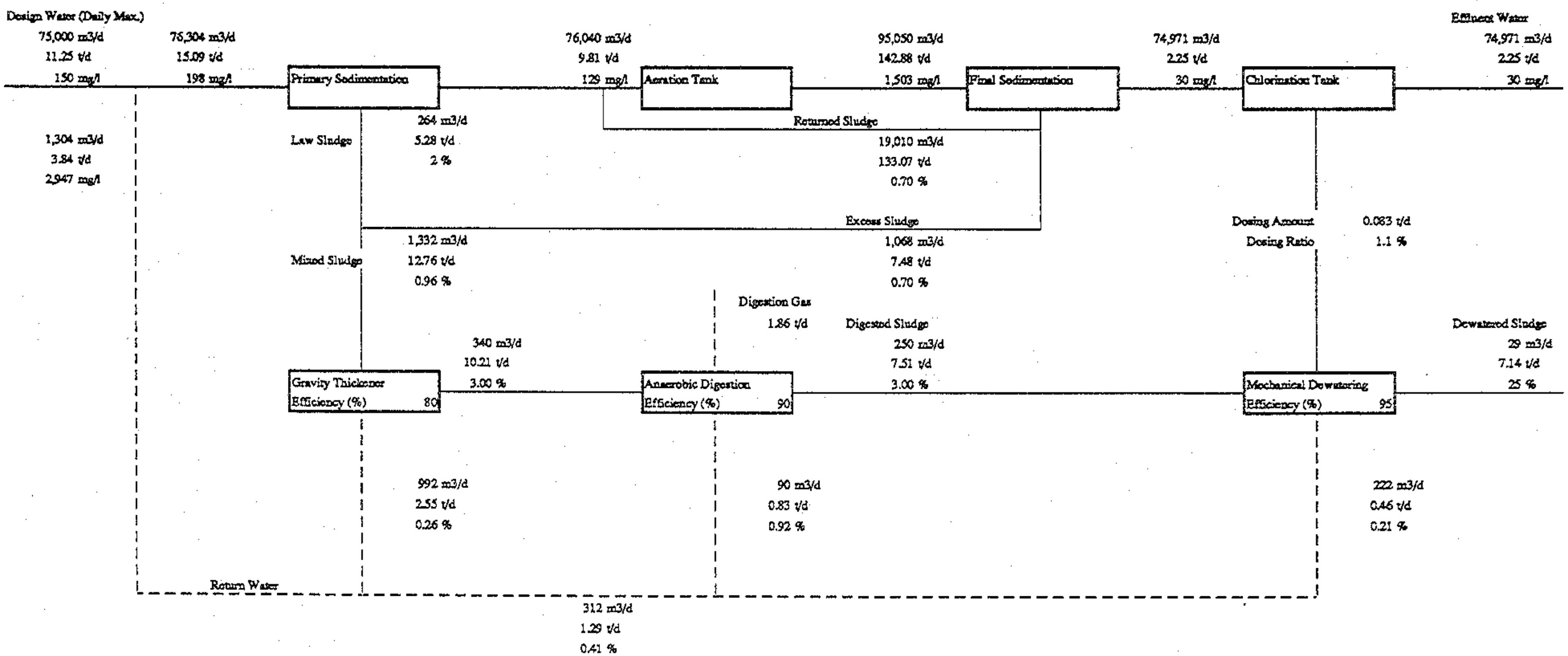
Overflow Chamber shall be installed under the public road. The conditions for selection of the location are as follows:

(1) Junction of public roads
(2) Junction of private and public roads (public road side) for connection of pipe from the housing estate.
(3) Just downstream point in case that the train from private land is connected to the pipe under public road.
(4) Except for the above conditions, it shall be installed with a maximum spacing of 500m.
(5) Additional installation shall be done in case of the construction of new housing areas.

Table 2.6.3.(1) Number of overflow Chambers

No.	Sewer No.	Quantity (M3/S)	Dia. (MM)	Slope (1/1000)	Full How (M/S)	(M3/S)	Type
1	101	0.171	φ400	7.0	1.387	0.1742	B
2	102	0.065	φ300	5.0	0.967	0.0694	B
3	104	2.283	φ500	6.0	1.490	0.2925	B
4	1-1	0.436	φ600	5.5	1.611	0.4554	C
5	2-2	0.057	φ300	4.0	0.865	0.0612	B
6	301	0.107	φ400	3.0	0.908	0.1141	C
7	302	0.196	φ400	9.0	1.572	0.1976	B
8	304	0.051	φ300	3.0	0.749	0.0530	B
9	305	0.023	φ300	2.0	0.612	0.0432	C
10	3-1	0.036	φ300	2.0	0.612	0.0432	C
11	3-2	0.041	φ300	2.0	0.612	0.0432	C
12	4-2	0.019	φ300	2.0	0.612	0.0432	C
13	5-1	0.015	φ300	2.0	0.612	0.0432	C
14	5-2	0.011	φ300	2.0	0.612	0.0432	C
15	6-7	0.050	φ300	2.0	0.612	0.0432	C
16	701	0.042	φ300	2.0	0.612	0.0432	C
17	7-1	0.025	φ300	2.0	0.612	0.0432	C
18	702	0.052	φ300	3.0	0.749	0.0530	C
19	703	0.017	φ300	2.0	0.612	0.0432	C
20	7-4	0.002	φ300	2.0	0.612	0.0432	C
21	6-8	0.093	φ400	2.0	0.741	0.0931	C
22	6-9	0.007	φ300	2.0	0.612	0.0432	C
	Total	1.799					

2.7.3.1 Mass Balance of SS in Rangsit Sewage Treatment Plant



Sludge Rang M/P Centrifugal E1993/11/1

2.7.3.2 Design of Facilities

Wastewater Treatment

(1) Inflow Pump Station

The inflow pump station of treatment plant consists of initial bar screen followed with the pump facilities.

1) Design Condition

	Dry Weather Flow	Wet Weather Flow
Design Flow (hourly max.)	33,300 m3/d = 23.1 m3/min.	100,000 m3/d = 69.4 m3/min.
Surface loading of grit chamber	1,800 m3/m2/day	3.600 m3/m2/day
Average velocity of grit chamber	0.3 m/sec	0.6 m/sec
Retention time	60 sec	30 sec

2) Proposed Inflow Pump Station

Grit Chamber

- Dry Weather Flow: 1.6 m (w) x 0.7 m (h) x 11 m (l) x 1 unit
- Wet Weather Flow: 1.6 m (w) x 0.7 m (h) x 11 m (l) x 1 unit

Inflow Pump

- Dry Weather Flow: ϕ350 x 2 pumps (11.55 m3/min. x 2)
- Wet Weather Flow: ϕ350 x 2 pumps, 800 x 1 pump (11.55 m3/min. x 2 + 23.15 m3/min.x 1)

(2) Primary Sedimentation Basin for Wastewater

1) Design Condition

Design Flow (Daily Max.)	25,700 m3/day
Surface Loading	35 m3/m2 day
Sedimentation Time	3.0 hr
Effective Depth	4.0 m
Overflow Loading of Weir	less than 250 m3/m/day
Reduction Efficiency	BOD : 30% SS : 35%
Influent Water Quality	BOD : 150 mg/l SS : 150 mg/l
Effluent Water Quality	BOD :105 mg/l SS : 97.5 mg/l

2) Proposed Sedimentation Basin

- Sedimentation Basin: ϕ16.0 m x 4 units
- Surface Area: 804 m2

(3) Storm Water Sedimentation Basin

1) Design Condition

Design Flow (Wet hourly max. – dry daily max.)	74,300 m3/day (100,000 – 25,700)
Surface Loading	70 m3/m2 day
Sedimentation Time	0.5 hr
Effective Depth	3.0 m
Overflow Loading of Weir	less than 250 m3/m/day

2) Proposed Storm water Sedimention Basin

Sedimentation Basin	ϕ18.5 m x 4 units
Surface Area	1,075 m2

(4) Aeration Tank

Based on the discussion with PWD of an emergency condition, generator will not be installed at the treatment plant from the economical view point. Hence, the diffused air aeration system is not proposed because of the easiness of diffuser clogging by the floccule while power failure. The mechanical aerator is proposed for this project.

1) Design Condition

Design Flow (daily max.)	25,700 m3/day
Aeration Time	6 hr
BOD−SS Loading	0.35 kg−BOD/kg−SS/day
Return sludge Ratio	25%
Returen Sludge Solid Concentration	7,000 mg/l
BOD Volumetric Loading	0.3 − 0.8 kg/m3/day
Sludge Age	2 − 4 days

2) Proposed Aeration Tank

Aeration Tank	15 m (w) x 75 m (l) x 3 m (d) x 2 units
Aerator	22 kw x 2 units, 11 kw x 3 units

(5) Secondary Sedimentation Basin

1) Design Condition

Design Flow (daily max.)	25,700 m3/day
Surface Loading	25 m3/m2day
Sedimentation Time	2.5 hr
Overflow Loading of Weir	less than 150 m3/m/day

2) Proposed Secondary Sedimentation Basin

Sedimentation Basin	ϕ18.5 m x 2.5 m (d) x 4 units
Surface Area	1,075 m2

(6) Disinfection Tank

Calcium hypochlorite is proposed to use the disinfection of treated water.

1) Design Condition

	Dry Weather Flow	Wet Weather Flow
Disitn Flow	25,700 m3/day	100,000 m3/day
Contact Time	10 min.	10 min.

2) Proposed Disinfection Tank

Tank Size	2 m (w) x 180 m (l) x 2 m (d) x 1 unit

Sludge Treatment

(1) Gravity Thickener

1) Design Condition

From the Mass Balance calculation in Fig. 7.###, design condition is shown below.

Primary Law Sludge Density	2%
Excess Sludge Density	0.7%
Thickened Sludge Density	3%
Solid Mass Loading	60 – 90 kg/m2/day
Effective Depth	4 m
Efficiency of Thickener	80 %

2) Proposed Gravity Thickener

Gravity Thickener — ϕ6 m x 4 m (d) x 2 unit

Thickening Time — 11.9 hr

(2) Anaerobic Digestion Tank

1) Design Condition

Thickened Sludge Organic Material Ratio	60%
Digestion Ratio	50%
Efficiency of Digestion Tank	90%
Effective Depth	more than 4 m
Digestion Time	1st Tank 20 days 2nd Tank 10 days

2) Proposed Anaerobic Digestion Tank

1st digestion Tank — ϕ17.5 m x 5 m (d) x 2 units

2,336 m3 20.6 days

ϕ12.0 m x 5 m (d) x 3 units

1,168 m3 9.7 days

(3) Centrifugal Dewatering

1) Dewatering Condition

Operation Hour	6 days a week, 6 hours a day
Digested Sludge Volume	86 m3/day, 2.57 t/day
Digested Sludge Density	3%
Efficiency of Centrifugal Dewatering	95%
Dewatered Sludge Moisture Content	79%
Chemical Dosing Ratio	1.1%

2) Proposed Centrifugal Dewatering

Capacity : — 8 m3/hr x 1 unit, 15 m3/hr x 1 unit

Dewatered Sludge — 10 m3/day, 2.45 t/day (Moisture content = 79%)

Design Calculation of Rangsit Wastewater Treatment Plant
for MASTER PLAN

(1) Design Discharge

		m3/day	m3/min.	m3/sec.
Daily Average	(Qda)	62,500	43.4	0.723
Daily Maximum in Dry Weather	(Qdmd)	75,000	52.1	0.868
Hourly Maximum in Dry Weather	(Qhmd)	97,500	67.7	1.128
Hourly Maximum in Wet Weather	(Qhmw)	292,500	203.1	3.385

	Influent	Effluent
BOD (mg/l)	175	20
SS (mg/l)	150	30

(2) Design Calculation

1) Grit Chamber
(Dry Weather)

Design Flow Rate

Hourly Maximum in Dry Weather	Qhmd=	97,500 m3/day		
	=	1.128 m3/sec.		
Design Condition				
Surface Loading	Ls=	1,800 m3/m2/day		
Average Velocity	Va=	0.3 m/sec.		
Retention Time	Rs=	60 sec.		
Size				
Required Surface Area	A=Qhmd/Ls=	54.17 m2		
Effective Depth	He=	0.7 m		
Required Width	Be=	4.8 m		
Size of Structure				
Width	B=	1.6	=	**1.6 m**
Length	L=A/Be=	11.28	=	**11.0 m**
Depth	H=	0.7	=	**0.7 m**
Numbers	n=	3	=	**3 units**
Verification				
Surface Loading	Ls=Qhmd/B/L/n=	1,847 m3/m2/day		
Average Velocity	Va=Qhmd/B/He=	0.336 m/sec.		
Retention Time	Rt=L/Va=	32.8 sec.		
Volume of Grit				
	Qhmd*0.00001*1.8 t/m3=	1.76 t/day		
Screenings	Qhmd*0.00001=	0.98 m3/day		

(Wet Weather)

Design Flow Rate

= Hourly Maximum in Wet Weather   Qhmw-Qhmd=   195,000 m3/day

-Houly Maximum in Dry Weather   =   2.257 m3/sec.

Design Condition

Surface Loading	Ls=	3,600 m3/m2/day
Average Velocity	Va=	0.6 m/sec.
Retention Time	Rs=	30 sec.

Size

Required Surface Area	A=Qhmw/Ls=	54.17 m2
Effective Depth	He=	0.7 m
Required Width	Be=	4.8 m

Size of Structure

Width	B=	1.6	=	**1.6 m**
Length	L=A/Be=	11.28	=	**11.0 m**
Depth	H=	0.7	=	**0.7 m**
Numbers	n=	3	=	**3 units**

Verification

Surface Loading	Ls=Qhmw/B/L/n=	3,693 m3/m2/day
Average Velocity	Va=Qhmw/B/He=	0.672 m/sec.
Retention Time	Rt=L/Va=	16.4 sec.
Volume of Grit		
	Qhmw*0.00001*1.8 t/m3=	3.51 t/day
Screenings	Qhmw*0.00001=	1.95 m3/day

2) Inflow Pump

(Inflow Pump for Wastewater)

Hourly Maximum in Dry Weather   Qhmd=   67.7 m3/min.

11.55 m3/min.	x		2 pumps	=	23.1	m3/min.
(Dia.=	350	mm,		V=	2.01	m/s)
23.15 m3/min.	x		2 pumps	=	46.3	m3/min.
(Dia.=	500	mm,		V=	1.97	m/s)
Total					69.4	m3/min.

(Inflow Pump for Storm Water)

Hourly Maximum in Wet Weather   Qhmw=   203.1 m3/min.

11.55 m3/min.	x		2 pumps	=	23.1	m3/min.
(Dia.=	350	mm,		V=	2.01	m/s)
23.15 m3/min.	x		2 pumps	=	46.3	m3/min.
(Dia.=	500	mm,		V=	1.97	m/s)
66.85 m3/min.	x		2 pumps	=	133.7	m3/min.
(Dia.=	800	mm,		V=	2.23	m/s)
Total					203.1	m3/min.

3) Primary Sedimentation Tank

Design Flow Rate

Daily Maximum in Dry Weather	Qdmd=	75,000 m3/day
	=	3,125 m3/hr

Design Condition

Surface Loading	Ls=	35 m3/m2/day
Settling Time	Ts=	3.0 hr
Effective Depth	He=	4.0 m

Size

Required Surface Area	An=Qdmd/Ls=	2,143 m2
Required Tank Volume	V=Qdmd*Ts=	9,375 m3

Size of Structure

Diameter	D=	15.8	=	**16.0 m**
Depth	H=	4.0	=	**4.0 m**
Numbers	n=	12	=	**12 units**

Volume of Tank	V=	9,646 m3
Surface Area	As=	2,412 m2

Verification

Surface Loading	Ls=	31.1 m3/m2/day
Settling Time	Ts=	3.1 hr
Wier Loading	Lw=	124.4 m3/m/day

4) Stormwater Sedimentation Tank

Design Flow Rate

= Hourly Maximum in Wet Weather	Qhmw-Qdmd=	217,500 m3/day
-Daily Maximum in Dry Weather	=	9,063 m3/hr

Design Condition

Surface Loading	Ls=	70 m3/m2/day
Settling Time	Ts=	0.5 hr
Effective Depth	He=	3.0 m

Size

Required Surface Area	An=Qdmw/Ls=	3,107 m2
Required Tank Volume	Lw=Qdmw*Ts=	4,531 m3

Size of Structure

Diameter	D=	18.2	=	**18.5 m**
Depth	H=	3.0	=	**3.0 m**
Numbers	n=	12	=	**12 units**

Volume of Tank	V=	9,672 m3
Surface Area	As=	3,224 m2

Verification

Surface Loading	Ls=	67.5 m3/m2/day
Settling Time	Ts=	1.1 hr
Wier Loading	Lw=	312.0 m3/m/day

5) Aeration Tank

Design Wastewater Quality

	Ci (BOD) :	122.5 mg/l		
	Ci (SS) :	98 mg/l		
Design Flow Rate				
Daily Maximum in Dry Weather	Qdmd=	75,000 m3/day		
Design Condition				
Aeration Time	Ta=	6.0 hr		
BOD - SS Loading	Ls=	0.35 kg/kg/day		
Return Sludge Ratio	Rs=	25.0 %		
Return Sludge Solid Concentration	Cr=	7,000 mg/l		
Size				
MLSS				
	(Ci(SS)+Cr*Rs/100)/(1+Rs/100)=	1,478 mg/l		
Required Tank Volume				
	V=Qdmd*Ci(BOD)/(BOD-SS Loading)*MLSS=	17,760 m3		
Size of Structure				
Width	B=	15.0	=	**15.0 m**
Length	L=Vn/H/n=	65.8	=	**75.0 m**
Depth	H=	3.0	=	**3.0 m**
Numbers	n=	6	=	**6 units**
Verification				
Cross Section	A=B*H-0.3^2=	44.91 m2		
Volume	V=A*L*n=	20,210 m3		
BOD - SS Loading				
	Ls=Qdmd*Ci/V/MLSS=	0.31 kg/kg/day		
Aeration Time	Ta=V/Qdmd*24=	6.47 hr		
BOD Volumetric Load				
	Lv=Qdmd*Ci(BOD)/V/1,000=	0.45 kg/m3/day		
Sludge Age				
	Sa=MLSS*V/Qdmd/Ci(SS)=	4.08 days		

6) Secondary Sedimentation Tank

Design Flow Rate				
Daily Maximum in Dry Weather	Qdmd=	75,000 m3/day		
	=	3,125 m3/hr		
Design Condition				
Surface Loading	Ls=	25 m3/m2/day		
Settling Time	Ts=	2.5 hr		
Effective Depth	He=	2.5 m		
Size				
Required Surface Area	A=Qdmd/Ls=	3,000 m2		
Required Tank Volume	Lw=Qdmd*Ts=	7,813 m3		
Size of Structure				
Diameter	D=	18.2	=	**18.5 m**
Depth	H=	2.5	=	**2.5 m**
Numbers	n=	12	=	**12 units**

Volume of Tank	V=	8,060 m3		
Surface Area	As=	3,224 m2		

Verification

Surface Loading	Ls=	23.3 m3/m2/day		
Settling Time	Ts=	2.6 hr		
Wier Loading	Lw=	107.6 m3/m/day		

7) Disinfection Tank

(Dry Weather)

Design Flow Rate

Daily Maximum in Dry Weather	Qdmd=	75,000 m3/day
	=	3,125 m3/hr
	=	52.1 m3/min.

Design Condition

Contact Time of Disinfecion Tank	Tc=	10 min.
	Required Volume=	521 m3

Size of Structure

Width	B=	2.0	=	**2.0 m**
Length	L=	43.4	=	**180.0 m**
Depth	H=	2.0	=	**2.0 m**
Numbers	n=	3	=	**3 units**

Verification

Volume of Tank	V=	2,160 m3
Contact Time of Disinfecion Tank	Tc=	41.5 min.

(Wet Weather)

Design Flow Rate

Hourly Maximum in Wet Weather	Qhmw=	292,500 m3/day
	=	12,188 m3/hr
	=	203.1 m3/min.

Design Condition

Contact Time of Disinfecion Tank	Tc=	10 min.
	Required Volume=	2,031 m3

Size of Structure

Width	B=	2.0	=	**2.0 m**
Length	L=	169.3	=	**180.0 m**
Depth	H=	2.0	=	**2.0 m**
Numbers	n=	3	=	**3 units**

Verification

Volume of Tank	V=	2,160 m3
Contact Time of Disinfecion Tank	Tc=	10.6 min.

8) Gravity Thickener

Design Flow Rate

Daily Maximum in Dry Weather		Qdmd=	75,000 m3/day		
Row Sludge			264 m3/day		
		(	5.28 t-DS/day)		
Excess Sludge			1068 m3/day		
		(	7.48 t-DS/day)		
	Total of Sludge Volume :	Dv1=	1,332 m3/day		
		(Ds1=	12.76 t-DS/day)		

Design Condition

Type : Gravity Thickener					
Solids Loading	LDs1= 60	to	90 kg/m2 day		
Required Surface Area					
	A=Ds1/LDs1= 141.8	to	212.7 m2		
Thickening Time		Tt=	12 hr		
Required Volume		V=Dv1*Tt=	666.0 m3		
Effective Depth		He=	4.0 m		
	(Required Surface Area = V/He =		166.5 m2)		

Size of Structure

Diameter		D=	5.9	=	**6.0 m**
Depth		H=	4.0	=	**4.0 m**
Numbers		n=	6	=	**6 units**
Effective Volume		V=	679.2 m3		
Effective Surface Area		A=	169.8 m2		

Verification

Solids Loading		LDs1'=	75.1 kg/m2 day		
Thickening Time		Tt'=	12.2 hr		

Volume of Effluent

Efficiency of Thickener		Et=	80 %		
Solids Content		Ds1'=Ds1*Et=	10.21 t-DS/day		
Moisture Content		Dw=	97 %		
Effluent Volume					
		Dv1'=Ds1'*100/(100-Dw)=	340 m3/day		

Thickened Sludge

Solids Content		Dst=Ds1-Ds1'=	2.55 t-DS/day		
Moisture Content		Dw=	0.26 %		
Volume of Thickened Sludge		Dvt=Dv1-Dv1'=	992 m3/day		

9) Digester

Design Sludge Volume		Dv2=Dv1'=	340 m3/day		
Moisture Content		Dw=	97 %		
Solids Content		Ds2=Ds1'=	10.21 t-DS/day		
Primary Digester		V1= Dv2 * 20 days =	6,805 m3		

Size of Primary Digester

Diameter	D=	17.0	=	**17.0 m**
Depth	He=	5.0	=	**5.0 m**
Numbers	n=	6	=	**6 units**

Verification

Digestion Time	Td=	20.0 days

Secondary Digester V2= Dv2 * 10 days = 3,403 m3

Size of Secondary Digester

Diameter	D=	12.0	=	**12.0 m**
Depth	He=	5.0	=	**5.0 m**
Numbers	n=	6	=	**6 units**

Verification

Digestion Time	Td=	10.0 days

Volume of Effluent

Organic Matter Content	Co=	60 %
Digestion Ratio	Rd=	50 %
Efficiency of Digestion Tank	De=	90 %
Digestion Gas	Vg=	1.86 t-DS/day
Solids Content	Ds2'=(Ds2-Vg)*De=	7.51 t-DS/day
Moisture Content	Dw=	97 %
Effluent Volume	Dv2'=Ds2'*100/(100-Dw)=	250 m3/day

Digested Sludge

Solids Content	Dsd=Ds2-Ds2'-Vg=	0.83 t-DS/day
Moisture Content	Dw=	0.92 %
Volume of Digested Sludge	Dvd=	90 m3/day

10) Dewatering

Type : Centrifuge

Design Sludge Volume	Dv3=Dv2'=	250 m3/day
Operation Day in A Week	Td=	6 days
Operation Hour in A Day	Tt=	6 hours
Dewatered Sludge Volume	Dvd=Dv3*7days/6days=	292 m3/day

Capacity of Dewatering Machine

Capacity	Number		Total	
8 m3/hr.x	2	=	16	m3/hr.
15 m3/hr.x	2	=	30	m3/hr.
		Vr =	46	m3/hr.

Operation Time Tt=Dvd/Vr= 6.3 hr.

Design Calculation of Rangsit Wastewater Treatment Plant
for PRELIMINARY ENGINEERING DESIGN

(1) Design Discharge

		m3/day	m3/min.	m3/sec.
Daily Average	(Qda)	21,350	14.8	0.247
Daily Maximum in Dry Weather	(Qdmd)	25,700	17.8	0.297
Hourly Maximum in Dry Weather	(Qhmd)	33,300	23.1	0.385
Hourly Maximum in Wet Weather	(Qhmw)	100,000	69.4	1.157

	Influent	Effluent
BOD (mg/l)	175	20
SS (mg/l)	150	30

(2) Design Calculation

1) Grit Chamber

(Dry Weather)

Design Flow Rate

Hourly Maximum in Dry Weather	Qhmd=	33,300 m3/day		
	=	0.385 m3/sec.		
Design Condition				
Surface Loading	Ls=	1,800 m3/m2/day		
Average Velocity	Va=	0.3 m/sec.		
Retention Time	Rs=	60 sec.		
Size				
Required Surface Area	A=Qhmd/Ls=	18.50 m2		
Effective Depth	He=	0.7 m		
Required Width	Be=	1.6 m		
Size of Structure				
Width	B=	1.6	=	**1.6 m**
Length	L=A/Be=	11.56	=	**11.0 m**
Depth	H=	0.7	=	**0.7 m**
Numbers	n=	1	=	**1 units**
Verification				
Surface Loading	Ls=Qhmd/B/L/n=	1,892 m3/m2/day		
Average Velocity	Va=Qhmd/B/He=	0.344 m/sec.		
Retention Time	Rt=L/Va=	32.0 sec.		
Volume of Grit				
	Qhmd*0.00001*1.8 t/m3=	0.60 t/day		
Screenings	Qhmd*0.00001=	0.33 m3/day		

(Wet Weather)

Design Flow Rate

= Hourly Maximum in Wet Weather	Qhmw-Qhmd=	66,700 m3/day
-Houly Maximum in Dry Weather	=	0.772 m3/sec.

Design Condition

Surface Loading	Ls=	3,600 m3/m2/day
Average Velocity	Va=	0.6 m/sec.
Retention Time	Rs=	30 sec.

Size

Required Surface Area	A=Qhmw/Ls=	18.53 m2
Effective Depth	He=	0.7 m
Required Width	Be=	1.6 m

Size of Structure

Width	B=	1.6	=	**1.6 m**
Length	L=A/Be=	11.58	=	**11.0 m**
Depth	H=	0.7	=	**0.7 m**
Numbers	n=	1	=	**1 units**

Verification

Surface Loading	Ls=Qhmw/B/L/n=	3,790 m3/m2/day
Average Velocity	Va=Qhmw/B/He=	0.689 m/sec.
Retention Time	Rt=L/Va=	16.0 sec.
Volume of Grit		
	Qhmw*0.00001*1.8 t/m3=	1.20 t/day
Screenings	Qhmw*0.00001=	0.67 m3/day

2) Inflow Pump

(Inflow Pump for Wastewater)

Hourly Maximum in Dry Weather Qhmd= 23.1 m3/min.

11.55 m3/min. x 2 pumps = 23.1 m3/min.

(Dia.= 350 mm, V= 2.01 m/s)

(Inflow Pump for Storm Water)

Hourly Maximum in Wet Weather Qhmw= 69.4 m3/min.

11.55 m3/min.	x	2 pumps	=		23.1 m3/min.
(Dia.= 350	mm,			V= 2.01	m/s)
23.15 m3/min.	x	1 pumps	=		23.15 m3/min.
(Dia.= 800	mm,			V= 0.77	m/s)
Total					46.25 m3/min.

3) Primary Sedimentation Tank

Design Flow Rate				
Daily Maximum in Dry Weather	Qdmd=	25,700 m3/day		
	=	1,071 m3/hr		
Design Condition				
Surface Loading	Ls=	35 m3/m2/day		
Settling Time	Ts=	3.0 hr		
Effective Depth	He=	4.0 m		
Size				
Required Surface Area	An=Qdmd/Ls=	734 m2		
Required Tank Volume	V=Qdmd*Ts=	3,213 m3		
Size of Structure				
Diameter	D=	16.0	=	**16.0 m**
Depth	H=	4.0	=	**4.0 m**
Numbers	n=	4	=	**4 units**
Volume of Tank	V=	3,215 m3		
Surface Area	As=	804 m2		
Verification				
Surface Loading	Ls=	32.0 m3/m2/day		
Settling Time	Ts=	3.0 hr		
Wier Loading	Lw=	127.9 m3/m/day		

4) Stormwater Sedimentation Tank

Design Flow Rate				
= Hourly Maximum in Wet Weather	Qhmw-Qdmd=	74,300 m3/day		
-Daily Maximum in Dry Weather	=	3,096 m3/hr		
Design Condition				
Surface Loading	Ls=	70 m3/m2/day		
Settling Time	Ts=	0.5 hr		
Effective Depth	He=	3.0 m		
Size				
Required Surface Area	An=Qdmw/Ls=	1,061 m2		
Required Tank Volume	Lw=Qdmw*Ts=	1,548 m3		
Size of Structure				
Diameter	D=	18.4	=	**18.5 m**
Depth	H=	3.0	=	**3.0 m**
Numbers	n=	4	=	**4 units**
Volume of Tank	V=	3,224 m3		
Surface Area	As=	1,075 m2		
Verification				
Surface Loading	Ls=	69.1 m3/m2/day		
Settling Time	Ts=	1.0 hr		
Wier Loading	Lw=	319.8 m3/m/day		

5) Aeration Tank

Design Wastewater Quality

	Ci (BOD) :	122.5 mg/l
	Ci (SS) :	98 mg/l

Design Flow Rate

Daily Maximum in Dry Weather	Qdmd=	25,700 m3/day

Design Condition

Aeration Time	Ta=	6.0 hr
BOD - SS Loading	Ls=	0.35 kg/kg/day
Return Sludge Ratio	Rs=	25.0 %
Return Sludge Solid Concentration	Cr=	7,000 mg/l

Size

MLSS	(Ci(SS)+Cr*Rs/100)/(1+Rs/100)=	1,478 mg/l
Required Tank Volume	V=Qdmd*Ci(BOD)/(BOD-SS Loading)*MLSS=	6,086 m3

Size of Structure

Width	B=	15.0	=	**15.0 m**
Length	L=Vn/H/n=	67.6	=	**75.0 m**
Depth	H=	3.0	=	**3.0 m**
Numbers	n=	2	=	**2 units**

Verification

Cross Section	A=B*H-0.3^2=	44.91 m2
Volume	V=A*L*n=	6,737 m3
BOD - SS Loading	Ls=Qdmd*Ci/V/MLSS=	0.32 kg/kg/day
Aeration Time	Ta=V/Qdmd*24=	6.29 hr
BOD Volumetric Load	Lv=Qdmd*Ci(BOD)/V/1,000=	0.47 kg/m3/day
Sludge Age	Sa=MLSS*V/Qdmd/Ci(SS)=	3.97 days

6) Secondary Sedimentation Tank

Design Flow Rate

Daily Maximum in Dry Weather	Qdmd=	25,700 m3/day
	=	1,071 m3/hr

Design Condition

Surface Loading	Ls=	25 m3/m2/day
Settling Time	Ts=	2.5 hr
Effective Depth	He=	2.5 m

Size

Required Surface Area	A=Qdmd/Ls=	1,028 m2
Required Tank Volume	Lw=Qdmd*Ts=	2,677 m3

Size of Structure

Diameter	D=	18.5	=	**18.5 m**
Depth	H=	2.5	=	**2.5 m**
Numbers	n=	4	=	**4 units**

Volume of Tank	V=	2,687 m3		
Surface Area	As=	1,075 m2		

Verification

Surface Loading	Ls=	23.9 m3/m2/day		
Settling Time	Ts=	2.5 hr		
Wier Loading	Lw=	110.6 m3/m/day		

7) Disinfection Tank

(Dry Weather)

Design Flow Rate

Daily Maximum in Dry Weather	Qdmd=	25,700 m3/day		
	=	1,071 m3/hr		
	=	17.8 m3/min.		

Design Condition

Contact Time of Disinfecion Tank	Tc=	10 min.		
	Required Volume=	178 m3		

Size of Structure

Width	B=	2.0	=	**2.0 m**
Length	L=	44.6	=	**180.0 m**
Depth	H=	2.0	=	**2.0 m**
Numbers	n=	1	=	**1 units**

Verification

Volume of Tank	V=	720 m3		
Contact Time of Disinfecion Tank	Tc=	40.3 min.		

(Wet Weather)

Design Flow Rate

Hourly Maximum in Wet Weather	Qhmw=	100,000 m3/day		
	=	4,167 m3/hr		
	=	69.4 m3/min.		

Design Condition

Contact Time of Disinfecion Tank	Tc=	10 min.		
	Required Volume=	694 m3		

Size of Structure

Width	B=	2.0	=	**2.0 m**
Length	L=	173.6	=	**180.0 m**
Depth	H=	2.0	=	**2.0 m**
Numbers	n=	1	=	**1 units**

Verification

Volume of Tank	V=	720 m3		
Contact Time of Disinfecion Tank	Tc=	10.4 min.		

8) Gravity Thickener

Design Flow Rate

Daily Maximum in Dry Weather			Qdmd=	25,700 m3/day	
Row Sludge				91 m3/day	
			(	1.81 t-DS/day)	
Excess Sludge				367 m3/day	
			(	2.57 t-DS/day)	
	Total of Sludge Volume :		Dv1=	457 m3/day	
			(Ds1=	4.38 t-DS/day)	

Design Condition

Type : Gravity Thickener					
Solids Loading	LDs1=	60	to	90 kg/m2 day	
Required Surface Area					
	A=Ds1/LDs1=	48.7	to	73.0 m2	
Thickening Time			Tt=	12 hr	
Required Volume			V=Dv1*Tt=	228.5 m3	
Effective Depth			He=	4.0 m	
	(Required Surface Area = V/He =			57.1 m2)	

Size of Structure

Diameter	D=	6.0	=	**6.0 m**
Depth	H=	4.0	=	**4.0 m**
Numbers	n=	2	=	**2 units**
Effective Volume	V=	226.4 m3		
Effective Surface Area	A=	56.6 m2		

Verification

Solids Loading	LDs1'=	77.4 kg/m2 day
Thickening Time	Tt'=	11.9 hr

Volume of Effluent

Efficiency of Thickener	Et=	80 %
Solids Content	Ds1'=Ds1*Et=	3.50 t-DS/day
Moisture Content	Dw=	97 %
Effluent Volume		
	Dv1'=Ds1'*100/(100-Dw)=	117 m3/day

Thickened Sludge

Solids Content	Dst=Ds1-Ds1'=	0.88 t-DS/day
Moisture Content	Dw=	0.26 %
Volume of Thickened Sludge	Dvt=Dv1-Dv1'=	340 m3/day

9) Digester

Design Sludge Volume	Dv2=Dv1'=	117 m3/day
Moisture Content	Dw=	97 %
Solids Content	Ds2=Ds1'=	3.50 t-DS/day
Primary Digester	V1= Dv2 * 20 days =	2,336 m3

Size of Primary Digester				
Diameter	D=	17.3	=	**17.5 m**
Depth	He=	5.0	=	**5.0 m**
Numbers	n=	2	=	**2 units**
Verification				
Digestion Time	Td=	20.6 days		
Secondary Digester	V2= Dv2 * 10 days =	1,168 m3		
Size of Secondary Digester				
Diameter	D=	12.2	=	**12.0 m**
Depth	He=	5.0	=	**5.0 m**
Numbers	n=	2	=	**2 units**
Verification				
Digestion Time	Td=	9.7 days		
Volume of Effluent				
Organic Matter Content	Co=	60 %		
Digestion Ratio	Rd=	50 %		
Efficiency of Digestion Tank	De=	90 %		
Digestion Gas	Vg=	0.64 t-DS/day		
Solids Content	Ds2'=(Ds2-Vg)*De=	2.57 t-DS/day		
Moisture Content	Dw=	97 %		
Effluent Volume				
	Dv2'=Ds2'*100/(100-Dw)=	86 m3/day		
Digested Sludge				
Solids Content	Dsd=Ds2-Ds2'-Vg=	0.29 t-DS/day		
Moisture Content	Dw=	0.94 %		
Volume of Digested Sludge	Dvd=	31 m3/day		

10) Dewatering

Type : Centrifuge		
Design Sludge Volume	Dv3=Dv2'=	86 m3/day
Operation Day in A Week	Td=	6 days
Operation Hour in A Day	Tt=	6 hours
Dewatered Sludge Volume	Dvd=Dv3*7days/6days=	100 m3/day

Capacity of Dewatering Machine

Capacity	Number		Total	
8 m3/hr.x	1	=	8	m3/hr.
15 m3/hr.x	1	=	15	m3/hr.
		Vr =	23	m3/hr.

Operation Time Tt=Dvd/Vr= 4.3 hr.

Calculation of Mechanical Surface Aerator of Rangsit Wastewater Treatment Plant for Master Plan

1. Design Condition
   a. Design Flow
      - Daily Average : Qa 62,500 m3/day
      - Daily Maximum : Qm 75,000 m3/day
   b. Influent Quality (BOD) : Qb 122.5 mg/l
   c. BOD Removal Efficiency : ε 83.7 %
   d. Temperature : T 25 ℃

2. Influent BOD : Bw kg/day

   $Bw = \gamma \cdot Qb \cdot Qa \cdot 10^{(-3)}$

   γ = Load Factor = Daily Maximum(Qm) / Daily Average(Qa)

   Bw = 9,188 kg/day

3. Excluded BOD : Br kg/day

   $Br = Bw \cdot \varepsilon \cdot 10^{(-2)}$

   Br = 7,690 kg/day

4. Supplied Oxygen in Operation : Na kgO2 / hr

   $Na = Br \cdot \eta / 24$

   η = Required Oxygen for Exclusion of Unit BOD kg = 0.8

   Na = 256.3 kgO2/hr

5. Oxygen Transfer in Standard Condition : N kgO2 / hr

   $N = Na / \alpha \{(Csw-Cl)/Cs\}(1.024)^{(T-20)}$

   α : Oxygen Transfer into Wastewater/ Oxygen Transfer into Pure Water = 0.8

   $Csw = \beta \cdot Css =$ 7.542 mg/l

   β : Oxygen Saturation in Wastewater / Oxygen Saturation in Pure Water = 0.9

   Css : Oxygen Saturation in Pure Water in T ℃ = 8.38 mg/l

   Cl : Dissolved Oxygen = 2.0 mg/l

   Cs : Oxygen Saturation in Pure Water in Standard Condition = 9.17 mg/l

   T : 25℃

   $(1.024)^{(T-20)}$: 1.126

   N = 596.9 kgO2 / hr

6. Supplied Oxygen per Motor Power of Aerator : Ns kgO2 / kw / hr

5 ~ 20 HP	:	1.9	kgO2 / kw / hr
25 ~ 50 HP	:	1.8	kgO2 / kw / hr
60 ~ 150 HP	:	1.7	kgO2 / kw / hr

7. Required Power of Aerator : HP

   $HP = N / (Ns \cdot Ef \cdot N0 \cdot 0.7457)$

   Ef = Gear Reduction Factor : 5 ~ 20 HP : Ef = 97.5 %

   : 25 ~ 150 HP : Ef = 96.7 %

   N0 = Number of Aerator

   HP = 432.1 kw = 72.0 kw/basin

11	kw	x	3	units	=	33	kw
22	kw	x	2	units	=	44	kw
			5	units/basin		77	kw/basin

Calculation of Mechanical Surface Aerator of Rangsit Wastewater Treatment Plant
for Preliminary Engineering Design

1. Design Condition
   a. Design Flow

Daily Average	: Qa	21,350	m3/day
Daily Maximum	: Qm	25,700	m3/day
b. Influent Quality (BOD)	: Qb	122.5	mg/l
c. BOD Removal Efficiency	: ε	83.7	%
d. Temperature	: T	25	℃

2. Influent BOD : Bw kg/day

Bw = γ · Qb · Qa · 10^(-3)

γ = Load Factor = Daily Maximum(Qm) / Daily Average(Qa)

Bw = 3,138 kg/day

3. Excluded BOD : Br kg/day

Br = Bw · ε · 10^(-2)

Br = 2,627 kg/day

4. Supplied Oxygen in Operation : Na kgO2 / hr

Na = Br · η / 24

η = Required Oxygen for Exclusion of Unit BOD kg = 0.8

Na = 87.6 kgO2/hr

5. Oxygen Transfer in Standard Condition : N kgO2 / hr

N = Na/ α {(Csw-Cl)/Cs}(1.024)^(T-20)

α : Oxygen Transfer into Wastewater/ Oxygen Transfer into Pure Water = 0.8

Csw = β · Css = 7.542 mg/l

β : Oxygen Saturation in Wastewater / Oxygen Saturation in Pure Water = 0.9

Css : Oxygen Saturation in Pure Water in T ℃ = 8.38 mg/l

Cl : Dissolved Oxygen = 2.0 mg/l

Cs : Oxygen Saturation in Pure Water in Standard Condition = 9.17 mg/l

T : 25℃

(1.024)^(T-20) : 1.126

N = 204 kgO2 / hr

6. Supplied Oxygen per Motor Power of Aerator : Ns kgO2 / kw / hr

5 ~ 20 HP	:	1.9	kgO2 / kw / hr
25 ~ 50 HP	:	1.8	kgO2 / kw / hr
60 ~ 150 HP	:	1.7	kgO2 / kw / hr

7. Required Power of Aerator : HP

HP = N / (Ns · Ef · N0 · 0.7457)

Ef = Gear Reduction Factor : 5 ~ 20 HP : Ef = 97.5 %
: 25 ~ 150 HP : Ef = 96.7 %

N0 = Number of Aerator

HP = 147.7 kw = 73.85 kw/basin

11	kw	x	3	units	=	33	kw
22	kw	x	2	units	=	44	kw
			5	units/basin		77	kw/basin

Hydraulic Calculation of Rangsit Treatment Plant

1. Design Condition

1) Design Wastewater Quantity

Preliminary Design	(m^3/day)	(m^3/min)	(m^3/sec)
Daily Average (Qdap)	21,350	14.82	0.247
Daily Max. (Qdmp)	25,700	17.85	0.298
Hourly Max. (dry) (Qhmdp)	33,300	23.13	0.386
Hourly Max. (wet) (Qhmwp)	100,000	69.44	1.157
Master Plan	(m^3/day)	(m^3/min)	(m^3/sec)
Daily Average (Qdam)	62,500	43.40	0.723
Daily Max. (Qdmm)	75,000	52.08	0.868
Hourly Max. (dry) (Qhmdm)	97,500	67.71	1.129
Hourly Max. (wet) (Qhmwm)	292,500	203.13	3.386

2) Unit and Capacity of Treatment Facility

Unit of each treatment facility is as follows.

	Unit	
	Preliminary Design	Master Plan
Primary Sedimentation Tank	4	12
Aeration Tank	2	6
Final Sedimentation Tank	4	12
Disinfection Tank	1	1
Gravity Thickener	2	4
Digestion Tank (1st)	2	6
Digestion Tank (2nd)	2	6
Dewatering	1	1

3) Inlet Conduit

Conduit Size	1,600 mm x 1,600 mm
Gradient	0.1 %
Invert Elevation of Inlet Conduit	MSL - 5.00 m

4) Design Grand Elevation MSL + 2.5 m

5) Discharge

Discharge Point		Khlong Son
HWL		MSL + 1.40
Discharge Conduit	Size	1,600 mm x 1,600 mm
	Length	500 m

6) Formula for Hydraulic Calculation

Manning's Formula n = 0.013

2. Hydraulic Calculation

1).Water Level of Disinfection Tank Effluent Chamber (WL 1)

Design Water	Qhmwm = 292,500 m3/day = 3.386 m^3/sec
Velocity	V= 1.53 m/sec
Hydraulic Gradient	i= 0.09 %
Friction Loss	l=0.09 % x 500 m = 0.45 m

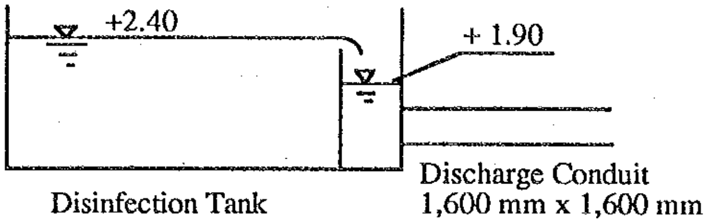
WL 1 = + 1.40 + 0.45 = 1.85 say <u>+ 1.90 m</u>

2) Water Level of Disinfection Tank (WL 2)

Water Depth of Effluent Weir

Width of Weir = 6.0 m

h ≒ (Qhmwm / (1.84 x 6.0))^(2/3) = 0.45 m



WL 2 = 1.90 + 0.45 = 2.35 say +2.40 m

3) Hydraulic Loss of Connection Pipe of D.T and F.S.T

Diameter	ø 500 mm x 6
Length	350 m
Design Water	Qdmm = 0.145 m^3 / sec
Velocity	v = 0.745 m / sec
Hydraulic Gradient	i = 0.15 %

Hydraulic Loss = 350 m x 0.15 % = 0.525 m

4) Water Level of Final Sedimentation Tank Effluent Chamber (WL 3)

WL 3 = + 2.40 + 0.53 = + 2.93 m say + 3.00 m

5) Water Level of Final Sedimentation Tank (WL 4)

Water Depth of Effluent Triangle Weir

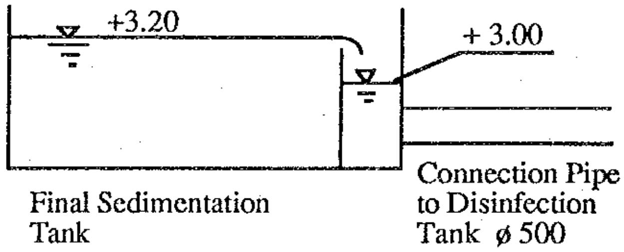
Length of Weir = 55 m

Design Water per unit weir long

q = (Qdmm / 12) / 55 = 0.0013 m^3 / m / sec

h = (q / 1.42)^(2/5) = 0.06 m

WL 4 = + 3.00 + 0.06 =+ 3.06 say + 3.20



6) Hydraulic Loss of Connection Pipe of F.S.T and Aeration Tank

Diameter	ø 500 mm
Length	40 m
Design Water	Qdmm / 6= 0.868 m^3 / sec / 6 = 0.145 m^3 / sec
Velocity	v = 0.745 m / sec
Hydraulic Gradient	i = 0.15 %

Hydraulic Loss = 40 m x 0.15 % = 0.06 m

7) Water Level of Aeration Tank Effluent Chamber (WL 5)

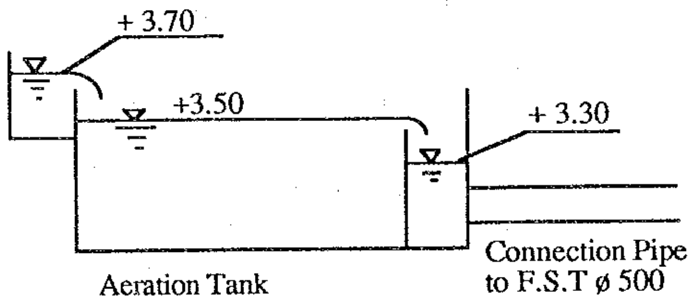
WL 5 = + 3.20 + 0.06 = + 3.26 say <u>+ 3.30 m</u>

8) Water Level of Aeration Tank (WL 6)

Water Depth of Effluent Weir

Width of Weir = 3 m

h = (Qdmm/6/(1.84 x 3.0)) ^ (2/3) = 0.088 m



WL 6 = + 3.30 + 0.09 = + 3.39 say <u>+ 3.50 m</u>

9) Water Level of Aeration Tank Influent Chamber (WL 7)

Water Depth of Influent Weir

Width of Weir = 3.0 m

h = (Qdmm / 6 / (1.84 x 3)) ^ (2/3) = 0.088 m

WL 7 = + 3.50 + 0.09 = + 3.59 say <u>+ 3.70 m</u>

10) Hydraulic Loss of Connection Pipe of A.T to P.S T

Diameter	ø 500 mm

Length	40 m
Design Water	Qdmm / 6= 0.868 m^3 / sec / 6 = 0.145 m^3 / sec
Velocity	v = 0.745 m / sec
Hydraulic Gradient	i = 0.15 %

Hydraulic Loss = 40 m x 0.15 % = 0.06 m

11) Water Level of Primary Sedimentation Tank Effluent Chamber (WL 8)

WL 8 = + 3.70 + 0.06 = + 3.76 say <u>+ 3.80 m</u>

12) Water Level of Primary Sedimentation Tank (WL 9)

Water Depth of Effluent Weir

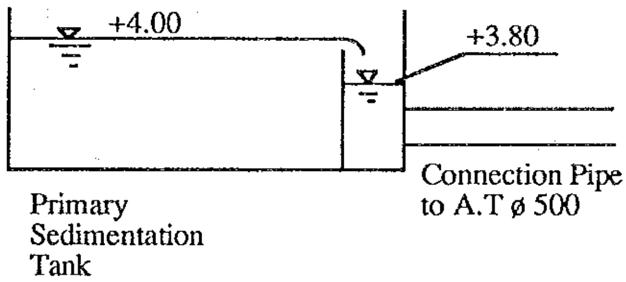
Triangle Weir Width = 50 m

Design Water per unit weir long

q = (Qdmm / 12) / 50 = 0.00145 m^3 / m / sec

h = (q / 1.42) ^ (2/5) = 0.06 m

WL 9 = + 3.80 + 0.06 = + 3.86 say <u>+ 4.00 m</u>



13) Hydraulic Loss of Connection Pipe of P.S T to Distribution Tank

Diameter	ø 400 mm
Length	30 m
Design Water	Qdmm / 12= 0.868 m^3 / sec / 12 = 0.072 m^3 / sec
Velocity	v = 0.574 m / sec
Hydraulic Gradient	i = 0.12 %

Hydraulic Loss = 30 m x 0.12 % = 0.036 m

14) Water Level of Distribution Tank Effluent Chamber (WL 10)

WL 10 = + 4.00 + 0.04 = + 4.04 say <u>+ 4.10 m</u>

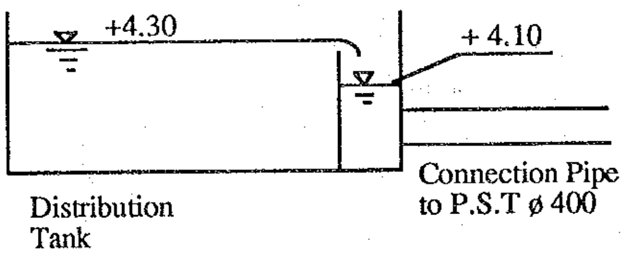
15) Water Level of Distribution Tank (WL 11)

Water Depth of Effluent Weir

Weir Width = 1.0 m

h = (Qdmm / 12 / (1.84 x 1.0) ^ (2/3) = 0.115 m

WL 11 = + 4.10 + 0.115 = + 4.215 say <u>+ 4.30 m</u>



2.9.1.1 Unit Construction Cost of Wastewater Collection Facilities

Table 2.9.1.1 (1)-1 Unit Construction Cost of Interceptors

Diameter (mm)	Unit Cost	300	400	500	600	800	1000	1200	1500
(1) Quantity									
Earth Covering Depth (m)		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Outer of Diameter (m)		0.40	0.52	0.64	0.75	0.99	1.22	1.45	1.80
Width of Excavation (m)		1.00	1.12	1.24	1.35	1.59	1.82	2.05	2.40
Excavation Depth (m)		2.00	2.15	2.30	2.44	2.74	3.03	3.31	3.75
Sheetpile Length (m)		-	3.23	3.45	3.66	4.11	4.54	4.97	5.63
Volume of Pavement (m3)		0.35	0.39	0.43	0.47	0.56	0.64	0.72	0.84
Excavation (Backhoe m3)		2.00	2.41	2.85	3.29	4.35	5.51	6.79	9.00
Backfill (granular m3)		0.57	0.71	0.84	0.98	1.28	1.60	1.94	2.50
Backfill (original m3)		0.91	1.07	1.25	1.42	1.85	2.34	2.89	3.86
Backfill (selected soil m3)		0.17	0.24	0.33	0.42	0.66	0.93	1.24	1.80
Residual Soil (m3)		1.09	1.34	1.60	1.87	2.50	3.17	3.90	5.14
Pavement (m2)		1.60	1.72	1.84	1.95	2.19	2.42	2.65	3.00
Sheetpile Length (m)		-	16.15	17.25	18.30	20.55	22.70	24.85	28.15
Sheetpile (kg)		-	775.20	828.00	878.40	986.40	1,089.60	1,192.80	1,351.20
Bracing (kg)		-	446	461	477	501	530	558	616
(2) Construction Cost (Baht/m)									
Excavation (Backhoe)	60.0	120.0	144.6	171.0	197.4	261.0	330.6	407.4	540.0
Backfill (granular)	300.0	171.0	213.0	252.0	294.0	384.0	480.0	582.0	750.0
Backfill (original)	60.0	54.6	64.2	75.0	85.2	111.0	140.4	173.4	231.6
Backfill (selected soil)	300.0	51.0	72.0	99.0	126.0	198.0	279.0	372.0	540.0
Residual Soil	30.0	32.7	40.2	48.0	56.1	75.0	95.1	117.0	154.2
Pavement	400.0	640.0	688.0	736.0	780.0	876.0	968.0	1,060.0	1,200.0
Sheetpile (kg)	3.2	-	2,480.6	2,649.6	2,810.9	3,156.5	3,486.7	3,817.0	4,323.8
Bracing (kg)	5.1	-	2,274.6	2,351.1	2,432.7	2,555.1	2,703.0	2,845.8	3,141.6
Pipe/Laying	1 ls	253.0	350.0	439.0	509.0	779.0	1,267.0	1,643.0	2,702.0
Dewatering/Others	1 ls	7.6	8.5	9.5	10.9	12.7	15.2	19.0	25.4
Total		1,329.9	6,335.7	6,830.2	7,302.2	8,408.3	9,765.0	11,036.6	13,608.6

Table 2.9.1.1 (1)-2 Unit Construction Cost of Interceptors

Diameter (mm)	Unit Cost	300	400	500	600	800	1000	1200	1500
(1) Quantity									
Earth Covering Depth (m)		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Outer of Diameter (m)		0.40	0.52	0.64	0.75	0.99	1.22	1.45	1.80
Width of Excavation (m)		1.00	1.12	1.24	1.35	1.59	1.82	2.05	2.40
Excavation Depth (m)		2.50	2.65	2.80	2.94	3.24	3.53	3.81	4.25
Sheetpile Length (m)		3.75	3.98	4.20	4.41	4.86	5.29	5.72	6.38
Volume of Pavement (m3)		0.35	0.39	0.43	0.47	0.56	0.64	0.72	0.84
Excavation (Backhoe m3)		2.50	2.97	3.47	3.97	5.15	6.42	7.82	10.20
Backfill (granular m3)		0.57	0.71	0.84	0.98	1.28	1.60	1.94	2.50
Backfill (original m3)		1.41	1.63	1.87	2.10	2.65	3.25	3.92	5.06
Backfill (selected soil m3)		0.17	0.24	0.33	0.42	0.66	0.93	1.24	1.80
Residual Soil (m3)		1.09	1.34	1.60	1.87	2.50	3.17	3.90	5.14
Pavement (m2)		1.60	1.72	1.84	1.95	2.19	2.42	2.65	3.00
Sheetpile Length (m)		18.75	19.90	21.00	22.05	24.30	26.45	28.60	31.90
Sheetpile (kg)		900.00	955.20	1,008.00	1,058.40	1,166.40	1,269.60	1,372.80	1,531.20
Bracing (kg)		422	446	461	477	501	530	558	616
(2) Construction Cost (Baht/m)									
Excavation (Backhoe)	60.0	150.0	178.2	208.2	238.2	309.0	385.2	469.2	612.0
Backfill (granular)	300.0	171.0	213.0	252.0	294.0	384.0	480.0	582.0	750.0
Backfill (original)	60.0	84.6	97.8	112.2	126.0	159.0	195.0	235.2	303.6
Backfill (selected soil)	300.0	51.0	72.0	99.0	126.0	198.0	279.0	372.0	540.0
Residual Soil	30.0	32.7	40.2	48.0	56.1	75.0	95.1	117.0	154.2
Pavement	400.0	640.0	688.0	736.0	780.0	876.0	968.0	1,060.0	1,200.0
Sheetpile (kg)	3.2	2,880.0	3,056.6	3,225.6	3,386.9	3,732.5	4,062.7	4,393.0	4,899.8
Bracing (kg)	5.1	2,152.2	2,274.6	2,351.1	2,432.7	2,555.1	2,703.0	2,845.8	3,141.6
Pipe/Laying	1 ls	253.0	350.0	439.0	509.0	779.0	1,267.0	1,643.0	2,702.0
Dewatering/Others	1 ls	7.6	8.5	9.5	10.9	12.7	15.2	19.0	25.4
Total		6,422.1	6,978.9	7,480.6	7,959.8	9,080.3	10,450.2	11,736.2	14,328.6

Table 2.9.1.1 (1)-3 Unit Construction Cost of Interceptors

Diameter (mm)	Unit Cost	300	400	500	600	800	1000	1200	1500
(1) Quantity									
Earth Covering Depth (m)		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Outer of Diameter (m)		0.40	0.52	0.64	0.75	0.99	1.22	1.45	1.80
Width of Excavation (m)		1.00	1.12	1.24	1.35	1.59	1.82	2.05	2.40
Excavation Depth (m)		3.50	3.65	3.80	3.94	4.24	4.53	4.81	5.25
Sheetpile Length (m)		5.25	5.48	5.70	5.91	6.36	6.79	7.22	7.88
Volume of Pavement (m3)		0.35	0.39	0.43	0.47	0.56	0.64	0.72	0.84
Excavation (Backhoe m3)		3.50	4.09	4.71	5.32	6.74	8.24	9.87	12.60
Backfill (granular m3)		0.57	0.71	0.84	0.98	1.28	1.60	1.94	2.50
Backfill (original m3)		2.41	2.75	3.11	3.45	4.24	5.07	5.97	7.46
Backfill (selected soil m3)		0.17	0.24	0.33	0.42	0.66	0.93	1.24	1.80
Residual Soil (m3)		1.09	1.34	1.60	1.87	2.50	3.17	3.90	5.14
Pavement (m2)		1.60	1.72	1.84	1.95	2.19	2.42	2.65	3.00
Sheetpile Length (m)		26.25	27.40	28.50	29.55	31.80	33.95	36.10	39.40
Sheetpile (kg)		1,260.00	1,315.20	1,368.00	1,418.40	1,526.40	1,629.60	1,732.80	1,891.20
Bracing (kg)		422	446	461	477	501	530	558	616
(2) Construction Cost (Baht/m)									
Excavation (Backhoe)	60.0	210.0	245.4	282.6	319.2	404.4	494.4	592.2	756.0
Backfill (granular)	300.0	171.0	213.0	252.0	294.0	384.0	480.0	582.0	750.0
Backfill (original)	60.0	144.6	165.0	186.6	207.0	254.4	304.2	358.2	447.6
Backfill (selected soil)	300.0	51.0	72.0	99.0	126.0	198.0	279.0	372.0	540.0
Residual Soil	30.0	32.7	40.2	48.0	56.1	75.0	95.1	117.0	154.2
Pavement	400.0	640.0	688.0	736.0	780.0	876.0	968.0	1,060.0	1,200.0
Sheetpile (kg)	3.2	4,032.0	4,208.6	4,377.6	4,538.9	4,884.5	5,214.7	5,545.0	6,051.8
Bracing (kg)	5.1	2,152.2	2,274.6	2,351.1	2,432.7	2,555.1	2,703.0	2,845.8	3,141.6
Pipe/Laying	1 ls	253.0	350.0	439.0	509.0	779.0	1,267.0	1,643.0	2,702.0
Dewatering/Others	1 ls	7.6	8.5	9.5	10.9	12.7	15.2	19.0	25.4
Total		7,694.1	8,265.3	8,781.4	9,273.8	10,423.1	11,820.6	13,134.2	15,768.6

Table 2.9.1.1 (1)-4 Unit Construction Cost of Interceptors

Diameter (mm)	Unit Cost	300	400	500	600	800	1000	1200	1500
(1) Quantity									
Earth Covering Depth (m)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Outer of Diameter (m)		0.40	0.52	0.64	0.75	0.99	1.22	1.45	1.80
Width of Excavation (m)		1.00	1.12	1.24	1.35	1.59	1.82	2.05	2.40
Excavation Depth (m)		4.50	4.65	4.80	4.94	5.24	5.53	5.81	6.25
Sheetpile Length (m)		6.75	6.98	7.20	7.41	7.86	8.29	8.72	9.38
Volume of Pavement (m3)		0.35	0.39	0.43	0.47	0.56	0.64	0.72	0.84
Excavation (Backhoe m3)		4.50	5.21	5.95	6.67	8.33	10.06	11.92	15.00
Backfill (granular m3)		0.57	0.71	0.84	0.98	1.28	1.60	1.94	2.50
Backfill (original m3)		3.41	3.87	4.35	4.80	5.83	6.89	8.02	9.86
Backfill (selected soil m3)		0.17	0.24	0.33	0.42	0.66	0.93	1.24	1.80
Residual Soil (m3)		1.09	1.34	1.60	1.87	2.50	3.17	3.90	5.14
Pavement (m2)		1.60	1.72	1.84	1.95	2.19	2.42	2.65	3.00
Sheetpile Length (m)		33.75	34.90	36.00	37.05	39.30	41.45	43.60	46.90
Sheetpile (kg)		1,620.00	1,675.20	1,728.00	1,778.40	1,886.40	1,989.60	2,092.80	2,251.20
Bracing (kg)		422	446	461	477	501	530	558	616
(2) Construction Cost (Baht/m)									
Excavation (Backhoe)	60.0	270.0	312.6	357.0	400.2	499.8	603.6	715.2	900.0
Backfill (granular)	300.0	171.0	213.0	252.0	294.0	384.0	480.0	582.0	750.0
Backfill (original)	60.0	204.6	232.2	261.0	288.0	349.8	413.4	481.2	591.6
Backfill (selected soil)	300.0	51.0	72.0	99.0	126.0	198.0	279.0	372.0	540.0
Residual Soil	30.0	32.7	40.2	48.0	56.1	75.0	95.1	117.0	154.2
Pavement	400.0	640.0	688.0	736.0	780.0	876.0	968.0	1,060.0	1,200.0
Sheetpile (kg)	3.2	5,184.0	5,360.6	5,529.6	5,690.9	6,036.5	6,366.7	6,697.0	7,203.8
Bracing (kg)	5.1	2,152.2	2,274.6	2,351.1	2,432.7	2,555.1	2,703.0	2,845.8	3,141.6
Pipe/Laying	1 ls	253.0	350.0	439.0	509.0	779.0	1,267.0	1,643.0	2,702.0
Dewatering/Others	1 ls	7.6	8.5	9.5	10.9	12.7	15.2	19.0	25.4
Total		8,966.1	9,551.7	10,082.2	10,587.8	11,765.9	13,191.0	14,532.2	17,208.6

Table 2.9.1.1 (1)-5 Unit Construction Cost of Interceptors

Diameter (mm)	Unit Cost	300	400	500	600	800	1000	1200	1500
(1) Quantity									
Earth Covering Depth (m)		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Outer of Diameter (m)		0.40	0.52	0.64	0.75	0.99	1.22	1.45	1.80
Width of Excavation (m)		1.00	1.12	1.24	1.35	1.59	1.82	2.05	2.40
Excavation Depth (m)		5.50	5.65	5.80	5.94	6.24	6.53	6.81	7.25
Sheetpile Length (m)		8.25	8.48	8.70	8.91	9.36	9.79	10.22	10.88
Volume of Pavement (m3)		0.35	0.39	0.43	0.47	0.56	0.64	0.72	0.84
Excavation (Backhoe m3)		5.50	6.33	7.19	8.02	9.92	11.88	13.97	17.40
Backfill (granular m3)		0.57	0.71	0.84	0.98	1.28	1.60	1.94	2.50
Backfill (original m3)		4.41	4.99	5.59	6.15	7.42	8.71	10.07	12.26
Backfill (selected soil m3)		0.17	0.24	0.33	0.42	0.66	0.93	1.24	1.80
Residual Soil (m3)		1.09	1.34	1.60	1.87	2.50	3.17	3.90	5.14
Pavement (m2)		1.60	1.72	1.84	1.95	2.19	2.42	2.65	3.00
Sheetpile Length (m)		41.25	42.40	43.50	44.55	46.80	48.95	51.10	54.40
Sheetpile (kg)		1,980.00	2,035.20	2,088.00	2,138.40	2,246.40	2,349.60	2,452.80	2,611.20
Bracing (kg)		422	446	461	477	501	530	558	616
(2) Construction Cost (Baht/m)	Unit Cost								
Excavation (Backhoe)	60.0	330.0	379.8	431.4	481.2	595.2	712.8	838.2	1,044.0
Backfill (granular)	300.0	171.0	213.0	252.0	294.0	384.0	480.0	582.0	750.0
Backfill (original)	60.0	264.6	299.4	335.4	369.0	445.2	522.6	604.2	735.6
Backfill (selected soil)	300.0	51.0	72.0	99.0	126.0	198.0	279.0	372.0	540.0
Residual Soil	30.0	32.7	40.2	48.0	56.1	75.0	95.1	117.0	154.2
Pavement	400.0	640.0	688.0	736.0	780.0	876.0	968.0	1,060.0	1,200.0
Sheetpile (kg)	3.2	6,336.0	6,512.6	6,681.6	6,842.9	7,188.5	7,518.7	7,849.0	8,355.8
Bracing (kg)	5.1	2,152.2	2,274.6	2,351.1	2,432.7	2,555.1	2,703.0	2,845.8	3,141.6
Pipe/Laying	1 ls	253.0	350.0	439.0	509.0	779.0	1,267.0	1,643.0	2,702.0
Dewatering/Others	1 ls	7.6	8.5	9.5	10.9	12.7	15.2	19.0	25.4
Total		10,238.1	10,838.1	11,383.0	11,901.8	13,108.7	14,561.4	15,930.2	18,648.6

Table 2.9.1.1 (2) Unit Construction Cost of Manhole

Type	Manhole Hight	Construction Cost (Baht/Unit)
NO.1	2 m	11,480
	3 m	12,690
	4 m	13,890
	5 m	15,110
NO.2	2 m	14,680
	3 m	15,880
	4 m	17,080
	5 m	18,290
NO.3	2 m	18,070
	3 m	19,270
	4 m	20,470
	5 m	21,700
NO.4	2 m	24,420
	3 m	25,620
	4 m	26,820
	5 m	28,020
NO.5	4 m	35,660

Table 2.9.1.1 (3) Unit Costruction Cost of Overflow Chamber

Type of Overflow Chamber	Construction Cost (Baht/Unit)
B	24,150
C	18,700

2.9.1.2 Direct Construction Cost by Major Facilities

Table 2.9.1.2 (1) Construction Cost of Interceptors

Diameter (mm)	Average Earth Covering Depth (m)	Length of Sewer (m)	Unit Construction Cost (Baht/m)	Construction Cost (x 1,000 Baht)
ø300	1.5	755	1,329.9	1,005
	2	320	6,422.1	2,056
	Sub-total	1,075		3,061
ø400	1.5	1,200	6,335.7	7,603
	2	350	6,978.9	2,443
	5	65	10,838.1	705
	Sub-total	1,615		10,751
ø500	2	1,210	7,480.6	9,052
	4	240	10,082.2	2,420
	Sub-total	1,450		11,472
ø600	1.5	550	7,302.2	4,017
	3	1,110	9,273.8	10,294
	Sub-total	1,660		14,311
ø800	1.5	770	8,408.3	6,475
	3	750	10,423.1	7,818
	4	840	11,765.9	9,884
	5	460	13,108.7	6,031
	Sub-total	2,820		30,208
ø1000	1.5	2,090	9,765.0	20,409
	3	1,620	11,820.6	19,150
	5	530	14,561.4	7,718
	Sub-total	4,240		47,277
ø1200	1.5	50	11,036.6	552
	2	1,440	11,736.2	16,901
	3	700	13,134.2	9,194
	4	423	14,532.2	6,148
	Sub-total	2,613		32,795
ø1500	1.5	920	13,608.6	12,520
	2	290	14,328.6	4,156
	5	580	18,648.6	10,817
	Sub-total	1,790		27,493
⊡1600	4	1,690	19,804.1	33,469
	5	680	21,268.1	14,463
	Sub-total	2,370		47,932
	Total	19,633		225,300

Table 2.9.1.2 (2) Construction Cost of Manhole

Type of Mahole	Manhole Hight (m)	Nos. of Manhole	Unit Construction Cost (Baht/unit)	Construction Cost (x 1,000 Baht)
No.1	2	75	11,480	861
	3	39	12,690	495
	4	38	13,890	528
	5	24	15,110	363
	Sub-total	176		2,247
No.2	3	1	15,880	16
	4	21	17,080	359
	5	17	18,290	311
	Sub-total	39		686
No.3	3	21	19,270	405
	4	78	20,470	1,597
	5	21	21,700	456
	Sub-total	120		2,458
No.4	3	12	25,620	308
	5	11	28,020	309
	Sub-total	23		617
	Total	358		6,008

Table 2.9.1.2 (3) Construction Cost of Overflow Chamber (Rangsit)

Type of Overflow Chamber	No. of Overflow Chamber	Unit Construction Cost (Baht/unit)	Construction Cost (x 1,000 Baht)
B	6	24,150	145
C	16	18,700	299
Total	22		444

Table 2.9.1.2 (4)-1 Construction Cost of Inverted Siphon

1 - 5 (No.1)

Item		Quantity	Unit Cost (Baht)	Construction Cost (x 1,000Baht) Domestic Portion	Foreign Portion	Total
Excavation	(m3)	2,244	60	135		135
Backfill (Granular)	(m3)	13.36	300	4		4
Backfill (Soil)	(m3)	1,621	60	97		97
Sheet Pile	(kg)	83,798	3.2	268		268
Rubble Stone	(m3)	19.94	400	8		8
Piling	(piece)	157	1,900	298		298
Concrete	(m3)	361.59	4,658	1,684		1,684
Lean Concrete	(m3)	4.98	1,950	10		10
Reinforced Steel Bar	(kg)	32,540	12	390		390
Form Work	(m2)	629.96	300	189		189
Cover	(unit)	8	7,000	56		56
Screen (1.9m x 2.85m)	(unit)	1			282	282
		Total		3,139	282	3,421

6 - 13 (No.2)

Item		Quantity	Unit Cost (Baht)	Construction Cost (x 1,000Baht) Domestic Portion	Foreign Portion	Total
Excavation	(m3)	2,129	60	128		128
Backfill (Granular)	(m3)	33.96	300	10		10
Backfill (Soil)	(m3)	1,920	60	115		115
Sheet Pile	(kg)	86,880	3.2	278		278
Rubble Stone	(m3)	34.69	400	14		14
Piling	(piece)	128	1,900	243		243
Concrete	(m3)	264.18	4,658	1,231		1,231
Lean Concrete	(m3)	8.67	1,950	17		17
Reinforced Steel Bar	(kg)	23,780	12	285		285
Form Work	(m2)	680.37	300	204		204
Cover	(unit)	8	7,000	56		56
Screen (1.6m x 2.45m)	(unit)	1			238	238
		Total		2,581	238	2,819

Table 2.9.1.2 (4)-2 Construction Cost of Inverted Siphon

6 - 16 (No.3)

Item		Quantity	Unit Cost (Baht)	Construction Cost (x 1,000Baht) Domestic Portion	Foreign Portion	Total
Excavation	(m3)	1,572	60	94		94
Backfill (Granular)	(m3)	16.32	300	5		5
Backfill (Soil)	(m3)	1,205	60	72		72
Sheet Pile	(kg)	57,216	3.2	183		183
Rubble Stone	(m3)	26.99	400	11		11
Piling	(piece)	100	1,900	190		190
Concrete	(m3)	204.54	4,658	953		953
Lean Concrete	(m3)	6.75	1,950	13		13
Reinforced Steel Bar	(kg)	18,140	12	218		218
Form Work	(m2)	539.18	300	162		162
Cover	(unit)	8	7,000	56		56
Screen (1.6m x 2.45m)	(unit)	1			238	238
		Total		1,957	238	2,195

7 - 3 (No.4)

Item		Quantity	Unit Cost (Baht)	Construction Cost (x 1,000Baht) Domestic Portion	Foreign Portion	Total
Excavation	(m3)	1,424	60	85		85
Backfill (Granular)	(m3)	9.327	300	3		3
Backfill (Soil)	(m3)	1,202	60	72		72
Sheet Pile	(kg)	66,528	3.2	213		213
Rubble Stone	(m3)	20.32	400	8		8
Piling	(piece)	78	1,900	148		148
Concrete	(m3)	141.60	4,658	660		660
Lean Concrete	(m3)	5.08	1,950	10		10
Reinforced Steel Bar	(kg)	12,750	12	153		153
Form Work	(m2)	398.13	300	119		119
Cover	(unit)	8	7,000	56		56
Screen (0.9m x 1.65m)	(unit)	1			133	133
		Total		1,527	133	1,660

Table 2.9.1.2 (5)-1 Construction Cost of Pump Station

No.1

Item		Quantity	Unit Cost (Baht)	Construction Cost (x1,000 Baht) Domestic Portion	Foreign Portion	Total
1) Civil and Architecture Work						
Excavation	(m3)	2,345	60	141		141
Backfill (Granular)	(m3)	21.08	300	6		6
Backfill (Soil)	(m3)	1,272	60	76		76
Sheet Pile	(kg)	88,512	3.2	283		283
Bracing	(kg)	1,134.77	5.2	6		6
Rubble Stone	(m3)	34.14	400	14		14
Piling	(m)	133	3,800	505		505
Concrete	(m3)	1,134.77	4,658	5,286		5,286
Lean Concrete	(m3)	8.54	1,950	17		17
Reinforced Steel Bar	(kg)	54,200	12	650		650
Form Work	(m2)	1,249.7	300	375		375
Architecture	(LS)			175		175
Sub-total of 1)				7,534		7,534
2) Mechanical and Electrical Works						
Screen (1.2m x 2.3m)	(unit)	2	178		356	356
Gate (1.2m x 1.2m)	(unit)	2	251		502	502
Pump (ø400mm x 22kw)	(unit)	1	1,905		1,905	1,905
Pump (ø600mm x 45kw)	(unit)	2	2,619		5,238	5,238
Piping and Valves	(LS)				1,429	1,429
Instrumentation	(LS)				2,143	2,143
Installation	(LS)				1,429	1,429
Sub-total of 2)					13,001	13,001
Total				7,534	13,001	20,535

No.2

Item		Quantity	Unit Cost (Baht)	Construction Cost (x1,000 Baht) Domestic Portion	Foreign Portion	Total
1) Civil and Architecture Work						
Excavation	(m3)	2,345	60	141		141
Backfill (Granular)	(m3)	21.08	300	6		6
Backfill (Soil)	(m3)	1,272	60	76		76
Sheet Pile	(kg)	88,512	3.2	283		283
Bracing	(kg)	1,135	5.2	6		6
Rubble Stone	(m3)	34.14	400	14		14
Piling	(m)	133	3,800	505		505
Concrete	(m3)	1,134.77	4,658	5,286		5,286
Lean Concrete	(m3)	8.54	1,950	17		17
Reinforced Steel Bar	(kg)	54,200	12	650		650
Form Work	(m2)	1,249.7	300	375		375
Architecture	(LS)			175		175
Sub-total of 1)				7,534		7,534
2) Mechanical and Electrical Works						
Screen (1.2m x 2.3m)	(unit)	2	178		356	356
Gate (1.2m x 1.2m)	(unit)	2	251		502	502
Pump (ø500mm x 30kw)	(unit)	1	2,413		2,413	2,413
Pump (ø600mm x 45kw)	(unit)	2	2,619		5,238	5,238
Piping and Valves	(LS)				1,530	1,530
Instrumentation	(LS)				2,295	2,295
Installation	(LS)				1,530	1,530
Sub-total of 2)			5,461		13,865	13,865
Total				7,534	13,865	21,399

Table 2.9.1.2 (5)-2 Construction Cost of Pump Station

No.3

Item		Quantity	Unit Cost (Baht)	Construction Cost (x1,000 Baht) Domestic Portion	Foreign Portion	Total
1) Civil and Architecture Work						
Excavation	(m3)	78.89	60	5		5
Backfill (Sand)	(m3)	60.35	300	18		18
Sheet Pile	(kg)	19,008	3.2	61		61
Bracing	(kg)	2,085	5.2	11		11
Rubble Stone	(m3)	0.67	400	0.3		0.3
Concrete	(m3)	6.28	4,658	29		29
Lean Concrete	(m3)	0.17	1,950	0.3		0.3
Form Work	(m2)	74.5	300	22		22
Sub-total of 1)				147		147
2) Mechanical and Electrical Works						
Pump (ø150mm x 5.5kw)	(unit)	2	62		124	124
Piping and Valves	(LS)				25	25
Instrumentation	(LS)				37	37
Installation	(LS)				25	25
Sub-total of 2)					211	211
Total				147	211	357

No.5

Item		Quantity	Unit Cost (Baht)	Construction Cost (x1,000 Baht) Domestic Portion	Foreign Portion	Total
1) Civil and Architecture Work						
Excavation	(m3)	1,847	60	111		111
Backfill (Granular)	(m3)	43.20	300	13		13
Backfill (Soil)	(m3)	931	60	56		56
Sheet Pile	(kg)	92,160	3.2	295		295
Bracing	(kg)	820.58	5.2	4		4
Rubble Stone	(m3)	25.37	400	10		10
Piling	(m)	95	3,800	361		361
Concrete	(m3)	799.94	4,658	3,726		3,726
Lean Concrete	(m3)	6.34	1,950	12		12
Reinforced Steel Bar	(kg)	38,350	12	460		460
Form Work	(m2)	1,006.9	300	302		302
Architecture				122		122
Sub-total of 1)				5,472		5,472
2) Mechanical and Electrical Works						
Screen (1.0m x 2.4m)	(unit)	2	142		284	284
Gate (1.0m x 1.0m)	(unit)	2	200		400	400
Pump (ø300mm x 11kw)	(unit)	2	1,262		2,524	2,524
Piping and Valves	(LS)				585	585
Instrumentation	(LS)				877	877
Installation	(LS)				585	585
Sub-total of 2)					5,255	5,255
Total				5,472	5,255	10,727

Table 2.9.1.2 (5)-3 Construction Cost of Pump Station

No.6

Item		Quantity	Unit Cost (Baht)	Construction Cost (x1,000 Baht) Domestic Portion	Foreign Portion	Total
1) Civil and Architecture Work						
Excavation	(m3)	2,105	60	126		126
Backfill (Granular)	(m3)	51.84	300	16		16
Backfill (Soil)	(m3)	1,012	60	61		61
Sheet Pile	(kg)	102,240	3.2	327		327
Bracing	(kg)	905.44	5.2	5		5
Rubble Stone	(m3)	26.54	400	11		11
Piling	(m)	102	3,800	388		388
Concrete	(m3)	905.44	4,658	4,218		4,218
Lean Concrete	(m3)	6.64	1,950	13		13
Reinforced Steel Bar	(kg)	44,220	12	531		531
Form Work	(m2)	1,123.5	300	337		337
Architecture	(LS)			122		122
Sub-total of 1)				6,155		6,155
2) Mechanical and Electrical Works						
Screen (1.0m x 2.4m)	(unit)	2	142		284	284
Gate (1.0m x 1.0m)	(unit)	2	200		400	400
Pump (ø300mm x 15kw)	(unit)	2	1,357		2,714	2,714
Piping and Valves	(LS)				623	623
Instrumentation	(LS)				934	934
Installation	(LS)				623	623
Sub-total of 2)					5,578	5,578
Total				6,155	5,578	11,733

No.7

Item		Quantity	Unit Cost (Baht)	Construction Cost (x1,000 Baht) Domestic Portion	Foreign Portion	Total
1) Civil and Architecture Work						
Excavation	(m3)	2,345	60	141		141
Backfill (Granular)	(m3)	21.08	300	6		6
Backfill (Soil)	(m3)	1,272	60	76		76
Sheet Pile	(kg)	88,512	3.2	283		283
Bracing	(kg)	1,134.77	5.2	6		6
Rubble Stone	(m3)	34.14	400	14		14
Piling	(m)	133	3,800	505		505
Concrete	(m3)	1,134.77	4,658	5,286		5,286
Lean Concrete	(m3)	8.54	1,950	17		17
Reinforced Steel Bar	(kg)	54,200	12	650		650
Form Work	(m2)	1,249.7	300	375		375
Architecture	(LS)			175		175
Sub-total of 1)				7,534		7,534
2) Mechanical and Electrical Works						
Screen (1.2m x 2.3m)	(unit)	2	178		356	356
Gate (1.2m x 1.2m)	(unit)	2	251		502	502
Pump (ø350mm x 15kw)	(unit)	2	1,667		3,334	3,334
Piping and Valves	(LS)				767	767
Instrumentation	(LS)				1,151	1,151
Installation	(LS)				767	767
Sub-total of 2)					6,877	6,877
Total				7,534	6,877	14,411

Table 2.9.1.2 (5)-4 Construction Cost of Pump Station

No.11

Item		Quantity	Unit Cost (Baht)	Construction Cost (x1,000 Baht) Domestic Portion	Foreign Portion	Total
1) Civil and Architecture Work						
Excavation	(m3)	1,455	60	87		87
Backfill (Granular)	(m3)	22.71	300	7		7
Backfill (Soil)	(m3)	676	60	41		41
Sheet Pile	(kg)	82,944	3.2	265		265
Bracing	(kg)	542.48	5.2	3		3
Rubble Stone	(m3)	19.83	400	8		8
Piling	(m)	72	3,800	274		274
Concrete	(m3)	542.48	4,658	2,527		2,527
Lean Concrete	(m3)	4.96	1,950	10		10
Reinforced Steel Bar	(kg)	31,430	12	377		377
Form Work	(m2)	811.5	300	243		243
Architecture				90		90
Sub-total of 1)				3,932		3,932
2) Mechanical and Electrical Works						
Screen (0.8m x 1.8m)	(unit)	2	119		238	238
Gate (0.8m x 0.8m)	(unit)	2	167		334	334
Pump (ø200mm x 5.5kw)	(unit)	2	809		1,618	1,618
Pump (ø350mm x 7.5kw)	(unit)	2	1,500		3,000	3,000
Piping and Valves	(LS)				924	924
Instrumentation	(LS)				1,385	1,385
Installation	(LS)				924	924
Sub-total of 2)					8,423	8,423
Total				3,932	8,423	12,355

No.12

Item		Quantity	Unit Cost (Baht)	Construction Cost (x1,000 Baht) Domestic Portion	Foreign Portion	Total
1) Civil and Architecture Work						
Excavation	(m3)	1,455	60	87		87
Backfill (Granular)	(m3)	22.71	300	7		7
Backfill (Soil)	(m3)	676	60	41		41
Sheet Pile	(kg)	82,944	3.2	265		265
Bracing	(kg)	542.48	5.2	3		3
Rubble Stone	(m3)	19.83	400	8		8
Piling	(m)	72	3,800	274		274
Concrete	(m3)	542.48	4,658	2,527		2,527
Lean Concrete	(m3)	4.96	1,950	10		10
Reinforced Steel Bar	(kg)	31,430	12	377		377
Form Work	(m2)	811.5	300	243		243
Architecture				90		90
Sub-total of 1)				3,932		3,932
2) Mechanical and Electrical Works						
Screen (0.8m x 1.8m)	(unit)	2	119		238	238
Gate (0.8m x 0.8m)	(unit)	2	167		334	334
Pump (ø200mm x 5.5kw)	(unit)	2	809		1,618	1,618
Pump (ø250mm x 7.5kw)	(unit)	2	1,071		2,142	2,142
Piping and Valves	(LS)				752	752
Instrumentation	(LS)				1,128	1,128
Installation	(LS)				752	752
Sub-total of 2)					6,964	6,964
Total				3,932	6,964	10,896

Table 2.9.1.2 (6) Contruction Cost of Treatment Plant

Item		Construction Cost (x 1,000 Baht) Domestic Portion	Foreign Portion	Total
1. Civil and Architecture Facilities				
1-1 Grit Chamber	11.0 (L)m x 1.6 (W)m x 0.7 (H)m x 3units	5,965		5,965
	11.0 (L)m x 1.6 (W)m x 0.7 (H)m x 3units			
1-2 Primary Sedimentation Tank	16.0(D)m x 4.0(H)m x 4units	5,810		5,810
1-3 Stormwater Sedimentation Tank	18.5(D)m x 3.0(H)m x 4units	6,403		6,403
1-4 Aeration Tank	75.0(L)m x 15.0(W)m x 3.0(H)m x 2units	17,611		17,611
1-5 Secondary Sedimentation Tank	18.5(D)m x 2.5(H)m x 4units	6,046		6,046
1-6 Disinfection Tank	180.0(L)m x 2.0(W)m x 2.0(H)m x 1unit	3,450		3,450
1-7 Thickener	6.0(D)m x 4.0(H)m x 2units	1,075		1,075
1-8 Digestion Tank	1st : 17.5(D)m x 5.0(H)m x 2units	5,310		5,310
	2nd : 12.0(D)m x 5.0(H)m x 2units	3,367		3,367
1-9 Dewatering Unit		800		800
1-10 Miscellaneous		5,700		5,700
Sub-total of 1.		61,537		61,537
2. Mechanical & Electrical Facilities				
2-1 Grit Chamber			5,833	5,833
2-2 Inflow Pump			12,619	12,619
2-3 Primary Sedimentation Tank			11,548	11,548
2-4 Stormwater Sedimentation Tank			1,071	1,071
2-5 Aeration Tank			10,536	10,536
2-6 Secondary Sedimentation Tank			13,571	13,571
2-7 Disinfection Tank			2,024	2,024
2-8 Thickener			357	357
2-9 Digestion Tank			39,167	39,167
2-10 Dewatering Unit			16,429	16,429
2-11 Piping Materials, Valves and Gates			16,548	16,548
2-12 Control Panel and Instrumentation			19,762	19,762
2-13 Transportation and Instalation			24,286	24,286
2-14 Pump Station Monitoring Facilities			2,260	2,260
2-15 Laboratory Equipment			595	595
2-16 Miscellaneous			10,952	10,952
Sub-total of 2.			187,558	187,558
Total		61,537	187,558	249,095

Assumption for Estimate of Interceptor Cleaning Cost

1) The Length of cleaning for one time is the distance of an average manhole interval (approximately 50m).

2) The nozzle moves forward and is pulled backward with jets three (3) times for one time cleaning.

3) It takes about ten (10) min. for the nozzle to move forward and backward.

4) The water (3 m3) of High Pressure Cleaner' tank is used for one time cleaning.

5) A cleaning team consists of "High Pressure Sewer Cleaner", "Vacuum Sludge Loader", "Water Wagon" and "Truck".

6) The Volume of a water wagon tank is 4 m3.

7) Required time for water feeding to a water wagon and discharging sludge is 1.5 hours (including traveling time).

From the above assumption,

The possible length of cleaning interceptor in a year,

In case that working hour is 8 hours, times of cleaning is the following.

8 hr. x 2 hr./time = 4 times

As the length of cleaning interceptor for one time is 50 m,

50 m/time x 4 times = 200 m/day

When actual Working hour in a year is 20 day/month x 12 months x 0.8 = 192 day/year,
the possible length of cleaning interceptor in a year is the following.

200 m/day x 192 days = 38,400 m/year

Annual expenses for interceptor cleaning are,

(1) Labor Cost

Type of Vehicle	Classi -fication	Required No.	Working Day	Wage	Cost
1-1. High Pressure Sewer Cleaner	Driver	1 person			
	Operator	2 persons			
1-2. Vacuum Sludge Loader	Driver	1 person			
	Operator	2 persons			
1-3. Water Wagon	Driver	1 person			
1-4. Truck	Driver	1 person			
	Labor	4 persons			
Total	Driver	4 persons	192 days x	420 B/day =	322,560
	Operator	4 persons	192 days x	360 B/day=	276,480
	Labor	4 persons	192 days x	140 B/day=	107,520
Annual Labor Cost (Baht/Year)					706,560

(2) Fuel Cost

3-1. High Pressure Sewer Cleaner / Vacuum Sludge Loader

20 l / hr.	x	8 hr.	x	192 days =	30,720
				x (Vehicles)	3
					92,160

3-2. Water Wagon / Truck

10 l / hr.	x	3 hr.	x	192 days =	5,760
				x (Vehicles)	1
					5,760

Annual Fuel Cost (Baht/Year) 97,920

(3) Spare Parts Cost

Type of Vehicle	Price	Working Life		Cost
1-1. High Pressure Sewer Cleaner	1,000,000 Baht	5 Years	=	200,000
1-2. Vacuum Sludge Loader	1,000,000 Baht	5 Years	=	200,000
1-3. Water Wagon	1,000,000 Baht	5 Years	=	200,000
1-4. Truck	700,000 Baht	10 Years	=	70,000
Annual Vehicle Cost (Baht/Year)				670,000

670,000 (Vehicle Cost) x 3 % = 20,100

Spare Parts Cost (Baht/Year) 20,100

Annual Cleaning Cost (Baht/Year) 824,580

Cleaning Cost of Interceptor per Meter (Baht/m) 21.5

3.6.1 Distribution of Population and Wastewater Quantity

Table 3.6.1.1 Population Distribution

BangBuaThong (F/S)

NO.ofSewers		Commercal-Area			Residential-Area			Residential-Area			PublicLand		IndustrialArea		VacantArea		ServiceArea			Adopted		
Current Sewer	Down-stream	Area (ha)	P.Dens. (p./ha)	Design P. (person)	Area (ha)	P.Dens. (p./ha)	Design P. (person)	Area (ha)	P.Dens. (p./ha)	Design P. (person)	Area (ha)	Design P. (person)	Area (ha)	Design P. (person)	Area (ha)	Design P. (person)	Area (ha)	P.Dens. (p./ha)	Design P. (person)	Area (ha)	P.Dens. (p./ha)	Design P. (person)
1/1	1/3	17.2	200	3,440	45.8	100	4,580	15.0	30	450	5.4	0	0.0	0	0.0	0	83.4	101.56	8,470	83.4	100.90	8,415
(101–105)																						
1/4	1/6	48.3	200	9,660	4.7	100	470	3.1	30	93	4.6	0	0.0	0	0.0	0	60.7	168.42	10,223	60.7	168.40	10,222
(106)																						
1/7	1/10	22.0	200	4,400	25.6	100	2,560	16.4	30	492	0	0	0.0	0	0.0	0	64.0	116.44	7,452	64.0	116.60	7,462
(107–108)																						
1/11	1/12	0.0	200	0	14.4	100	1,440	11.9	30	357	0	0	0.0	0	0.0	0	26.3	68.33	1,797	26.3	68.30	1,796
2/1	2/2	7.9	200	1,580	0.0	100	0	0.2	30	6	4.6	0	0.0	0	0.0	0	12.7	124.88	1,586	12.7	65.70	834
2/3	2/5	0.0	200	0	73.2	100	7,320	19.8	30	594	0	0	0.0	0	0.0	0	93.0	85.10	7,914	93.0	85.10	7,914
(201–202)																						
2/6		0.0	200	0	0.0	100	0	2.1	30	63	0	0	0.0	0	0.0	0	2.1	30.00	63	2.1	30.00	63
3/1	3/5	0.0	200	0	0.0	100	0	0.0	30	0	0	0	0.0	0	0.0	0	0.0	0.00	0	0.0	0.00	0
3/6	3/7	0.0	200	0	95.8	100	9,580	0.0	30	0	0	0	0.0	0	0.0	0	95.8	100.00	9,580	95.8	100.00	9,580
Adopted		95.4		19,080	259.5		25,950	68.5		2,055	14.6	0	0.0	0	0.0	0	438.0		47,085	438.0		46,287

Table 3.6.1.2 (1) Hydraulic Calculation for Design of Sewers (Bang Bua Thong-North (1))

No. of Sewers	Downstream Sewers No.	Drainage Area: Area	Drainage Area: Total	Length: Length	Length: Total	Concentrated Time	Run-off Storm: Rainfall	Run-off Storm: Run-off Coeffi.	Run-off Storm: Arranged Area: Area	Run-off Storm: Arranged Area: Total	Run-off Storm: Rainfall	Wastewater Flow: Pop. Density	Wastewater Flow: Population: Sewer	Wastewater Flow: Population: Total	Wastewater Flow: Design Flow	Other W.W: Sewer	Other W.W: Total	Grand Total Design Flow	Designing of Sewers: Diameter	Designing of Sewers: Slope	Designing of Sewers: Velocity	Designing of Sewers: Flow	Designing of Sewers: Elevation	Designing of Sewers: Invert Level	Designing of Sewers: Earth Cover	Remarks
		ha	ha	m	m	min	m³/sec·ha	·	ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
1-1	1-2A	790	790	530	530							100.9	798	798	0015	0039	0039	0054	400	130	070	0088	155 254	0215 -0866	100 297	
101	1-2A	000	000	0	0							100.9	0	0	0000	0053	0053	0053	400	130	070	0088	254 254	-0025 -0025	213 213	
102		1970	1970	750	750							100.9	1988	1988	0037			0037	300	220	064	0045	213 294	0300 -1030	100 364	
103		550	2520	600	1350							100.9	555	2543	0048			0048	400	130	070	0088	294 274	-1130 -2357	364 456	
104		2030	4550	15	1365							100.9	2048	4591	0086	0021	0021	0107	500	160	077	0151	274 254	-2457 -2481	456 448	
1-2A		000	5340	0	1365							0.00	0	5389	0101		0113	0214	600	160	087	0246	254 254	-2481 0800	437 109	P.U
1-2	1-3	1360	6700	510	1875							100.9	1372	6761	0127		0113	0240	600	160	087	0246	254 199	0790 -0156	110 150	
105		1670	1670	15	15							100.9	1686	1686	0032			0032	300	220	064	0045	199 199	0600 0567	105 109	
1-3		000	8370	38	1913							0.00	-1	8446	0158		0113	0271	400	400	105	0132	199 194	-3469 -3621	502 513	FUSEKOSI
1-3A	1-4	000	8370	0	1913							0.00	0	8446	0158		0113	0271	600	160	087	0246	194 194	-3621 -0450	491 174	
106		500	500	15	15							168.4	842	842	0016			0016	300	220	064	0045	194 194	0610 0577	100 103	
1-4		1430	10300	400	2313							168.4	2408	11696	0219		0113	0332	800	160	105	0529	194 219	-0650 -1340	172 266	

Table 3.6.1.2 (2) Hydraulic Calculation for Design of Sewers (Bang Bua Thong-North (1))

No. of Sewers	Downstream Sewers No.	Drainage Area: Area	Drainage Area: Total	Length: Length	Length: Total	Concentrated Time	Run-off Storm: Rainfall	Run-off Storm: Run-off Coeffi.	Run-off Storm: Arranged Area: Area	Run-off Storm: Arranged Area: Total	Run-off Storm: Rainfall	Wastewater Flow: Pop. Density	Wastewater Flow: Population: Sewer	Wastewater Flow: Population: Total	Wastewater Flow: Design Flow	Other W.W: Sewer	Other W.W: Total	Grand Total Design Flow	Designing of Sewers: Diameter	Designing of Sewers: Slope	Designing of Sewers: Velocity	Designing of Sewers: Flow	Designing of Sewers: Elevation	Designing of Sewers: Invert Level	Designing of Sewers: Earth Cover	Remarks
		ha	ha	m	m	min	m³/sec·ha	·	ha	ha	m³/sec	Pe/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
1-5		0.00	103.00	15	2328							0.00	0	11696	0.219		0.113	0.332	800	1.60	1.05	0.529	2.19 2.19	-1.350 -1.374	2.67 2.70	
1-6	1-7	41.40	144.40	710	3038							168.4	6972	18668	0.349		0.113	0.462	800	1.60	1.05	0.529	2.19 2.09	-1.384 -2.513	2.71 3.84	
2-1		12.40	12.40	380	380							65.70	815	815	0.015	0.027	0.027	0.042	300	2.20	0.64	0.045	1.74 1.92	0.410 -0.517	1.30 2.11	
2-2	2-3	0.00	12.40	15	395							0.00	0	815	0.015		0.027	0.042	300	2.20	0.64	0.045	1.92 1.92	-0.527 -0.560	2.12 2.15	
201A		52.40	52.40	0	0							85.10	4460	4460	0.083			0.083	500	1.60	0.77	0.151	1.96 1.96	-0.140 -0.141	1.56 1.56	
201		0.00	52.40	440	440							0.00	0	4460	0.083			0.083	400	1.80	0.70	0.088	1.96 1.92	-0.151 -1.053	1.68 2.54	
2-3	2-4	11.70	76.50	710	1150							85.10	995	6270	0.117		0.027	0.144	500	1.60	0.77	0.151	1.92 2.30	-1.153 -2.458	2.53 4.22	
202		26.90	26.90	310	310							85.10	2290	2290	0.043			0.043	300	2.20	0.64	0.045	1.96 2.30	0.630 -0.119	1.00 2.09	
2-4		2.00	105.40	170	1320							85.10	169	8729	0.163		0.027	0.190	600	1.60	0.87	0.246	2.30 2.76	-2.558 -2.868	4.21 4.98	
2-5		0.00	105.40	17	1337							0.00	0	8729	0.163		0.027	0.190	600	1.60	0.87	0.246	2.76 2.76	-2.878 -2.905	4.99 5.02	
2-6		2.10	107.50	160	1497							30.00	63	8792	0.165		0.027	0.192	600	1.60	0.87	0.246	2.76 2.09	-2.915 -3.201	5.03 4.64	
1-7	1-8A	0.00	251.90	60	3098							0.00	0	27460	0.514		0.140	0.654	1000	1.40	1.14	0.897	2.09 1.78	-3.501 -3.685	4.61 4.38	

Table 3.6.1.2 (3) Hydraulic Calculation for Design of Sewers (Bang Bua Thong-North (1))

No. of Sewers	Downstream Sewers No.	Drainage Area: Area	Drainage Area: Total	Length: Length	Length: Total	Concentrated Time	Run-off Storm: Rainfall	Run-off Storm: Run-off Coeffi.	Run-off Storm: Arranged Area: Area	Run-off Storm: Arranged Area: Total	Run-off Storm: Rainfall	Wastewater Flow: Pop. Density	Wastewater Flow: Population: Sewer	Wastewater Flow: Population: Total	Wastewater Flow: Design Flow	Other W.W: Sewer	Other W.W: Total	Grand Total Design Flow	Designing of Sewers: Diameter	Designing of Sewers: Slope	Designing of Sewers: Velocity	Designing of Sewers: Flow	Designing of Sewers: Elevation	Designing of Sewers: Invert Level	Designing of Sewers: Earth Cover	Remarks
		ha	ha	m	m	min	m³/sec·ha		ha	ha	m³/sec	Per/ha	Person		m³/sec	m³/sec	m³/sec	m³/sec	mm	‰	m/sec	m³/sec	M	M	m	
107		28.50	28.50	560	560							116.6	3324	3324	0.062			0.062	400	1.30	0.70	0.088	2.68 2.01	1.141 -0.253	1.10 1.83	
108		5.10	33.60	420	980							116.6	594	3918	0.073			0.073	400	1.30	0.70	0.088	2.01 1.78	-0.263 -1.117	1.84 2.46	
1-8A		0.00	285.50	0	3098							0.00	-1	31377	0.587		0.140	0.727	1000	1.40	1.14	0.897	1.78 1.78	-3.585 -0.320	4.38 1.02	P.U
1-8		21.70	307.20	650	3748							116.6	2531	33908	0.635		0.140	0.775	1000	1.40	1.14	0.897	1.76 2.01	-0.330 -1.331	1.03 2.26	
1-9		8.70	315.90	250	3998							116.6	1014	34922	0.654		0.140	0.794	1000	1.40	1.14	0.897	2.01 1.54	-1.341 -1.723	2.27 2.18	
1-10		0.00	315.90	30	4028							0.00	0	34922	0.654		0.140	0.794	1000	1.40	1.14	0.897	1.54 1.61	-2.757 -2.799	3.22 3.33	
1-11	1-12	26.30	342.20	250	4278							68.30	1796	36718	0.687		0.140	0.827	1000	1.40	1.14	0.897	1.61 2.34	-2.809 -3.188	3.34 4.45	
3-6		0.00	0.00	0	0							0.00	0	0	0.000	0.092	0.092	0.092	500	1.60	0.77	0.151	2.42 2.42	0.040 0.040	1.84 1.84	
3-7		95.80	95.80	470	470							100.0	9580	9580	0.179		0.092	0.271	800	1.60	1.05	0.529	2.42 2.34	-0.260 -1.073	1.31 2.55	
1-12	T.PL ANT	0.00	438.00	50	4328							0.00	0	46298	0.866		0.232	1.098	1200	1.20	1.19	1.351	2.34 2.00	-3.388 -3.448	4.43 4.15	

3.6.2 Design Fundamentals and Facility Specifications

Table 3.6.2.1 Pump Station

(1) Design Fundamentals

No.	Sewer No.	Design Flow		Invert Level		Water Level		Actual Head	G.L	
		P/D (M3/S)	M/P (M3/S)	Inlet (M)	Outlet (M)	Inlet (M)	Outlet (M)	(M)	Present (M)	Plan (M)
1	1−2A	0.101	0.214	−2.481	−0.800	−1.98	1.30	3.28	2.54	2.80
2	1−8A	0.588	0.727	−3.685	−0.320	−2.99	0.38	3.37	1.78	2.00

(2) Design Flow

No.	Sewer No.	P/D				M/P			
		Q1 (M3/m)	Q2 (M3/m)	Q3 (M3/m)	Q4 (M3/m)	Q1 (M3/m)	Q2 (M3/m)	Q3 (M3/m)	Q4 (M3/m)
1	1−2A	1.30	1.56	2.02	6.06	2.74	3.30	4.28	12.84
2	1−8A	7.55	9.05	11.76	35.28	9.33	11.19	14.54	43.62

Note: Q1; Daily Ave.
Q2; Daily Max.
Q3; Hourly Max.
Q4; 3xHourly Max.

(3) Pump Specification

No.	Sewer No.	Pump Type	No. of units by Dia.				R.M
			150(mm)	200(mm)	300(mm)	400(mm)	
1	1−2A	C	2	2			
2	1−8A	C			2	2	

Note: Common Type
Manhole Type

(4) Pump Head and H.P

No.	Sewer No.	Actual Head (M)	Pump Head		H.P by Dia.				R.M
			Loss (M)	Total (M)	150(mm) (KW/unit)	200(mm) (KW/unit)	300(mm) (KW/unit)	400(mm) (KW/unit)	
1	1−2A	3.28	1.50	4.78	3.70	5.50			
2	1−8A	3.37	1.50	4.87			11.00	18.50	

(5) Manner of Pump Operation

No.	Pump Dia. (mm)	P/D				M/P			
		Q1 (unit)	Q2 (unit)	Q3 (unit)	Q4 (unit)	Q1 (unit)	Q2 (unit)	Q3 (unit)	Q4 (unit)
1	(m3/m)	1.3	1.56	2.02	6.06	2.75	3.3	4.28	12.84
	150	1	1	1	1	2	2	2	2
	200				1				2
2	(m3/m)	7.55	9.05	11.76	35.28	9.33	11.19	14.54	43.62
	300	1			1	2	2	2	2
	400		1	1	2				2

Table 3.6.2.2 Inverted Siphon

No.	Sewer No.	Design Flow		Inlet		Siphon				Outlet	
		P/D (M3/S)	M/P (M3/S)	Dia. (MM)	Invert L. (M)	Dia. (MM)	Velocity (M/S)	Length (M)	Loss (M)	Inver L. (M)	W.L. (M)
1	1−3	0.16	0.27	600	−0.16	400x2 line	1.05	38	0.28	−0.45	−0.15

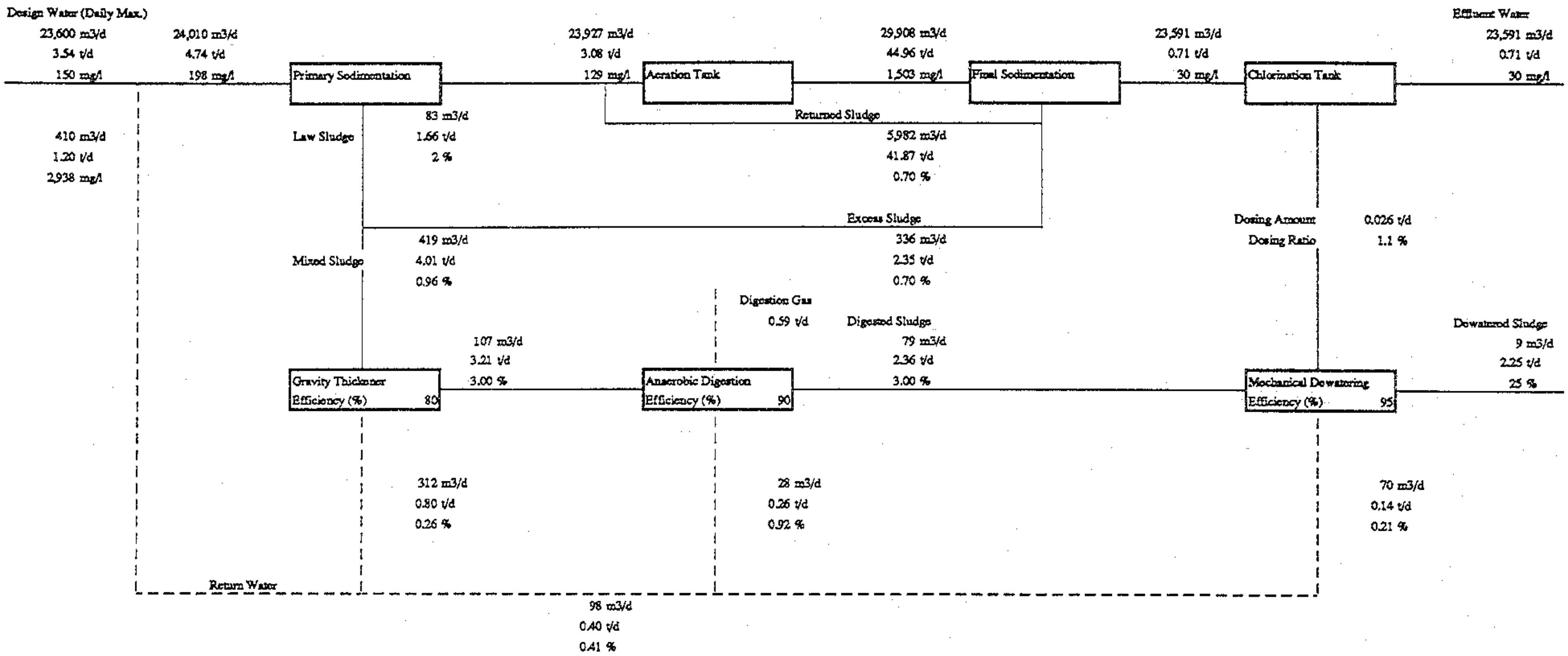
3.6.2.3 Overflow Chamber

Number of overflow chambers is shown in table 3.6.2 (5) according to same conditions in Rang Sit project.

Table 3.6.2.(1) Number of overflow Chambers

No.	Sewer No.	Quantity (M3/S)	Dia. (MM)	Slope (1/1000)	Full How (M/S)	(M3/S)	Type
1	1-1	0.054	ϕ300	4.0	0.865	0.0612	C
2	102	0.037	ϕ300	2.0	0.612	0.0432	B
3	103	0.011	ϕ300	2.0	0.612	0.0432	C
4	104	0.059	ϕ300	4.0	0.865	0.0612	C
5	1-2	0.026	ϕ300	2.0	0.612	0.0432	B
6	105	0.032	ϕ300	2.0	0.612	0.0432	C
7	106	0.016	ϕ300	2.0	0.612	0.0432	C
8	1-4	0.045	ϕ300	2.5	0.684	0.0484	C
9	1-6	0.130	ϕ400	4.0	1.048	0.1317	C
10	2-1	0.042	ϕ300	2.0	0.612	0.0432	C
11	201	0.083	ϕ300	8.0	1.224	0.0865	C
12	2-3	0.019	ϕ300	2.0	0.612	0.0432	C
13	202	0.043	ϕ300	2.0	0.612	0.0432	C
14	2-4	0.003	ϕ300	2.0	0.612	0.0432	C
15	2-6	0.002	ϕ300	2.0	0.612	0.0432	C
16	107	0.062	ϕ300	5.0	0.967	0.0684	C
17	108	0.011	ϕ300	2.0	0.612	0.0432	C
18	1-8	0.047	ϕ300	2.5	0.684	0.0484	C
19	1-9	0.019	ϕ300	2.0	0.612	0.0432	C
20	1-11	0.034	ϕ300	2.0	0.612	0.0432	C
21	3-7	0.179	ϕ400	8.0	1.482	0.1863	B
	Total	0.954					

3.7.3.1 Mass Balance of SS in Bang Bua Thong Sewage Treatment Plant



Sludge BBT M/P Centrifugal E1993/11/1

3.7.3.2 Design of Facilities

Wastewater Treatment

(1) Inflow Pump Station

The inflow pump station of treatment plant consists of initial bar screen followed with the pump facilities.

1) Design Condition

	Dry Weather Flow	Wet Weather Flow
Design Flow (hourly max.)	14,200 m3/d = 9.86 m3/min.	42,600 m3/d = 29.58 m3/min.
Surface loading of grit chamber	1,800 m3/m2/day	3.600 m3/m2/day
Average velocity of grit chamber	0.3 m/sec	0.6 m/sec
Retention time	60 sec	30 sec

2) Proposed Inflow Pump Station
   Grit Chamber
      Dry Weather Flow — 1.0 m (w) x 0.4 m (h) x 9 m (l) x 1 unit
      Wet Weather Flow — 1.4 m (w) x 0.4 (h) x 9 (l) x 1 unit
   Inflow Pump
      Dry Weather Flow — ϕ250 x 2 pumps (4.93 m3/min. x 2)
      Wet Weather Flow — ϕ250 x 2 pumps, 450 x 1 pump (4.93 m3/min. x 2 + 21.35 m3/min. x 1)

(2) Primary Sedimentation Basin for Wastewater

1) Design Condition

Design Flow (Daily Max.)	10,900 m3/day
Surface Loading	35 m3/m2/day
Sedimentation Time	3,0 hr
Effective Depth	4.0 m
Overflow Loadign of Weir	less than 250 m3/m/day
Reduction Efficiency	BOD : 30% SS : 35%
Influent Water Quality	BOD : 150 mg/l SS : 150 mg/l
Effluent Water Quality	BOD :105 mg/l SS : 97.5 mg/l

2) Proposed Sedimentation Basin
   Sedimentation Basin — ϕ15.0 m x 2 units
   Surface Area — 353 m2

(3) Storm Water Sedimentation Basin

1) Design Condition

Design Flow (Wet hourly max. – dry daily max.)	31,700 m3/day (42,600 – 10,900)
Surface Loading	70 m3/m2 day
Sedimentation Time	0.5 hr
Effective Depth	3.0 m
Overflow Loading of Weir	less than 250 m3/m/day

2) Proposed Storm water Sedimention Basin

Sedimentation Basin	ϕ14.0 m x 3 units
Surface Area	462 m2

(4) Aeration Tank

Based on the discussion with PWD of the emergency condition, generator will not be installed at the treatment plant from the economical view point. Hence, the diffused air aeration system is not proposed because of the easiness of diffuser clogging by the floccule while power failure. The mechanical aerator is proposed for this project.

1) Design Condition

Design Flow (daily max.)	10,900 m3/day
Aeration Time	6 hr
BOD-SS Loading	0.35 kg-BOD/kg-SS/day
Return sludge Ratio	25%
Returen Sludge Solid Concentration	7,000 mg/l
BOD Volumetric Loading	0.3 - 0.8 kg/m3/day
Sludge Age	2 - 4 days

2) Proposed Aeration Tank

Aeration Tank	12 m (w) x 36 m (l) x 3 m (d) x 2 units
Aerator	11 kw x 3 units

(5) Secondary Sedimentation Basin

1) Design Condition

Design Flow (daily max.)	10,900 m3/day
Surface Loading	25 m3/m2day
Sedimentation Time	2.5 hr
Overflow Loading of Weir	less than 150 m3/m/day

2) Proposed Secondary Sedimentation Basin

Sedimentation Basin	ϕ17.0 m x 2.5 m (d) x 2 units
Surface Area	454 m2

(6) Disinfection Tank

Calcium hypochlorite is proposed to use the disinfection of treated water.

1) Design Condition

	Dry Weather Flow	Wet Weather Flow
Disitn Flow	10,900 m3/day	42,600 m3/dya
Contact Time of Disinfection Tank	8 min.	8 min.

2) Proposed Disinfection Tank

Tank Size	2 m (w) x 60 m (l) x 1.5 m (d) x 3 units

Sludge Treatment

(1) Gravity Thickener

1) Design Condition

From the Mass Balance calculation in Fig. 7.###, design condition is shown below.

Primary Law Sludge Density	2%
Excess Sludge Density	0.7%
Design Sludge Density	1.04%
Design Sludge Volume	193 m3/d. 1.85 t/d
Thickened Sludge Density	3%
Solid Mass Loading	60 – 90 kg/m2/day
Effective Depth	4 m
Efficiency of Thickener	80 %

2) Proposed Gravity Thickener

Gravity Thickener — ϕ 6 m x 4 m (d) x 1 unit (for 2001)

Thickening Time — 14.1 hr

(2) Anaerobic Digestion Tank

1) Design Condition

Thickened Sludge Organic Material Ratio	60%
Digestion Ratio	50%
Efficiency of Digestion Tank	90%
Effective Depth	more than 4 m
Digestion Time	1st Tank 20 days 2nd Tank 10 days

2) Proposed Anaerobic Digestion Tank

1st Digestion Tank — ϕ 12 m x 5 m(d) x 2 units; 987 m3 22.9 days

2nd Digestion Tank — ϕ 8.5 m x 5 m(d) x 2 units; 493 m3 11.5 days

(3) Centrifugal Dewatering

1) Dewatering Condition

Operation Hour	6 days a week, 6 hours a day
Digested Sludge Volume	36 m3/day, 1.09 t/day
Digested Sludge Density	3%
Efficiency of Centrifugal Dewatering	95%
Dewatered Sludge Moisture Content	79%
Chemical Dosing Ratio	1.1%

2) Proposed Centrifugal Dewatering

Capacity : — 7 m3/hr x 1 unit

Dewatered Sludge — 4 m3/day, 1.04 t/day (Moisture content = 79%)

Design Calculation of Bang Bua Thong Wastewater Treatment Plant
for MASTER PLAN

(1) Design Discharge

		m3/day	m3/min.	m3/sec.
Daily Average	(Qda)	19,700	13.7	0.228
Daily Maximum in Dry Weather	(Qdmd)	23,600	16.4	0.273
Hourly Maximum in Dry Weather	(Qhmd)	30,700	21.3	0.355
Hourly Maximum in Wet Weather	(Qhmw)	92,100	64.0	1.066

	Influent	Effluent
BOD (mg/l)	150	20
SS (mg/l)	150	30

(2) Design Calculation

1) Grit Chamber
(Dry Weather)

Design Flow Rate

Hourly Maximum in Dry Weather	Qhmd=	30,700 m3/day		
	=	0.355 m3/sec.		
Design Condition				
Surface Loading	Ls=	1,800 m3/m2/day		
Average Velocity	Va=	0.3 m/sec.		
Retention Time	Rs=	60 sec.		
Size				
Required Surface Area	A=Qhmd/Ls=	17.06 m2		
Effective Depth	He=	0.4 m		
Required Width	Be=	2.0 m		
Size of Structure				
Width	B=	1.0	=	**1.0 m**
Length	L=A/Be=	8.53	=	**9.0 m**
Depth	H=	0.4	=	**0.4 m**
Numbers	n=	2	=	**2 units**
Verification				
Surface Loading	Ls=Qhmd/B/L/n=	1,706 m3/m2/day		
Average Velocity	Va=Qhmd/B/He=	0.444 m/sec.		
Retention Time	Rt=L/Va=	20.3 sec.		
Volume of Grit	Qhmd*0.00001*1.8 t/m3=	0.55 t/day		
Screenings	Qhmd*0.00001=	0.31 m3/day		

(Wet Weather)

Design Flow Rate

= Hourly Maximum in Wet Weather   Qhmw-Qdmd=   61,400 m3/day

-Hourly Maximum in Dry Weather   =   0.711 m3/sec.

Design Condition

Surface Loading	Ls=	3,600 m3/m2/day
Average Velocity	Va=	0.6 m/sec.
Retention Time	Rs=	30 sec.

Size

Required Surface Area	A=Qhmw/Ls=	17.06 m2
Effective Depth	He=	0.4 m
Required Width	Be=	2.8 m

Size of Structure

Width	B=	1.4	=	**1.4 m**
Length	L=A/Be=	6.09	=	**9.0 m**
Depth	H=	0.4	=	**0.4 m**
Numbers	n=	2	=	**2 units**

Verification

Surface Loading	Ls=Qhmw/B/L/n=	2,437 m3/m2/day
Average Velocity	Va=Qhmw/B/He=	0.635 m/sec.
Retention Time	Rt=L/Va=	14.2 sec.
Volume of Grit		
	Qhmw*0.00001*1.8 t/m3=	1.11 t/day
Screenings	Qhmw*0.00001=	0.61 m3/day

2) Inflow Pump

(Inflow Pump for Wastewater)

Hourly Maximum in Dry Weather   Qhmd=   21.30 m3/min.

4.93 m3/min.	x	2 pumps	=	9.86 m3/min.	
(Dia.= 250	mm,		V=	1.68	m/s)
11.44 m3/min.	x	1 pumps	=	11.44 m3/min.	
(Dia.= 350	mm,		V=	1.99	m/s)
Total				21.30 m3/min.	

(Inflow Pump for Storm Water)

Hourly Maximum in Wet Weather   Qhmw=   64.00 m3/min.

4.93 m3/min.	x	2 pumps	=	9.86 m3/min.	
(Dia.= 250	mm,		V=	1.68	m/s)
11.44 m3/min.	x	1 pumps	=	11.44 m3/min.	
(Dia.= 350	mm,		V=	1.99	m/s)
21.35 m3/min.	x	2 pumps	=	42.70 m3/min.	
(Dia.= 450	mm,		V=	2.25	m/s)
Total				64.00 m3/min.	

3) Primary Sedimentation Tank

Design Flow Rate

Daily Maximum in Dry Weather	Qdmd=	30,700 m3/day		
	=	1,279 m3/hr		
Design Condition				
Surface Loading	Ls=	35 m3/m2/day		
Settling Time	Ts=	3.0 hr		
Effective Depth	He=	4.0 m		
Size				
Required Surface Area	An=Qdmd/Ls=	877 m2		
Required Tank Volume	V=Qdmd*Ts=	3,838 m3		
Size of Structure				
Diameter	D=	16.7	=	**15.0 m**
Depth	H=	4.0	=	**4.0 m**
Numbers	n=	4	=	**4 units**
Volume of Tank	V=	2,826 m3		
Surface Area	As=	707 m2		
Verification				
Surface Loading	Ls=	43.5 m3/m2/day		
Settling Time	Ts=	2.2 hr		
Wier Loading	Lw=	163 m3/m/day		

4) Stormwater Sedimentation Tank

Design Flow Rate

= Hourly Maximum in Wet Weather	Qhmw-Qdmd=	68,500 m3/day		
-Daily Maximum in Dry Weather	=	2,854 m3/hr		
Design Condition				
Surface Loading	Ls=	70 m3/m2/day		
Settling Time	Ts=	0.5 hr		
Effective Depth	He=	3.0 m		
Size				
Required Surface Area	An=Qdmw/Ls=	979 m2		
Required Tank Volume	Lw=Qdmw*Ts=	1,427 m3		
Size of Structure				
Diameter	D=	14.4	=	**14.0 m**
Depth	H=	3.0	=	**3.0 m**
Numbers	n=	6	=	**6 units**
Volume of Tank	V=	2,769 m3		
Surface Area	As=	923 m2		
Verification				
Surface Loading	Ls=	74.2 m3/m2/day		
Settling Time	Ts=	1.0 hr		
Wier Loading	Lw=	260 m3/m/day		

5) Aeration Tank

Design Wastewater Quality

	Ci (BOD) :	105 mg/l		
	Ci (SS) :	98 mg/l		
Design Flow Rate				
Daily Maximum in Dry Weather	Qdmd=	23,600 m3/day		
Design Condition				
Aeration Time	Ta=	6.0 hr		
BOD - SS Loading	Ls=	0.35 kg/kg/day		
Return Sludge Ratio	Rs=	25.0 %		
Return Sludge Solid Concentration	Cr=	7,000 mg/l		
Size				
MLSS				
	(Ci(SS)+Cr*Rs/100)/(1+Rs/100)=	1,478 mg/l		
Required Tank Volume				
	V=Qdmd*Ci(BOD)/(BOD-SS Loading)*MLSS=	4,790 m3		
Size of Structure				
Width	B=	12.0	=	**12.0 m**
Length	L'=Vn/H/n=	33.3	=	**36.0 m**
Depth	H=	3.0	=	**3.0 m**
Numbers	n=	4	=	**4 units**
Verification				
Cross Section	A=B*H-0.3^2=	35.91 m2		
Volume	V=A*L'*n=	5,171 m3		
BOD - SS Loading				
	Ls=Qdmd*Ci/V/MLSS=	0.32 kg/kg/day		
Aeration Time	Ta=V/Qdmd*24=	5.26 hr		
BOD Volumetric Load				
	Lv=Qdmd*Ci(BOD)/V/1,000=	0.48 kg/m3/day		
Sludge Age				
	Sa=MLSS*V/Qdmd/Ci(SS)=	3.32 days		

6) Secondary Sedimentation Tank

Design Flow Rate				
Daily Maximum in Dry Weather	Qdmd=	23,600 m3/day		
	=	983 m3/hr		
Design Condition				
Surface Loading	Ls=	25 m3/m2/day		
Settling Time	Ts=	2.5 hr		
Effective Depth	He=	2.5 m		
Size				
Required Surface Area	A=Qdmd/Ls=	944 m2		
Required Tank Volume	Lw=Qdmd*Ts=	2,458 m3		
Size of Structure				
Diameter	D=	17.7	=	**17.0 m**
Depth	H=	2.5	=	**2.5 m**
Numbers	n=	4	=	**4 units**

Volume of Tank	V=	2,269 m3
Surface Area	As=	907 m2

Verification

Surface Loading	Ls=	26.0 m3/m2/day
Settling Time	Ts=	2.3 hr
Wier Loading	Lw=	111 m3/m/day

7) Disinfection Tank

(Dry Weather)

Design Flow Rate

Daily Maximum in Dry Weather	Qdmd=	23,600 m3/day
	=	983 m3/hr
	=	16.4 m3/min.

Design Condition

Contact Time of Disinfection Tank	Tc=	8 min.
(Contact time of Discharge Pipe is 7 min.)		
	Required Volume=	131 m3

Size of Structure

Width	B=	2.0	=	**2.0 m**
Length	L=	14.6	=	**60.0 m**
Depth	H=	1.5	=	**1.5 m**
Numbers	n=	3	=	**3 units**

Verification

Volume of Tank	V=	540 m3
Contact Time of Disinfection Tank	Tc=	32.9 min.

(Wet Weather)

Design Flow Rate

Hourly Maximum in Wet Weather	Qhmw=	92,100 m3/day
	=	3,838 m3/hr
	=	64.0 m3/min.

Design Condition

Contact Time of Disinfection Tank	Tc=	8 min.
	Required Volume=	512 m3

Size of Structure

Width	B=	2.0	=	**2.0 m**
Length	L=	56.9	=	**60.0 m**
Depth	H=	1.5	=	**1.5 m**
Numbers	n=	3	=	**3 units**

Verification

Volume of Tank	V=	540 m3
Contact Time	Tc=	8.4 min.

8) Gravity Thickener

Design Flow Rate

Daily Maximum in Dry Weather	Qdmd=	23,600 m3/day
Row Sludge		83 m3/day
	(	1.66 t-DS/day)
Excess Sludge		336 m3/day
	(	2.35 t-DS/day)
Total of Sludge Volume :	Dv1=	419 m3/day
	(Ds1=	4.01 t-DS/day)

Design Condition

Type : Gravity Thickener				
Solids Loading	LDs1=	60	to	90 kg/m2 day
Required Surface Area				
	A=Ds1/LDs1=	44.6	to	66.8 m2
Thickening Time			Tt=	12 hr
Required Volume			V=Dv1*Tt=	209.5 m3
Effective Depth			He=	4.0 m
(Required Surface Area = V/He =				52.4 m2)

Size of Structure

Diameter	D=	5.8	=	**6.0 m**
Depth	H=	4.0	=	**4.0 m**
Numbers	n=	2	=	**2 units**
Effective Volume	V=	226.4 m3		
Effective Surface Area	A=	56.6 m2		

Verification

Solids Loading	LDs1'=	70.8 kg/m2 day
Thickening Time	Tt'=	13.0 hr

Volume of Effluent

Efficiency of Thickener	Et=	80 %
Solids Content	Ds1'=Ds1*Et=	3.21 t-DS/day
Moisture Content	Dw=	97 %
Effluent Volume		
	Dv1'=Ds1'*100/(100-Dw)=	107 m3/day

Thickened Sludge

Solids Content	Dst=Ds1-Ds1'=	0.80 t-DS/day
Moisture Content	Dw=	0.26 %
Volume of Thickened Sludge	Dvt=Dv1-Dv1'=	312 m3/day

9) Digester

Design Sludge Volume	Dv2=Dv1'=	107 m3/day
Moisture Content	Dw=	97 %
Solids Content	Ds2=Ds1'=	3.21 t-DS/day
Primary Digester	V1= Dv2 * 20 days =	2,139 m3

Size of Primary Digester

Diameter	D=	11.7	=	**12.0 m**
Depth	He=	5.0	=	**5.0 m**

Numbers	n=	4	=	**4 units**
Verification				
Digestion Time	Td=	21.2 days		
Secondary Digester	V2= Dv2 * 10 days =	1,069 m3		
Size of Secondary Digester				
Diameter	D=	8.3	=	**8.5 m**
Depth	He=	5.0	=	**5.0 m**
Numbers	n=	4	=	**4 units**
Verification				
Digestion Time	Td=	10.6 days		
Volume of Effluent				
Organic Matter Content	Co=	60 %		
Digestion Ratio	Rd=	50 %		
Efficiency of Digestion Tank	De=	90 %		
Digestion Gas	Vg=	0.59 t-DS/day		
Solids Content	Ds2'=(Ds2-Vg)*De=	2.36 t-DS/day		
Moisture Content	Dw=	97 %		
Effluent Volume				
	Dv2'=Ds2'*100/(100-Dw)=	79 m3/day		
Digested Sludge				
Solids Content	Dsd=Ds2-Ds2'-Vg=	0.26 t-DS/day		
Moisture Content	Dw=	0.92 %		
Volume of Digested Sludge	Dvd=	28 m3/day		

10) Dewatering

Type : Centrifuge		
Design Sludge Volume	Dv3=Dv2'=	79 m3/day
Operation Day in A Week	Td=	6 days
Operation Hour in A Day	Tt=	6 hours
Dewatered Sludge Volume	Dvd=Dv3*7days/6days=	92 m3/day

Required Capacity of Dewatering Machine

Capacity	Number		Total	
4 m3/hr.x	2	=	8	m3/hr.
7 m3/hr.x	1	=	7	m3/hr.
		Vr =	15	m3/hr.

Operation Time	Tt=Dvd/Vr=	6.1 hr.

Design Calculation fo Bang Bua Thong Wastewater Treatment Plant
for PRELIMINARY ENGINEERING DESIGN

(1) Design Discharge

		m3/day	m3/min.	m3/sec.
Daily Average	(Qda)	9,100	6.32	0.105
Daily Maximum in Dry Weather	(Qdmd)	11,000	7.64	0.127
Hourly Maximum in Dry Weather	(Qhmd)	14,300	9.93	0.166
Hourly Maximum in Wet Weather	(Qhmw)	42,900	29.79	0.497

	Influent	Effluent
BOD (mg/l)	150	20
SS (mg/l)	150	30

(2) Design Calculation

1) Grit Chamber
(Dry Weather)

Design Flow Rate				
Hourly Maximum in Dry Weather	Qhmd=	14,300 m3/day		
	=	0.166 m3/sec.		
Design Condition				
Surface Loading	Ls=	1,800 m3/m2/day		
Average Velocity	Va=	0.3 m/sec.		
Retention Time	Rs=	60 sec.		
Size				
Required Surface Area	A=Qhmd/Ls=	7.94 m2		
Effective Depth	He=	0.4 m		
Required Width	Be=	1.0 m		
Size of Structure				
Width	B=	1.0	=	**1.0 m**
Length	L=A/Be=	7.94	=	**9.0 m**
Depth	H=	0.4	=	**0.4 m**
Numbers	n=	1	=	**1 units**
Verification				
Surface Loading	Ls=Qhmd/B/L/n=	1,589 m3/m2/day		
Average Velocity	Va=Qhmd/B/He=	0.414 m/sec.		
Retention Time	Rt=L/Va=	21.8 sec.		
Volume of Grit				
	Qhmd*0.00001*1.8 t/m3=	0.26 t/day		
Screenings	Qhmd*0.00001=	0.14 m3/day		

(Wet Weather)

Design Flow Rate

= Hourly Maximum in Wet Weather	Qhmw-Qdmd=	28,400 m3/day
-Hourly Maximum in Dry Weather	=	0.329 m3/sec.

Design Condition

Surface Loading	Ls=	3,600 m3/m2/day
Average Velocity	Va=	0.6 m/sec.
Retention Time	Rs=	30 sec.

Size

Required Surface Area	A=Qhmw/Ls=	7.89 m2
Effective Depth	He=	0.4 m
Required Width	Be=	1.4 m

Size of Structure

Width	B=	1.4	=	**1.4 m**
Length	L=A/Be=	5.63	=	**9.0 m**
Depth	H=	0.4	=	**0.4 m**
Numbers	n=	1	=	**1 units**

Verification

Surface Loading	Ls=Qhmw/B/L/n=	2,254 m3/m2/day
Average Velocity	Va=Qhmw/B/He=	0.587 m/sec.
Retention Time	Rt=L/Va=	15.3 sec.
Volume of Grit		
	Qhmw*0.00001*1.8 t/m3=	0.51 t/day
Screenings	Qhmw*0.00001=	0.28 m3/day

2) Inflow Pump

(Inflow Pump for Wastewater)

Hourly Maximum in Dry Weather Qhmd= 9.86 m3/min.

4.93 m3/min.	x		2 pumps	=	9.86 m3/min.	
(Dia.=	250	mm,		V=	1.68	m/s)

(Inflow Pump for Storm Water)

Hourly Maximum in Wet Weather Qhmw= 29.58 m3/min.

4.93 m3/min.	x		2 pumps	=	9.86 m3/min.	
(Dia.=	250	mm,		V=	1.68	m/s)
19.72 m3/min.	x		1 pumps	=	19.72 m3/min.	
(Dia.=	450	mm,		V=	2.08	m/s)
Total					29.58 m3/min.	

3) Primary Sedimentation Tank

Design Flow Rate

Daily Maximum in Dry Weather	Qhmd=	10,900 m3/day		
	=	454 m3/hr		

Design Condition

Surface Loading	Ls=	35 m3/m2/day		
Settling Time	Ts=	3.0 hr		
Effective Depth	He=	4.0 m		

Size

Required Surface Area	An=Qdmd/Ls=	311 m2		
Required Tank Volume	V=Qdmd*Ts=	1,363 m3		

Size of Structure

Diameter	D=	14.1	=	**15.0 m**
Depth	H=	4.0	=	**4.0 m**
Numbers	n=	2	=	**2 units**
Volume of Tank	V=	1,413 m3		
Surface Area	As=	353 m2		

Verification

Surface Loading	Ls=	30.9 m3/m2/day		
Settling Time	Ts=	3.1 hr		
Wier Loading	Lw=	116 m3/m/day		

4) Stormwater Sedimentation Tank

Design Flow Rate

= Hourly Maximum in Wet Weather	Qhmw-Qdmd=	31,700 m3/day		
- Daily Maximum in Dry Weather	=	1,321 m3/hr		

Design Condition

Surface Loading	Ls=	70 m3/m2/day		
Settling Time	Ts=	0.5 hr		
Effective Depth	He=	3.0 m		

Size

Required Surface Area	An=Qdmw/Ls=	453 m2		
Required Tank Volume	Lw=Qdmw*Ts=	660 m3		

Size of Structure

Diameter	D=	13.9	=	**14.0 m**
Depth	H=	3.0	=	**3.0 m**
Numbers	n=	3	=	**3 units**
Volume of Tank	V=	1,385 m3		
Surface Area	As=	462 m2		

Verification

Surface Loading	Ls=	68.7 m3/m2/day		
Settling Time	Ts=	1.0 hr		
Wier Loading	Lw=	240 m3/m/day		

5) Aeration Tank

Design Wastewater Quality

	Ci (BOD) :	105 mg/l		
	Ci (SS) :	98 mg/l		
Design Flow Rate				
Daily Maximum in Dry Weather	Qdmd=	10,900 m3/day		
Design Condition				
Aeration Time	Ta=	6.0 hr		
BOD - SS Loading	Ls=	0.35 kg/kg/day		
Return Sludge Ratio	Rs=	25.0 %		
Return Sludge Solid Concentration	Cr=	7,000 mg/l		
Size				
MLSS				
	(Ci(SS)+Cr*Rs/100)/(1+Rs/100)=	1,478 mg/l		
Required Tank Volume				
	V=Qdmd*Ci(BOD)/(BOD-SS Loading)*MLSS=	2,212 m3		
Size of Structure				
Width	B=	12.0	=	**12.0 m**
Length	L'=Vn/H/n=	30.7	=	**36.0 m**
Depth	H=	3.0	=	**3.0 m**
Numbers	n=	2	=	**2 units**
Verification				
Cross Section	A=B*H-0.3^2=	35.91 m2		
Volume	V=A*L'*n=	2,586 m3		
BOD - SS Loading				
	Ls=Qdmd*Ci/V/MLSS=	0.30 kg/kg/day		
Aeration Time	Ta=V/Qdmd*24=	5.69 hr		
BOD Volumetric Load				
	Lv=Qdmd*Ci(BOD)/V/1,000=	0.44 kg/m3/day		
Sludge Age				
	Sa=MLSS*V/Qdmd/Ci(SS)=	3.60 days		

6) Secondary Sedimentation Tank

Design Flow Rate				
Daily Maximum in Dry Weather	Qdmd=	10,900 m3/day		
	=	454 m3/hr		
Design Condition				
Surface Loading	Ls=	25 m3/m2/day		
Settling Time	Ts=	2.5 hr		
Effective Depth	He=	2.5 m		
Size				
Required Surface Area	A=Qdmd/Ls=	436 m2		
Required Tank Volume	Lw=Qdmd*Ts=	1,135 m3		
Size of Structure				
Diameter	D=	17.0	=	**17.0 m**
Depth	H=	2.5	=	**2.5 m**
Numbers	n=	2	=	**2 units**

Volume of Tank	V=	1,134 m3		
Surface Area	As=	454 m2		

Verification

Surface Loading	Ls=	24.0 m3/m2/day		
Settling Time	Ts=	2.5 hr		
Wier Loading	Lw=	102 m3/m/day		

7) Disinfection Tank

(Dry Weather)

Design Flow Rate

Daily Maximum in Dry Weather	Qdmd=	10,900 m3/day
	=	454 m3/hr
	=	7.6 m3/min.

Design Condition

Contact Time	Tc=	8 min.
(Contact time of Discharge Pipe is 7 min.)		
	Required Volume=	61 m3

Size of Structure

Width	B=	2.0	=	**2.0 m**
Length	L=	6.7	=	**60.0 m**
Depth	H=	1.5	=	**1.5 m**
Numbers	n=	3	=	**3 units**

Verification

Volume of Tank	V=	540 m3
Contact Time of Disinfection Tank	Tc=	71.3 min.

(Wet Weather)

Design Flow Rate

Hourly Maximum in Wet Weather	Qhmw=	42,600 m3/day
	=	1,775 m3/hr
	=	29.6 m3/min.

Design Condition

Contact Time	Tc=	8 min.
	Required Volume=	237 m3

Size of Structure

Width	B=	2.0	=	**2.0 m**
Length	L=	26.3	=	**60.0 m**
Depth	H=	1.5	=	**1.5 m**
Numbers	n=	3	=	**3 units**

Verification

Volume of Tank	V=	540 m3
Contact Time	Tc=	18.3 min.

8) Gravity Thickener

Design Flow Rate

Daily Maximum in Dry Weather		Qdmd=	10,900 m3/day		
Row Sludge			38 m3/day		
		(	0.77 t-DS/day)		
Excess Sludge			155 m3/day		
		(	1.08 t-DS/day)		
	Total of Sludge Volume :	Dv1=	193 m3/day		
		(Ds1=	1.85 t-DS/day)		

Design Condition

Type : Gravity Thickener				
Solids Loading	LDs1= 60	to	90 kg/m2 day	
Required Surface Area				
	A=Ds1/LDs1= 20.6	to	30.8 m2	
Thickening Time		Tt=	12 hr	
Required Volume		V=Dv1*Tt=	96.5 m3	
Effective Depth		He=	4.0 m	
	(Required Surface Area = V/He =		24.1 m2)	

Size of Structure

Diameter	D=	5.5	=	**6.0 m**
Depth	H=	4.0	=	**4.0 m**
Numbers	n=	1	=	**1 units**
Effective Volume	V=	113.2 m3		
Effective Surface Area	A=	28.3 m2		

Verification

Solids Loading	LDs1'=	65.4 kg/m2 day
Thickening Time	Tt'=	14.1 hr

Volume of Effluent

Efficiency of Thickener	Et=	80 %
Solids Content	Ds1'=Ds1*Et=	1.48 t-DS/day
Moisture Content	Dw=	97 %
Effluent Volume		
	Dv1'=Ds1'*100/(100-Dw)=	49 m3/day

Thickened Sludge

Solids Content	Dst=Ds1-Ds1'=	0.37 t-DS/day
Moisture Content	Dw=	0.26 %
Volume of Thickened Sludge	Dvt=Dv1-Dv1'=	144 m3/day

9) Digester

Design Sludge Volume	Dv2=Dv1'=	49 m3/day
Moisture Content	Dw=	97 %
Solids Content	Ds2=Ds1'=	1.48 t-DS/day
Primary Digester	V1= Dv2 * 20 days =	987 m3

Size of Primary Digester

Diameter	D=	11.2	=	**12.0 m**
Depth	He=	5.0	=	**5.0 m**

Numbers	n=	2	=	**2 units**

Verification

Digestion Time	Td=	22.9 days

Secondary Digester	V2= Dv2 * 10 days =	493 m3

Size of Secondary Digester

Diameter	D=	7.9	=	**8.5 m**
Depth	He=	5.0	=	**5.0 m**
Numbers	n=	2	=	**2 units**

Verification

Digestion Time	Td=	11.5 days

Volume of Effluent

Organic Matter Content	Co=	60 %
Digestion Ratio	Rd=	50 %
Efficiency of Digestion Tank	De=	90 %
Digestion Gas	Vg=	0.27 t-DS/day
Solids Content	Ds2'=(Ds2-Vg)*De=	1.09 t-DS/day
Moisture Content	Dw=	97 %
Effluent Volume		
	Dv2'=Ds2'*100/(100-Dw)=	36 m3/day

Digested Sludge

Solids Content	Dsd=Ds2-Ds2'-Vg=	0.12 t-DS/day
Moisture Content	Dw=	0.93 %
Volume of Digested Sludge	Dvd=	13 m3/day

10) Dewatering

Type : Centrifuge

Design Sludge Volume	Dv3=Dv2'=	36 m3/day
Operation Day in A Week	Td=	6 days
Operation Hour in A Day	Tt=	6 hours
Dewatered Sludge Volume	Dvd=Dv3*7days/6days=	42 m3/day

Required Capacity of Dewatering Machine

Capacity	Number		Total	
4 m3/hr.x	2	=	8	m3/hr.
		Vr =	8	m3/hr.

Operation Time	Tt=Dvd/Vr=	5.3 hr.

Calculation for Mechanical Surface Aerator of Bang Bua Thong Wastewater Treatment Plant
for Mater Plan

1. Design Condition
   a. Design Flow
      - Daily Average : Qa 19,700 m3/day
      - Daily Maximum : Qm 23,600 m3/day
   b. Influent Quality (BOD) : Qb 105 mg/l
   c. BOD Removal Efficiency : ε 81 %
   d. Temperature : T 25 ℃

2. Influent BOD : Bw kg/day

   Bw = γ · Qb · Qa · 10^(-3)

   γ = Load Factor = Daily Maximum(Qm) / Daily Average(Qa)

   Bw = 2,482 kg/day

3. Excluded BOD : Br kg/day

   Br = Bw · ε · 10^(-2)

   Br = 2,010 kg/day

4. Supplied Oxygen in Operation : Na kgO2 / hr

   Na = Br · η / 24

   η = Required Oxygen for Exclusion of Unit BOD kg = 0.8

   Na = 67 kgO2/hr

5. Oxygen Transfer in Standard Condition : N kgO2 / hr

   N = Na/ α {(Csw-Cl)/Cs}(1.024)^(T-20)

   α : Oxygen Transfer into Wastewater/ Oxygen Transfer into Pure Water = 0.8

   Csw = β · Css = 7.542 mg/l

   β : Oxygen Saturation in Wastewater / Oxygen Saturation in Pure Water = 0.9

   Css : Oxygen Saturation in Pure Water in T ℃ = 8.38 mg/l

   Cl : Dissolved Oxygen = 2.0 mg/l

   Cs : Oxygen Saturation in Pure Water in Standard Condition = 9.17 mg/l

   T : 25℃

   (1.024)^(T-20) : 1.126

   N = 156 kgO2 / hr

6. Supplied Oxygen per Motor Power of Aerator : Ns kgO2 / kw / hr

   5 ~ 20 HP : 1.9 kgO2 / kw / hr

   25 ~ 50 HP : 1.8 kgO2 / kw / hr

   60 ~ 150 HP : 1.7 kgO2 / kw / hr

7. Required Power of Aerator : HP

   HP = N / (Ns · Ef · N0 · 0.7457)

   Ef = Gear Reuction Factor : 5 ~ 20 HP : Ef = 97.5 %

   : 25 ~ 150 HP : Ef = 96.7 %

   N0 = Number of Aerator

   HP = 112.9 kw = 28.2 kw/basin

11	kw	x	3	units	=	33	kw
			3	units/basin		33	kw/basin

Calculation for Mechanical Surface Aerator of Bang Bua Thong Wastewater Treatment Plant
for Preliminary Engineering Deign

1. Design Condition
   a. Design Flow

Daily Average	: Qa	9,030	m3/day
Daily Maximum	: Qm	10,900	m3/day
b. Influent Quality (BOD)	: Qb	105	mg/l
c. BOD Removal Efficiency	: ε	81	%
d. Temperature	: T	25	℃

2. Influent BOD : Bw kg/day

   Bw = γ · Qb · Qa · 10^(-3)

   γ = Load Factor = Daily Maximum(Qm) / Daily Average(Qa)

   Bw = 1,138 kg/day

3. Excluded BOD : Br kg/day

   Br = Bw · ε · 10^(-2)

   Br = 922 kg/day

4. Supplied Oxygen in Operation : Na kgO2 / hr

   Na = Br · η / 24

   η = Required Oxygen for Exclusion of Unit BOD kg = 0.8

   Na = 30.7 kgO2/hr

5. Oxygen Transfer in Standard Condition : N kgO2 / hr

   N = Na/ α {(Csw-Cl)/Cs}(1.024)^(T-20)

   α : Oxygen Transfer into Wastewater/ Oxygen Transfer into Pure Water = 0.8

   Csw = β · Css = 7.542 mg/l

   β : Oxygen Saturation in Wastewater / Oxygen Saturation in Pure Water = 0.9

   Css : Oxygen Saturation in Pure Water in T ℃ = 8.38 mg/l

   Cl : Dissolved Oxygen = 2.0 mg/l

   Cs : Oxygen Saturation in Pure Water in Standard Condition = 9.17 mg/l

   T : 25℃

   (1.024)^(T-20) : 1.126

   N = 71.5 kgO2 / hr

6. Supplied Oxygen per Motor Power of Aerator : Ns kgO2 / kw / hr

5 ~ 20 HP	:	1.9	kgO2 / kw / hr
25 ~ 50 HP	:	1.8	kgO2 / kw / hr
60 ~ 150 HP	:	1.7	kgO2 / kw / hr

7. Required Power of Aerator : HP

   HP = N / (Ns · Ef · N0 · 0.7457)

   Ef = Gear Reuction Factor : 5 ~ 20 HP : Ef = 97.5 %

   : 25 ~ 150 HP : Ef = 96.7 %

   N0 = Number of Aerator

   HP = 51.8 kw = 25.9 kw/basin

11	kw	x	3	units	=	33	kw
			3	units/basin		33	kw/basin

Hydraulic Calculation of Bang Bua Thong Treatment Plant

1. Design Condition

1) Design Wastewater Quantity

Preliminary Design	(m^3/day)	(m^3/min)	(m^3/sec)
Daily Average (Qdap)	9,030	6.27	0.105
Daily Max. (Qdmp)	10,900	7.57	0.126
Hourly Max. (dry) (Qhmdp)	14,200	9.86	0.164
Hourly Max. (wet) (Qhmwp)	42,600	29.58	0.493
Master Plan	(m^3/day)	(m^3/min)	(m^3/sec)
Daily Average (Qdam)	19,700	13.68	0.228
Daily Max. (Qdmm)	23,600	16.39	0.273
Hourly Max. (dry) (Qhmdm)	30,700	21.32	0.355
Hourly Max. (wet) (Qhmwm)	92,100	63.96	1.066

2) Unit and Capacity of Treatment Facility

Unit of each treatment facility is as follows.

	Unit	
	Preliminary Design	Master Plan
Primary Sedimentation Tank	2	4
Aeration Tank	2	4
Final Sedimentation Tank	2	4
Disinfection Tank	1	1
Gravity Thickener	1	2
Digestion Tank (1st)	2	4
Digestion Tank (2nd)	2	4
Dewatering	1	1

3) Inlet Pipe

Pipe Diameter	1,200 mm
Gradient	0.1 %
Invert Elevation of Inlet Pipe	MSL - 3.5 m

4) Design Grand Elevation MSL + 2.3 m

5) Discharge

Discharge Point		Khlong Ban Kluai
HWL		MSL + 0.71
Discharge Pipe	Diameter	1,200 mm
	Length	260 m

6) Formula for Hydraulic Calculation

Manning's Formula n = 0.013

2. Hydraulic Calculation

1).Water Level of Disinfection Tank Effluent Chamber (WL 1)

Design Water	Qhmwm = 92,100 m3/day = 1.066 m^3/sec
Velocity	V= 1.066/(1.2^2 x π /4) = 0.942 m/sec
Hydraulic Gradient	i= 0.08 %
Friction Loss	l=0.08 % x 260 m = 0.208 m

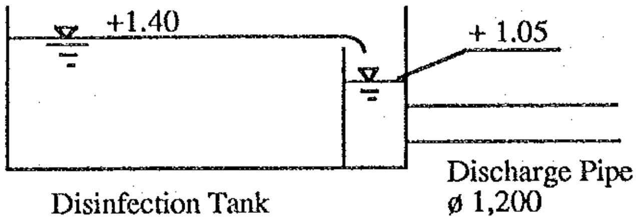
WL 1 = + 0.71 + 0.208 = 0.918 say <u>+ 1.05 m</u>

2) Water Level of Disinfection Tank (WL 2)

Water Depth of Effluent Weir

Widht of Weir = 4.0 m

h = (Qhmwm / (1.84 x 4.0))^(2/3) = 0.28 m



WL 2 = 1.05 + 0.28 = 1.33   say +1.40 m

3) Hydraulic Loss of Connection Pipe of D.T and F.S.T

Diameter	ø 600 mm
Lenght	170 m
Design Water	Qdmm = 0.273 m^3 / sec
Velocity	v = 0.971 m / sec
Hydraulic Gradient	i = 0.2 %

Hydraulic Loss = 170 m x 0.2 % = 0.34 m

4) Water Level of Final Sedimentation Tank Effluent Chamber (WL 3)

WL 3 = + 1.40 + 0.34 = + 1.74 m   say + 1.80 m

5) Water Level of Final Sedimentation Tank (WL 4)

Water Depth of Effluent Triangle Weir

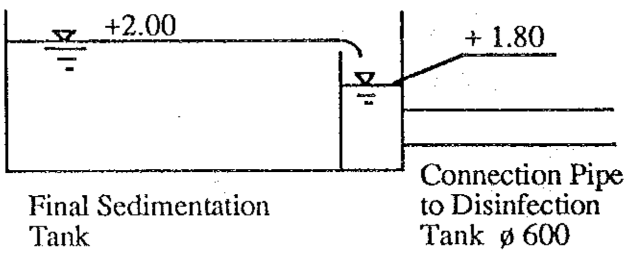
Length of Weir = ø 18.5 x π = 57 m

Design Water per unit weir long

q = (Qdmm / 4) / 57 = 0.0012 m^3 / m / sec

h = (q / 1.42)^(2/5) = 0.06 m

WL 4 = + 1.80 + 0.06 =+ 1.86   say + 2.00



6) Hydraulic Loss of Connection Pipe of F.S.T and aeration Tank

Diameter	ø 350 mm
Lenght	20 m
Design Water	Qdmm / 4= 0.273 m^3 / sec / 4 = 0.068 m^3 / sec
Velocity	v = 0.711 m / sec
Hydraulic Gradient	i = 0.22 %

Hydraulic Loss = 20 m x 0.22 % = 0.044 m

7) Water Level of Aeration Tank Effluent Chamber (WL 5)

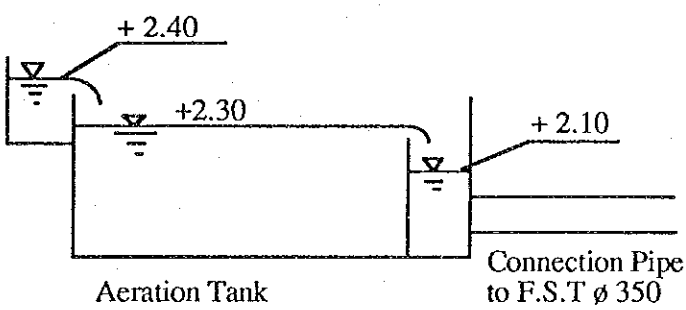
WL 5 = + 2.00 + 0.044 = + 2.044 say <u>+ 2.10 m</u>

8) Water Level of Aeration Tank (WL 6)

Water Depth of Effluent Weir

Width of Weir = 3 m

h = (Qdmm/4/(1.84 x 3.0)) ^ (2/3) = 0.05 m



WL 6 = + 2.10 + 0.05 = + 2.15 say <u>+ 2.30 m</u>

9) Water Level of Areration Tank Influent Chamber (WL 7)

Water Depth of Influent Weir

Width of Weir = 3.0 m

h = (Qdmm / 4 / (1.84 x 3)) ^ (2/3) = 0.05 m

WL 7 = + 2.30 + 0.05 = + 2.35 say <u>+ 2.40 m</u>

10) Hydraulic Loss of Connection Pipe of A.T to P.S T

Diameter ø 350 mm

Lenght 20 m

Design Water Qdmm / 4= 0.273 m^3 / sec / 4 = 0.068 m^3 / sec

Velocity v = 0.711 m / sec

Hydraulic Gradient i = 0.22 %

Hydraulic Loss = 20 m x 0.22 % = 0.044 m

11) Water Level of Primary Sedimentation Tank Effluent Chamber (WL 8)

WL 8 = + 2.40 + 0.044 = + 2.44 say <u>+ 2.50 m</u>

12) Water Level of Primary Sedimentation Tank (WL 9)

Water Depth of Effluent Weir

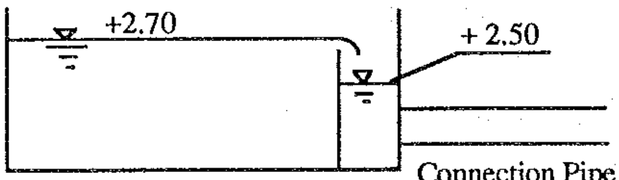
Triangle Weir Width = 47 m

Design Water per unit weir long

q = (Qdmm / 4) / 47 = 0.0015 m^3 / m / sec

h = (q / 1.42) ^ (2/5) = 0.06 m

WL 9 = + 2.50 + 0.06 = + 2.56 say <u>+ 2.70 m</u>



13) Hydraulic Loss of Connection Pipe of P.S T to Distribution Tank

Diameter ø 350 mm

Lenght 20 m

Design Water Qdmm / 4= 0.273 m^3 / sec / 4 = 0.068 m^3 / sec

Velocity v = 0.711 m / sec

Hydraulic Gradient i = 0.22 %

Hydraulic Loss = 50 m x 0.22 % = 0.11 m

14) Water Level of Distribution Tank Effluent Chamber (WL 10)

WL 10 = + 2.70 + 0.11 = + 2.81   say + 2.90 m

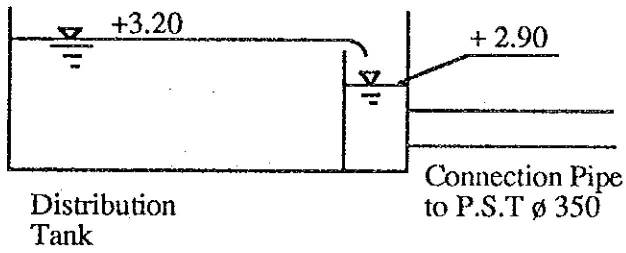
15) Water Level of Distribution Tank (WL 11)

Water Depth of Effluent Weir

Weir Width = 1.0 m

h = (Qdmm / 4 / (1.84 x 1.0) ^ (2/3) = 0.111 m

WL 11 = + 2.90 + 0.111 = + 3.011   say + 3.20 m



3.9.1.1 Unit Construction Cost of Wastewater Collection Facilities

Table 3.9.1.1 (1)-1 Unit Construction Cost of Interceptors

Diameter (mm)		300	400	500	600	800	1000	1200	1500
(1) Quantity									
Earth Covering Depth (m)		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Outer of Diameter (m)		0.40	0.52	0.64	0.75	0.99	1.22	1.45	1.80
Width of Excavation (m)		1.00	1.12	1.24	1.35	1.59	1.82	2.05	2.40
Excavation Depth (m)		2.00	2.15	2.30	2.44	2.74	3.03	3.31	3.75
Sheetpile Length (m)		-	3.23	3.45	3.66	4.11	4.54	4.97	5.63
Volume of Pavement (m3)		0.35	0.39	0.43	0.47	0.56	0.64	0.72	0.84
Excavation (Backhoe m3)		2.00	2.41	2.85	3.29	4.35	5.51	6.79	9.00
Backfill (granular m3)		0.57	0.71	0.84	0.98	1.28	1.60	1.94	2.50
Backfill (original m3)		0.91	1.07	1.25	1.42	1.85	2.34	2.89	3.86
Backfill (selected soil m3)		0.17	0.24	0.33	0.42	0.66	0.93	1.24	1.80
Residual Soil (m3)		1.09	1.34	1.60	1.87	2.50	3.17	3.90	5.14
Pavement (m2)		1.60	1.72	1.84	1.95	2.19	2.42	2.65	3.00
Sheetpile Length (m)		-	16.15	17.25	18.30	20.55	22.70	24.85	28.15
Sheetpile (kg)		-	775.20	828.00	878.40	986.40	1,089.60	1,192.80	1,351.20
Bracing (kg)		-	446	461	477	501	530	558	616
(2) Construction Cost (Baht/m)									
	Unit Cost								
Excavation (Backhoe)	60.0	120.0	144.6	171.0	197.4	261.0	330.6	407.4	540.0
Backfill (granular)	300.0	171.0	213.0	252.0	294.0	384.0	480.0	582.0	750.0
Backfill (original)	60.0	54.6	64.2	75.0	85.2	111.0	140.4	173.4	231.6
Backfill (selected soil)	300.0	51.0	72.0	99.0	126.0	198.0	279.0	372.0	540.0
Residual Soil	30.0	32.7	40.2	48.0	56.1	75.0	95.1	117.0	154.2
Pavement	400.0	640.0	688.0	736.0	780.0	876.0	968.0	1,060.0	1,200.0
Sheetpile (kg)	3.2	-	2,480.6	2,649.6	2,810.9	3,156.5	3,486.7	3,817.0	4,323.8
Bracing (kg)	5.1	-	2,274.6	2,351.1	2,432.7	2,555.1	2,703.0	2,845.8	3,141.6
Pipe/Laying	1 ls	253.0	350.0	439.0	509.0	779.0	1,267.0	1,643.0	2,702.0
Dewatering/Others	1 ls	7.6	8.5	9.5	10.9	12.7	15.2	19.0	25.4
Total		1,329.9	6,335.7	6,830.2	7,302.2	8,408.3	9,765.0	11,036.6	13,608.6

Table 3.9.1.1 (1)-2 Unit Construction Cost of Interceptors

Diameter (mm)	Unit Cost	300	400	500	600	800	1000	1200	1500
(1) Quantity									
Earth Covering Depth (m)		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Outer of Diameter (m)		0.40	0.52	0.64	0.75	0.99	1.22	1.45	1.80
Width of Excavation (m)		1.00	1.12	1.24	1.35	1.59	1.82	2.05	2.40
Excavation Depth (m)		2.50	2.65	2.80	2.94	3.24	3.53	3.81	4.25
Sheetpile Length (m)		3.75	3.98	4.20	4.41	4.86	5.29	5.72	6.38
Volume of Pavement (m3)		0.35	0.39	0.43	0.47	0.56	0.64	0.72	0.84
Excavation (Backhoe m3)		2.50	2.97	3.47	3.97	5.15	6.42	7.82	10.20
Backfill (granular m3)		0.57	0.71	0.84	0.98	1.28	1.60	1.94	2.50
Backfill (original m3)		1.41	1.63	1.87	2.10	2.65	3.25	3.92	5.06
Backfill (selected soil m3)		0.17	0.24	0.33	0.42	0.66	0.93	1.24	1.80
Residual Soil (m3)		1.09	1.34	1.60	1.87	2.50	3.17	3.90	5.14
Pavement (m2)		1.60	1.72	1.84	1.95	2.19	2.42	2.65	3.00
Sheetpile Length (m)		18.75	19.90	21.00	22.05	24.30	26.45	28.60	31.90
Sheetpile (kg)		900.00	955.20	1,008.00	1,058.40	1,166.40	1,269.60	1,372.80	1,531.20
Bracing (kg)		422	446	461	477	501	530	558	616
(2) Construction Cost (Baht/m)									
Excavation (Backhoe)	60.0	150.0	178.2	208.2	238.2	309.0	385.2	469.2	612.0
Backfill (granular)	300.0	171.0	213.0	252.0	294.0	384.0	480.0	582.0	750.0
Backfill (original)	60.0	84.6	97.8	112.2	126.0	159.0	195.0	235.2	303.6
Backfill (selected soil)	300.0	51.0	72.0	99.0	126.0	198.0	279.0	372.0	540.0
Residual Soil	30.0	32.7	40.2	48.0	56.1	75.0	95.1	117.0	154.2
Pavement	400.0	640.0	688.0	736.0	780.0	876.0	968.0	1,060.0	1,200.0
Sheetpile (kg)	3.2	2,880.0	3,056.6	3,225.6	3,386.9	3,732.5	4,062.7	4,393.0	4,899.8
Bracing (kg)	5.1	2,152.2	2,274.6	2,351.1	2,432.7	2,555.1	2,703.0	2,845.8	3,141.6
Pipe/Laying	1 ls	253.0	350.0	439.0	509.0	779.0	1,267.0	1,643.0	2,702.0
Dewatering/Others	1 ls	7.6	8.5	9.5	10.9	12.7	15.2	19.0	25.4
Total		6,422.1	6,978.9	7,480.6	7,959.8	9,080.3	10,450.2	11,736.2	14,328.6

Table 3.9.1.1 (1)-3 Unit Construction Cost of Interceptors

Diameter (mm)	Unit Cost	300	400	500	600	800	1000	1200	1500
(1) Quantity									
Earth Covering Depth (m)		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Outer of Diameter (m)		0.40	0.52	0.64	0.75	0.99	1.22	1.45	1.80
Width of Excavation (m)		1.00	1.12	1.24	1.35	1.59	1.82	2.05	2.40
Excavation Depth (m)		3.50	3.65	3.80	3.94	4.24	4.53	4.81	5.25
Sheetpile Length (m)		5.25	5.48	5.70	5.91	6.36	6.79	7.22	7.88
Volume of Pavement (m3)		0.35	0.39	0.43	0.47	0.56	0.64	0.72	0.84
Excavation (Backhoe m3)		3.50	4.09	4.71	5.32	6.74	8.24	9.87	12.60
Backfill (granular m3)		0.57	0.71	0.84	0.98	1.28	1.60	1.94	2.50
Backfill (original m3)		2.41	2.75	3.11	3.45	4.24	5.07	5.97	7.46
Backfill (selected soil m3)		0.17	0.24	0.33	0.42	0.66	0.93	1.24	1.80
Residual Soil (m3)		1.09	1.34	1.60	1.87	2.50	3.17	3.90	5.14
Pavement (m2)		1.60	1.72	1.84	1.95	2.19	2.42	2.65	3.00
Sheetpile Length (m)		26.25	27.40	28.50	29.55	31.80	33.95	36.10	39.40
Sheetpile (kg)		1,260.00	1,315.20	1,368.00	1,418.40	1,526.40	1,629.60	1,732.80	1,891.20
Bracing (kg)		422	446	461	477	501	530	558	616
(2) Construction Cost (Baht/m)	Unit Cost								
Excavation (Backhoe)	60.0	210.0	245.4	282.6	319.2	404.4	494.4	592.2	756.0
Backfill (granular)	300.0	171.0	213.0	252.0	294.0	384.0	480.0	582.0	750.0
Backfill (original)	60.0	144.6	165.0	186.6	207.0	254.4	304.2	358.2	447.6
Backfill (selected soil)	300.0	51.0	72.0	99.0	126.0	198.0	279.0	372.0	540.0
Residual Soil	30.0	32.7	40.2	48.0	56.1	75.0	95.1	117.0	154.2
Pavement	400.0	640.0	688.0	736.0	780.0	876.0	968.0	1,060.0	1,200.0
Sheetpile (kg)	3.2	4,032.0	4,208.6	4,377.6	4,538.9	4,884.5	5,214.7	5,545.0	6,051.8
Bracing (kg)	5.1	2,152.2	2,274.6	2,351.1	2,432.7	2,555.1	2,703.0	2,845.8	3,141.6
Pipe/Laying	1 ls	253.0	350.0	439.0	509.0	779.0	1,267.0	1,643.0	2,702.0
Dewatering/Others	1 ls	7.6	8.5	9.5	10.9	12.7	15.2	19.0	25.4
Total		7,694.1	8,265.3	8,781.4	9,273.8	10,423.1	11,820.6	13,134.2	15,768.6

Table 3.9.1.1 (1)-4 Unit Construction Cost of Interceptors

Diameter (mm)		300	400	500	600	800	1000	1200	1500
(1) Quantity									
Earth Covering Depth (m)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Outer of Diameter (m)		0.40	0.52	0.64	0.75	0.99	1.22	1.45	1.80
Width of Excavation (m)		1.00	1.12	1.24	1.35	1.59	1.82	2.05	2.40
Excavation Depth (m)		4.50	4.65	4.80	4.94	5.24	5.53	5.81	6.25
Sheetpile Length (m)		6.75	6.98	7.20	7.41	7.86	8.29	8.72	9.38
Volume of Pavement (m3)		0.35	0.39	0.43	0.47	0.56	0.64	0.72	0.84
Excavation (Backhoe m3)		4.50	5.21	5.95	6.67	8.33	10.06	11.92	15.00
Backfill (granular m3)		0.57	0.71	0.84	0.98	1.28	1.60	1.94	2.50
Backfill (original m3)		3.41	3.87	4.35	4.80	5.83	6.89	8.02	9.86
Backfill (selected soil m3)		0.17	0.24	0.33	0.42	0.66	0.93	1.24	1.80
Residual Soil (m3)		1.09	1.34	1.60	1.87	2.50	3.17	3.90	5.14
Pavement (m2)		1.60	1.72	1.84	1.95	2.19	2.42	2.65	3.00
Sheetpile Length (m)		33.75	34.90	36.00	37.05	39.30	41.45	43.60	46.90
Sheetpile (kg)		1,620.00	1,675.20	1,728.00	1,778.40	1,886.40	1,989.60	2,092.80	2,251.20
Bracing (kg)		422	446	461	477	501	530	558	616
(2) Construction Cost (Baht/m)									
	Unit Cost								
Excavation (Backhoe)	60.0	270.0	312.6	357.0	400.2	499.8	603.6	715.2	900.0
Backfill (granular)	300.0	171.0	213.0	252.0	294.0	384.0	480.0	582.0	750.0
Backfill (original)	60.0	204.6	232.2	261.0	288.0	349.8	413.4	481.2	591.6
Backfill (selected soil)	300.0	51.0	72.0	99.0	126.0	198.0	279.0	372.0	540.0
Residual Soil	30.0	32.7	40.2	48.0	56.1	75.0	95.1	117.0	154.2
Pavement	400.0	640.0	688.0	736.0	780.0	876.0	968.0	1,060.0	1,200.0
Sheetpile (kg)	3.2	5,184.0	5,360.6	5,529.6	5,690.9	6,036.5	6,366.7	6,697.0	7,203.8
Bracing (kg)	5.1	2,152.2	2,274.6	2,351.1	2,432.7	2,555.1	2,703.0	2,845.8	3,141.6
Pipe/Laying	1 ls	253.0	350.0	439.0	509.0	779.0	1,267.0	1,643.0	2,702.0
Dewatering/Others	1 ls	7.6	8.5	9.5	10.9	12.7	15.2	19.0	25.4
Total		8,966.1	9,551.7	10,082.2	10,587.8	11,765.9	13,191.0	14,532.2	17,208.6

Table 3.9.1.1 (1)-5 Unit Construction Cost of Interceptors

Diameter (mm)	Unit Cost	300	400	500	600	800	1000	1200	1500
(1) Quantity									
Earth Covering Depth (m)		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Outer of Diameter (m)		0.40	0.52	0.64	0.75	0.99	1.22	1.45	1.80
Width of Excavation (m)		1.00	1.12	1.24	1.35	1.59	1.82	2.05	2.40
Excavation Depth (m)		5.50	5.65	5.80	5.94	6.24	6.53	6.81	7.25
Sheetpile Length (m)		8.25	8.48	8.70	8.91	9.36	9.79	10.22	10.88
Volume of Pavement (m3)		0.35	0.39	0.43	0.47	0.56	0.64	0.72	0.84
Excavation (Backhoe m3)		5.50	6.33	7.19	8.02	9.92	11.88	13.97	17.40
Backfill (granular m3)		0.57	0.71	0.84	0.98	1.28	1.60	1.94	2.50
Backfill (original m3)		4.41	4.99	5.59	6.15	7.42	8.71	10.07	12.26
Backfill (selected soil m3)		0.17	0.24	0.33	0.42	0.66	0.93	1.24	1.80
Residual Soil (m3)		1.09	1.34	1.60	1.87	2.50	3.17	3.90	5.14
Pavement (m2)		1.60	1.72	1.84	1.95	2.19	2.42	2.65	3.00
Sheetpile Length (m)		41.25	42.40	43.50	44.55	46.80	48.95	51.10	54.40
Sheetpile (kg)		1,980.00	2,035.20	2,088.00	2,138.40	2,246.40	2,349.60	2,452.80	2,611.20
Bracing (kg)		422	446	461	477	501	530	558	616
(2) Construction Cost (Baht/m)	Unit Cost								
Excavation (Backhoe)	60.0	330.0	379.8	431.4	481.2	595.2	712.8	838.2	1,044.0
Backfill (granular)	300.0	171.0	213.0	252.0	294.0	384.0	480.0	582.0	750.0
Backfill (original)	60.0	264.6	299.4	335.4	369.0	445.2	522.6	604.2	735.6
Backfill (selected soil)	300.0	51.0	72.0	99.0	126.0	198.0	279.0	372.0	540.0
Residual Soil	30.0	32.7	40.2	48.0	56.1	75.0	95.1	117.0	154.2
Pavement	400.0	640.0	688.0	736.0	780.0	876.0	968.0	1,060.0	1,200.0
Sheetpile (kg)	3.2	6,336.0	6,512.6	6,681.6	6,842.9	7,188.5	7,518.7	7,849.0	8,355.8
Bracing (kg)	5.1	2,152.2	2,274.6	2,351.1	2,432.7	2,555.1	2,703.0	2,845.8	3,141.6
Pipe/Laying	1 ls	253.0	350.0	439.0	509.0	779.0	1,267.0	1,643.0	2,702.0
Dewatering/Others	1 ls	7.6	8.5	9.5	10.9	12.7	15.2	19.0	25.4
Total		10,238.1	10,838.1	11,383.0	11,901.8	13,108.7	14,561.4	15,930.2	18,648.6

Table 3.9.1.1 (2) Unit Construction Cost of Manhole

Type	Manhole Hight	Construction Cost (Baht/Unit)
NO.1	2 m	11,480
	3 m	12,690
	4 m	13,890
	5 m	15,110
NO.2	2 m	14,680
	3 m	15,880
	4 m	17,080
	5 m	18,290
NO.3	2 m	18,070
	3 m	19,270
	4 m	20,470
	5 m	21,700
NO.4	2 m	24,420
	3 m	25,620
	4 m	26,820
	5 m	28,020
NO.5	4 m	35,660

Table 3.9.1.1 (3) Unit Construction Cost of Overflow Chamber

Type of Overflow Chamber	Construction Cost (Baht/Unit)
B	24,150
C	18,700

3.9.1.2 Direct Construciton Cost by Major Facilities

Table 3.9.1.2 (1) Construction Cost of Interceptors

Diameter (mm)	Average Earth Covering Depth (m)	Length of Interceptor (m)	Unit Construction Cost (Baht/m)	Construction Cost (x 1,000 Baht)
ø300	1.5	720	1,329.9	958
	2	765	6,422.1	4,913
	Sub-total	1,485		5,871
ø400	1.5	560	6,335.7	3,548
	2	1,390	6,978.9	9,701
	4	600	9,551.7	5,732
	Sub-total	2,550		18,981
ø500	3	15	8,781.4	132
	5	710	11,383.0	8,082
	Sub-total	725		8,214
ø600	1.5	510	7,302.2	3,725
	5	347	11,901.8	4,130
	Sub-total	857		7,855
ø800	2	870	9,080.3	7,900
	3	725	10,423.1	7,557
	Sub-total	1,595		15,457
ø1000	1.5	650	9,765.0	6,348
	2	250	10,450.2	2,613
	3	30	11,820.6	355
	4	250	13,191.0	3,298
	5	60	14,561.4	874
	Sub-total	1,240		13,488
ø1200	4	50	14,532.2	727
	Sub-total	50		727
	Total	8,502		70,593

Table 3.9.1.2 (2) Construction Cost of Manhole

Type of Mahole	Manhole Hight (m)	Nos. of Manhole	Unit Construction Cost (Baht/unit)	Construction Cost (x 1,000 Baht)
No.1	2	71	11,480	816
	3	56	12,690	711
	4	28	13,890	389
	Sub-total	155		1,916
No.2	3	13	15,880	207
	4	13	17,080	223
	Sub-total	26		430
No.3	3	13	19,270	251
	4	9	20,470	185
	Sub-total	22		436
No.5	4	1	35,660	36
	Sub-total	1		36
	Total	204		2,818

Table 3.9.1.2 (3) Construction Cost of Overflow Chamber (Bang Bua Thong)

Type of Overflow Chamber	No. of Overflow Chamber	Unit Construction Cost (Baht/unit)	Construction Cost (x 1,000 Baht)
B	3	24,150	72
C	18	18,700	337
Total	21		409

Table 3.9.1.2 (4) Construction Cost of Inverted Siphon

1 - 3 (No.1)

Item		Quantity	Unit Cost (Baht)	Construction Cost (x 1,000Baht) Domestic Portion	Foreign Portion	Total
Excavation	(m3)	978	60	59		59
Backfill (Granular)	(m3)	10.58	300	3		3
Backfill (Soil)	(m3)	793	60	48		48
Sheet Pile	(kg)	52,800	3.2	169		169
Rubble Stone	(m3)	40.13	400	16		16
Piling	(piece)	64	1,900	122		122
Concrete	(m3)	92.03	4,658	429		429
Lean Concrete	(m3)	10.03	1,950	20		20
Reinforced Steel Bar	(kg)	8,280	12	99		99
Form Work	(m2)	386.16	300	116		116
Cover	(unit)	8	7,000	56		56
Screen (1.1m x 1.65m)	(unit)	1			164	164
		Total		1,137	164	1,301

Table 3.9.1.2 (5) Construction Cost of Pump Station

No.1

Item		Quantity	Unit Cost (Baht)	Construction Cost (x1,000 Baht) Domestic Portion	Foreign Portion	Total
1) Civil and Architecture Work						
Excavation	(m3)	1,455	60	87		87
Backfill (Granular)	(m3)	22.71	300	7		7
Backfill (Soil)	(m3)	676	60	41		41
Sheet Pile	(kg)	82,944	3.2	265		265
Bracing	(kg)	542.48	5.2	3		3
Rubble Stone	(m3)	19.83	400	8		8
Piling	(m)	72	3,800	274		274
Concrete	(m3)	542.48	4,658	2,527		2,527
Lean Concrete	(m3)	4.96	1,950	10		10
Reinforced Steel Bar	(kg)	31,430	12	377		377
Form Work	(m2)	811.5	300	243		243
Architecture				90		90
Sub-total of 1)				3,932		3,932
2) Mechanical and Electrical Works						
Screen (0.8m x 1.8m)	(unit)	2	119		238	238
Gate (0.8m x 0.8m)	(unit)	2	167		334	334
Pump (ø150mm x 5.5kw)	(unit)	1	97		97	97
Pump (ø200mm x 5.5kw)	(unit)	1	809		809	809
Piping and Valves	(LS)				181	181
Instrumentation	(LS)				272	272
Installation	(LS)				181	181
Sub-total of 2)					2,112	2,112
Total				3,932	2,112	6,044

No.2

Item		Quantity	Unit Cost (Baht)	Construction Cost (x1,000 Baht) Domestic Portion	Foreign Portion	Total
1) Civil and Architecture Work						
Excavation	(m3)	1,847	60	111		111
Backfill (Granular)	(m3)	43.20	300	13		13
Backfill (Soil)	(m3)	931	60	56		56
Sheet Pile	(kg)	92,160	3.2	295		295
Bracing	(kg)	821	5.2	4		4
Rubble Stone	(m3)	25.37	400	10		10
Piling	(m)	95	3,800	361		361
Concrete	(m3)	799.94	4,658	3,726		3,726
Lean Concrete	(m3)	6.34	1,950	12		12
Reinforced Steel Bar	(kg)	38,350	12	460		460
Form Work	(m2)	1,006.9	300	302		302
Architecture				122		122
Sub-total of 1)				5,472		5,472
2) Mechanical and Electrical Works						
Screen (1.0m x 2.4m)	(unit)	2	142		284	284
Gate (1.0m x 1.0m)	(unit)	2	200		400	400
Pump (ø300mm x 11kw)	(unit)	1	1,262		1,262	1,262
Pump (ø400mm x 18.5kw)	(unit)	2	1,905		3,810	3,810
Piping and Valves	(LS)				1,014	1,014
Instrumentation	(LS)				1,522	1,522
Installation	(LS)				1,014	1,014
Sub-total of 2)					9,306	9,306
Total				5,472	9,306	14,778

Table 3.9.1.2 (6) Construction Cost of Treatment Plant

Item		Construction Cost (x 1,000 Baht) Domestic Portion	Foreign Portion	Total
1. Civil and Architecture Facilities				
1-1 Grit Chamber	9.0 (L)m x 1.0 (W)m x 0.4 (H)m x 2units 9.0 (L)m x 1.4 (W)m x 0.4 (H)m x 2units	3,192		3,192
1-2 Primary Sedimentation Tank	15.0(D)m x 4.0(H)m x 2units	2,738		2,738
1-3 Stormwater Sedimentation Tank	14.0(D)m x 3.0(H)m x 3units	3,263		3,263
1-4 Aeration Tank	36.0(L)m x 12.0(W)m x 3.0(H)m x 2units	7,917		7,917
1-5 Secondary Sedimentation Tank	17.0(D)m x 2.5(H)m x 2units	2,754		2,754
1-6 Disinfection Tank	60.0(L)m x 2.0(W)m x 1.5(H)m x 3units	1,477		1,477
1-7 Thickener	6.0(D)m x 4.0(H)m x 1units	1,787		1,787
1-8 Digestion Tank	1st : 12.0(D)m x 5.0(H)m x 2units	2,877		2,877
	2nd : 8.5(D)m x 5.0(H)m x 2units	1,843		1,843
1-9 Dewatering Unit		210		210
1-10 Miscellaneous		2,850		2,850
Sub-total of 1.		30,908		30,908
2. Mechanical & Electrical Facilities				
2-1 Grit Chamber			1,667	1,667
2-2 Inflow Pump			5,119	5,119
2-3 Primary Sedimentation Tank			5,000	5,000
2-4 Stormwater Sedimentation Tank			595	595
2-5 Aeration Tank			4,524	4,524
2-6 Secondary Sedimentation Tank			5,952	5,952
2-7 Disinfection Tank			1,548	1,548
2-8 Thickener			357	357
2-9 Digestion Tank			20,000	20,000
2-10 Dewatering Unit			7,143	7,143
2-11 Piping Materials, Valves and Gates			7,500	7,500
2-12 Control Panel and Instrumentation			8,929	8,929
2-13 Transportation and Instalation			10,833	10,833
2-14 Pump Station Monitoring Facilities			1,315	1,315
2-15 Laboratory Equipment			595	595
2-15 Miscellaneous			8,571	8,571
Sub-total of 2.			89,648	89,648
Total		30,908	89,648	120,556

Assumption for Estimate of Interceptor Cleaning Cost

1) The Length of cleaning for one time is the distance of an average manhole interval (approximately 50m).

2) The nozzle moves forward and is pulled backward with jets three (3) times for one time cleaning.

3) It takes about ten (10) min. for the nozzle to move forward and backward.

4) The water (3 m3) of High Pressure Cleaner' tank is used for one time cleaning.

5) A cleaning team consists of "High Pressure Sewer Cleaner", "Vacuum Sludge Loader", "Water Wagon" and "Truck".

6) The Volume of a water wagon tank is 4 m3.

7) Required time for water feeding to a water wagon and discharging sludge is 1.5 hours (including traveling time).

From the above assumption,

The possible length of cleaning interceptor in a year,

In case that working hour is 8 hours, times of cleaning is the following.

8 hr. x 2 hr./time = 4 times

As the length of cleaning interceptor for one time is 50 m,

50 m/time x 4 times = 200 m/day

When actual Working hour in a year is 20 day/month x 12 months x 0.8 = 192 day/year,
the possible length of cleaning interceptor in a year is the following.

200 m/day x 192 days = 38,400 m/year

Annual expenses for interceptor cleaning are,

(1) Labor Cost

Type of Vehicle	Classi -fication	Required No.	Working Day	Wage	Cost
1-1. High Pressure Sewer Cleaner	Driver	1 person			
	Operator	2 persons			
1-2. Vacuum Sludge Loader	Driver	1 person			
	Operator	2 persons			
1-3. Water Wagon	Driver	1 person			
1-4. Truck	Driver	1 person			
	Labor	4 persons			
Total	Driver	4 persons	192 days x	420 B/day =	322,560
	Operator	4 persons	192 days x	360 B/day=	276,480
	Labor	4 persons	192 days x	140 B/day=	107,520
Annual Labor Cost (Baht/Year)					706,560

(2) Fuel Cost

3-1. High Pressure Sewer Cleaner / Vacuum Sludge Loader

20 l / hr.	x	8 hr.	x	192 days =	30,720
				x (Vehicles)	3
					92,160

3-2. Water Wagon / Truck

10 l / hr.	x	3 hr.	x	192 days =	5,760
				x (Vehicles)	1
					5,760

Annual Fuel Cost (Baht/Year) 97,920

(3) Spare Parts Cost

Type of Vehicle	Price	Working Life		Cost
1-1. High Pressure Sewer Cleaner	1,000,000 Baht	5 Years	=	200,000
1-2. Vacuum Sludge Loader	1,000,000 Baht	5 Years	=	200,000
1-3. Water Wagon	1,000,000 Baht	5 Years	=	200,000
1-4. Truck	700,000 Baht	10 Years	=	70,000
Annual Vehicle Cost (Baht/Year)				670,000

670,000 (Vehicle Cost) x 3 % = 20,100

Spare Parts Cost (Baht/Year) 20,100

Annual Cleaning Cost (Baht/Year) 824,580

Cleaning Cost of Interceptor per Meter (Baht/m) 21.5

3.14.1 Private Health and Sanitation Benefits

Data used in this study were gathered from the Central Region Survey on Income and Employment, National Institute of Health, Public Health Office.

Data on medical cost, illness cost were obtained from public helath office. Labor force particiaption, average monthly household income, average size of household, average wage rate were collected from Central REgion Survey Data. Morbidity rate for the wastewater-borne diseases were obtained from National Institute of Health.

Health Cost = $(MC_A + MC_B) \cdot (0.14) \cdot (PS)$ = 11.34 million Baht in 1991

where, MC_A = medical cost = $(EAP) \cdot (MR) \cdot (MC_1 + MC_2)$ = 232.6 Baht in 1991
MC_B = illness cost = $(EAP) \cdot (MR) \cdot (W) \cdot (D)$ = 99.43 Baht in 1991

0.14 = 14% of the water-borne diseases attributable to the sewerage project on the basis of diarrhea by cause in isolation (NIH Study 1978)

PS = In 1991, total population in the study area was 244,691, compared with 369,991 in the sewerage area in 2011.

EAP = economically active population of 13 years old and over in the labor force in the Central Region was 76.6%.

POP = population in the study area of eight municipalities, 248,710 in 1991 and 397,200 in 2011 respectively.

MR = morbidity rate for the water-borne disease, 2,984 per 100,000 population (National Institute of Health Study of 1987)

MC_1 = medical cost of treatment and care per person per hospital day was 560 Baht on the average, 7,840 Baht for an average of two weeks.

MC_2 = medical cost of treatment and care per person per consultation was 280 Baht on the average, 2,352 Baht for 2.1 consultation per person for an average of 4 days.

W = Average monthly household income with the average size of household, 3.1 persons was 6,060 in Central Region, 1990. The average working days per month is 25 days, the average daily household income is 242 Baht per day.

D = days lost due to illness (hospitalization and out-patient consultation days), 18 days.

The annual health cost is estimated at 8.67 million Baht in 1991, and 12.9 million Baht in 2026 in the study area of eight sewerage projects.

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