Appendix 12.3 Pumping Station - Capacity Calculation

1. Pumping Facility

Alternative		Alternative 1				Alternative 2		
Area		Kandy				Kandy		Katugastota
Pump Station		P/S 1	P/S 2-1	P/S 2-2	STP	P/S 1	STP	P/S 1
P/S Flow	m3/sec	0.01220	0.02900	0.02900	0.30000	0.00700	0.27333	0.02900
	m3/min	0.732	1.740	1.740	18.000	0.420	16.400	1.740
P/S Type		Circular	Circular	Circular	Rectangular	Circular	Rectangular	Circular
Number (+1)-standby		1 (+ 1)	1 (+ 1)	1 (+ 1)	2 (+ 1)	1 (+ 1)	2 (+ 1)	1 (+ 1)
Capacity	m3/min	0.74	1.74	1.74	9.00	0.42	8.20	1.74
Head	m	9	48	48	12	14	14	18
h1 =	m	7.00	40.00	40.00	10.00	7.00	10.00	15.00
h2 =	m	0.2	26.99	26.99	0.25	6.51	0.29	1.42
D =	mm	250	150	150	600	100	450	200
L =	m	630	1,400	1,400	150	650	50	300
V =	m/sec	0.249	1.641	1.641	1.061	0.891	1.719	0.923
h3 =	m	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Diameter	mm	79	122	122	392	60	374	122
Diameter	mm	150	125	125	400	150	400	125
Motor Output	kW	2.1	26.1	26.1	33.7	1.8	35.9	9.8
Motor Output	kW	2.2	30	30	37	2.2	37	11

2. Pump Pit (Circular)

Alternative		Alternative 1			Alternative 2	
Area		Kandy			Katugastota	Kandy
Pump Station		P/S 1-1	P/S 1-2	P/S 2	P/S 1	P/S 2
P/S Flow	m3/sec	0.02900	0.02900	0.01220	0.02900	0.01220
	m3/min	1.740	1.740	0.732	1.740	0.732
P/S Type		Circular	Circular	Circular	Circular	Circular
Number (+1)-standby		1 (+ 1)	1 (+ 1)	1 (+ 1)	1 (+ 1)	1 (+ 1)
Capacity	m3/min	1.74	1.74	0.74	1.74	0.74
Pump Minimum Starting Period	min	15	15	8	8	8
Pump Pit Capacity	cu.m	6.53	6.53	1.48	3.48	1.48
Therefore	cu.m	7.00	7.00	2.00	4.00	2.00
Ground Level	m	0.00	0.00	0.00	0.00	0.00
Inlet Pipe Level	m	-4.00	-4.00	-4.00	-4.00	-4.00
Effective Depth	m	1.00	1.00	1.00	1.00	1.00
Top	m	0.50	0.50	0.50	0.50	0.50
Bottom	m	0.50	0.50	0.50	0.50	0.50
Required Area	sq.m	7.00	7.00	2.00	4.00	2.00
Diameter	m	2.99	2.99	1.60	2.26	1.60
Therefore	m	3.00	3.00	1.60	2.50	1.60
Dimension (DIA)	m	3.00	3.00	1.60	2.50	1.60
(D)	m	6.00	6.00	6.00	6.00	6.00
Retention Time	min	4.06	4.06	2.75	2.82	2.75

3. Pump Pit (Rectangular)

Alternative		Alter. - 1	Alter. - 2
Area		Kandy	Kandy
Pump Station		STP	STP
P/S Flow	m3/sec	0.29570	0.26670
	m3/min	17.742	16.002
P/S Type		Rectangular	Rectangular
Number (+1)-standby		3 (+ 1)	3 (+ 1)
Capacity	m3/min	5.92	5.34
Pump Minimum Starting Period	min	15	15
Pump Pit Capacity	cu.m	22.20	20.03
Therefore	cu.m	24.00	22.00
Ground Level	m	0.00	0.00
Inlet Pipe Level	m	-4.00	-4.00
Effective Depth	m	0.80	0.80
Top	m	0.50	0.50
Bottom	m	0.70	0.70
Required Area	sq.m	30.00	27.50
Width	m	7.00	7.00
Length	m	4.29	3.93
Therefore	m	4.90	4.90
Dimension (W)	m	7.00	7.00
(L)	m	4.90	4.90
(D)	m	6.00	6.00
Retention Time	min	9.47	10.50

Appendix 12.4 Sewage Treatment Plant – Capacity Calculation

Appendix 12.4.1 Alternative 1 – Kandy (Oxidation Ditch)

Appendix 12.4.2 Alternative 2 – Kandy (Oxidation Ditch)

Appendix 12.4.3 Alternative 2 – Katugastota (Dual Power Aerated Lagoon)

Appendix 12.4.1 Sewage Treatment Plant - Capacity Calculation

CAPACITY CALCULATION OF FACILITIES
Alternative 1 - Kandy (Oxidation Ditch)

1 BASIC CONDITIONS

1-1 BASIC ITEMS

(1) Name : Kandy Sewage Treatment Plant

(2) Land Area : Approximately 3.00 ha

(3) Elevation : 474.000 m

(4) Inlet Pipe Level : 465.883 m

(5) Pipe Diameter : 600 m

(6) Land Use : -

(7) Collection System : Seperate Type

(8) Treatment Method : Sewage Treatment : Oxidation Ditch Method
Sludge Treatment : Sludge Thickener, Drying Bed

(9) Effluent Point : Mada Ela River

(10) Effluent Point Water Level : 470.640 m

(11) Target Year : Year 2005 (Phase 1), Year 2015 (Phase 2)

(12) Lowest Monthly Average Temperature 23.6 °C (January)

1-2 Design Population

Design Population : 55,000 Persons (Total)

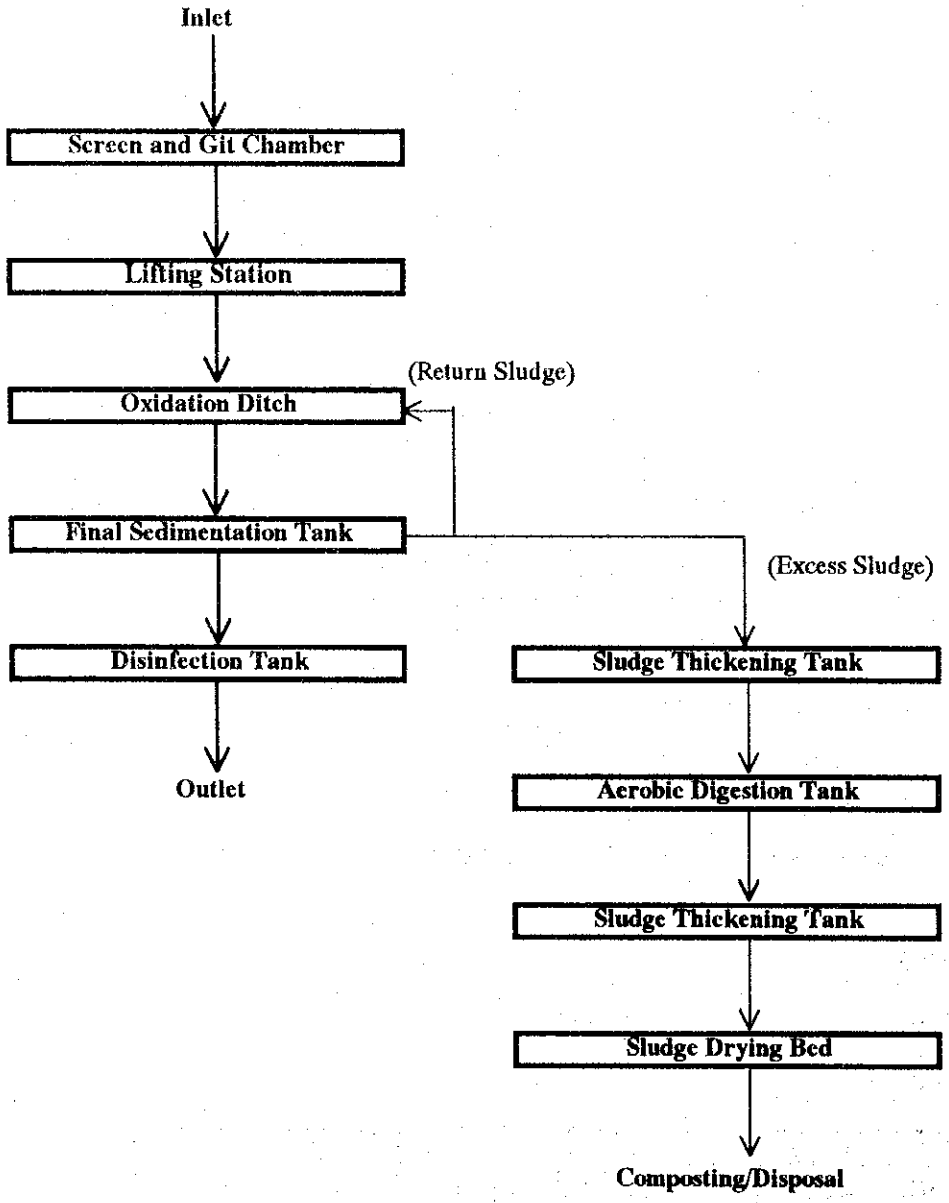
1-3 Design Sewage Flow

ITEM	m3/day	m3/hr	m3/min	m3/sec
Daily Average	15,220	634.2	10.57	0.176
Daily Maximum	18,000	750.0	12.50	0.208
Hourly Maximum	25,540	1064.2	17.74	0.296

1-4 Design Sewage Quality

ITEM	INFLUENT (mg/L)	EFFLUENT (mg/L)	REMOVAL RATIO (%)	REMARKS
BOD	240	30	88	
SS	250	50	80	

1-5 Flow Chart (Oxidation Ditch)



1-6 Design Criteria for Oxidation Ditch

ITEMS	UNIT	Formula or Value	Application
1-6-1 Grit Chamber			
(1) Water Surface Load	m3/m2/sec	< 1800	1,800
(2) Average Velocity	m/sec	< 0.3	0.3
1-6-2 Oxidation Ditch			
(1) BOD-SS Load	kg/kg/day	0.03 - 0.05	0.05
(2) MLSS Concentration	mg/l	3,000 - 4,000	4,000
(3) Return Sludge Ratio	%	100 - 200	150
(4) Water Depth	m	1.0 - 3.0	Same as Left
(5) Width	m	2.0 - 6.0	Same as Left
(6) Retention Time	hour	24 -48	Same as Left
(6) Oxygen Requirement	kgO2/kgBOD	1.4 - 2.2	2.0
(7) Sludge Age	day	8 - 50	Same as Left
1-6-3 Final Sedimentation Tank			
(1) Water Surface Load	m3/m2/day	8 - 12	8 - 12
(2) Retention Time	hour	6.0 - 12.0	Same as Left
(3) Water Depth	m	3.0 - 4.0	3.0
1-6-4 Disinfection Tank			
(1) Retention Time	min.	> 15	15
(2) Dosage	mg/l	2.0 - 4.0	3.0
1-6-5 Sludge Thickening Tank			
(1) Solid Matter Load	kg/m2/day	60 - 90	70
(2) Water Depth	m	Approximately 4.0	4.0
1-6-6 Aerobic Digestion Tank			
(1) Retention Time	day	10.0 - 15.0	Same as Left
(2) Solid Matter Load	kg/m2/day	1.60 - 4.81	Same as Left
1-6-7 Sludge Drying Bed			
(1) Drying Period	day	15 - 30	20
(2) Depth of Bed	m	0.3 - 1.0	0.3

2 CAPACITY CALCULATION

2-1 Grit Chamber and Screen (Hourly Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Parallel Flow Type	
Design Flow	Q1	m3/day	-	25,540
	Q2	m3/sec	-	0.30
Water Surface Load	WSL	m3/m2/day	-	1,800
Required Surface Area	RSA	m2	Q1/WSL	14.189
Basin Number (Total)	BN	basin	-	6
Basin Number (Stand-By)	BNS	basin	-	2
Average Velocity	V	m/sec	-	0.30
Depth	H	m	-	0.80
Width	W1	m	Q2/(V*H)	1.232
Therefore	W2	m	-	1.20
Length	L1	m	RSA/W2/(BN-BNS)	2.956
Therefore	L2	m	-	2.70
Dimension (W	W	m	W2	1.20
(L)	L	m	L2	2.70
(Basin)	-	basin	BN	4
(Stand-By)	-	stand-by	BNS	2
Screen Type	-	-	Fine Bar Screen	
Screen Set Number	SSN	set	BN	6
Check		UNIT	APPLICATION	RESULT
Water Surface Load		m3/m2/day	< 1800	1,971
Average Velocity		m/sec	< 0.3	0.08

2-2 Oxidation Ditch (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Re-circulation Flow Type	
Design Flow	Q1	m3/day	-	18,000
	Q2	m3/hr	-	750.0
Basin Number	BN	Basin	-	6
Inlet BOD Quality	C	mg/L	-	240
Inlet SS Quality	S	mg/L	-	250
Inlet BOD Matter	M	kg/day	Q1*C*10^-3	4,320
BOD-SS Load	BS	kg/kg/day	-	0.05
MLSS Concentration	SS	mg/L	-	4,000
Required Volume	V1	m3	M/(SS*BS*10^-3)	21,600
Therefore	V2	m3	-	21,600
Retention Time	T	hr	(V2/Q1)*24	28.8
Return Sludge Ratio	R1	%	-	150
	R2	-	R1/100	1.5
Return Sludge Quality	RS1	mg/L	(SS*(1+R2)-C)/R2	6,507
Therefore	RS2	mg/L	-	6,510
Sludge Age	SA	day	SS*V2/(Q1*S)	19.2
Width	W	m	-	6.0
Water Depth	H	m	-	3.0
Length	L1	m	(V2/BN)/(W*H)	200.0
Therefore	L2	m	-	200.0
Dimension (Width)	W	m	W	6.0
(Depth)	H	m	H	3.0
(Length)	L	m	L2	200.0
(Basin Number)	-	basin	BN	6
Required Oxygen	O2-day	kgO2/day	Q1*C*10^-3*2.0	8,640.0
	O2-hr	kgO2/hr	(O2-day)/24	360.0
Aerator Motor Output	-	kW	O2-hr/1.9	189.5
	-	kW	-	180.0
Aerator Type	-	-	Slanting Shaft Screw Aerator	
Check		UNIT	APPLICATION	RESULT
Retention Time		hour	24 -48	28.8
Oxygen Supply		kgO2/kg	1.4 - 2.2	2.0
Sludge Age		day	8 - 50	19.2

2-3 Final Sedimentation Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Radial Flow Circular Type	
Design Flow	Q1	m3/day	-	18,000
	Q2	m3/sec	-	750.00
Basin Number	BN	Basin	-	6
Water Surface Load	L	m3/m2/day	4.14*10^4*T^0.95*SS^-1.35	11.4
Therefore	L	m3/m2/day		12.0
Required Surface Area	A1	m2	Q1/L	1500.0
	A2	m2/Basin	A1/BN	250.0
Water Depth	H	m	-	3.0
Diameter	D1	m	(A2/3.14)^0.5*2	17.8
Therefore	D2	m	-	18.0
Dimension (Dian	D	m	D2	18.0
(Depth)	H	m	H	3.0
(Basin Number)	-	Basin	BN	6
Sludge Collector Type	-	-	Central Drive Type	
Check		UNIT	APPLICATION	RESULT
Water Surface Load		m3/m2/day	8 - 12	11.8
Retention Time		hour	6.0 - 12.0	5.1

2-4 Disinfection Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Chemical Type	-	-	Chlorination Type	
Design Flow	Q1	m3/day	-	18,000
	Q2	m3/min	-	12.50
Retention Time	T	min.	-	15.0
Basin Number	BN	basin	-	2
Required Volume	V	m3	Q2*T	94
Width	W	m	-	3.00
Water Depth	H	m	-	1.50
Length	L1	m	V/(W*H)	20.833
therefore	L2	m	-	21.00
Dosage	D	mg/L	-	3.0
Required Chemical	RC1	kg/day	Q1*D*10^-3/C	54.00
Therefore	RC2	kg/hr	RC1/24	2.25
Dimension (W	W	m	W	3.0
(Length)	L	m	L2	21.0
(Depth)	H	m	H	1.5
(Basin)	BN	basin	-	2
Chlorine Feeder	-	unit	including 1 for stand-by	3
Check		UNIT	APPLICATION	RESULT
Retention Time		min.	15	15.1

2-5 Sludge Thickening Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Radial Flow Circular Type	
Design Flow	Q1	m3/day	-	18,000
	Q2	m3/hr	-	634.2
Basin Number	BN	Basin	-	2
Inlet SS Quality	C	mg/L	-	250
Removal Ratio	R1	%	-	80
	R2	-	R1/100	0.80
Sludge Generation Ratio	SG1	%	-	75
(Oxidation Ditch)	SG2	-	SG1/100	0.75
Inlet SS Matter	M	kg/day	Q1*C*R2*SG2*10^-3	2,700
Solid Matter Load	L	kg/m2/day	-	70.0
Required Surface Area	A1	m2	M/L	38.6
	A2	m2/Basin	A1/BN	19.3
Water Depth	H	m	-	4.0
Diameter	D1	m	(A2/3.14)^0.5*2	5.0
Therefore	D2	m	-	5.0
Dimension	D	m	D2	5.0
(Depth)	H	m	H	4.0
(Basin)	Basin	Basin	BN	2
Check		UNIT	APPLICATION	RESULT
Solid Matter Load		kg/m2/day	70	68.8

2-6 Aerobic Sludge Digestion Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Circular Type	
Basin Number	BN	Basin	-	2
Design Flow	Q1	m3/day	-	18,000
Inlet SS Matter	M	kg/day	-	2,700
Moisture Content	G	%	-	97.5
Sludge Volume	V1	m3/day	M*100/(100-G)	108.0
Temperature - Summer	TS	°C	-	26.5
- Winter	TW	°C	-	23.6
Temperature - Sludge Age	TSA	day-°C	VolatileSolidReduction=40%	470
Sludge Age	SA	day	TSA/TS	19.9
Total Mass of VSS	VSS	kg/day	0.8*M	2,160
VSS Reduction - Summer (41%)	VRS	kg/day	VSS*0.4	864.0
- Winter (40%)	VRW	kg/day	VSS*0.41	885.6
Required Volume	V	m3	V1/0.7/(0.125*0.8+1/SA)	514
Water Depth	H	m	-	4.0
Diameter	D1	m	(A2/3.14)^0.5*2	12.8
Therefore	D2	m	-	13.0
Dimension	D	m	D2	13.0
(Depth)	H	m	H	4.0
(Basin)	Basin	Basin	BN	2
Required Oxygen	RO	kgO2/day	2.3*VRS	1987.2
Required Air	RA	kg-Air/hr	RO/(0.1*0.233*1.293)/1440	2,748.4
Check		UNIT	APPLICATION	RESULT
Retention Time		day	10.0 - 15.0	4.9
Solid Matter Load		kg/m3/day	1.60 - 4.81	10.2

2-7 Sludge Thickening Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Radial Flow Circular Type	
Basin Number	BN	Basin	-	2
Inlet SS Matter to Digestion	M1	kg/day	-	2,700
Removal Ratio at Digestion	R1	%	-	40%
Inlet SS Matter	M2	kg/day	M1*(1-R1)	1620
Moisture Content	G	%	-	99.0
Sludge Volume	V1	m3/day	M2*100/(100-G)	162.0
Solid Matter Load	L	kg/m2/day	-	70.0
Required Surface Area	A1	m2	M/L	23.1
	A2	m2/Basin	A1/BN	11.6
Water Depth	H	m	-	4.0
Diameter	D1	m	(A2/3.14)^0.5*2	3.8
Therefore	D2	m	-	5.0
Dimension	D	m	D2	5.0
(Depth)	H	m	H	4.0
(Basin)	Basin	Basin	BN	2
Check		UNIT	APPLICATION	RESULT
Solid Matter Load		kg/m2/day	70	41.3

2-8 Sludge Drying Bed (Daily Maxmum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Design Flow	Q1	m3/day	-	18,000
Inlet SS Matter	M1	kg/day	Q1*C*R2*10^-3	1,620
	M2	t/day	M1/1000	1.62
Moisture Content	G	%	-	97.0
Sludge Volume	V1	m3/day	M2*100/(100-G)	54.0
Drying Period	P	day	-	10
Required Volume	V2	m3/day	V1*P	540.0
Depth of Bed	H	m	-	0.3
Required Area	A	m2	V2/H	1,800
Unit Number	UN	Unit	-	20
Width per Unit	W	m	-	6.0
Length per Unit	L1	m	A/(UN*W)	15.0
Therefore	L2	m	-	15.0
Dimension (Width	W	m	W	6.0
(Length)	L	m	L2	15.0
(Depth)	H	m	H	0.3
(Basin)	Basin	Basin	BN	20.0
Check		UNIT	APPLICATION	RESULT
Drying Period		day	20	10.0

Appendix 12.4.2 Sewage Treatment Plant - Capacity Calculation

CAPACITY CALCULATION OF FACILITIES
Alternative 2 - Kandy (Oxidation Ditch)

1 BASIC CONDITIONS

1-1 BASIC ITEMS

(1) Name : Kandy Sewage Treatment Plant

(2) Land Area : Approximately 3.00 ha

(3) Elevation : 474.000 m

(4) Inlet Pipe Level : 465.883 m

(5) Pipe Diameter : 600 m

(6) Land Use : -

(7) Collection System : Seperate Type

(8) Treatment Method : Sewage Treatment : Oxidation Ditch Method
Sludge Treatment : Sludge Thickener, Drying Bed

(9) Effluent Point : Mada Ela River

(10) Effluent Point Water Level : 470.640 m

(11) Target Year : Year 2005 (Phase 1), Year 2015 (Phase 2)

(12) Lowest Monthly Average Temperature 23.6 °C (January)

1-2 Design Population

Design Population : 49,700 Persons (Total)

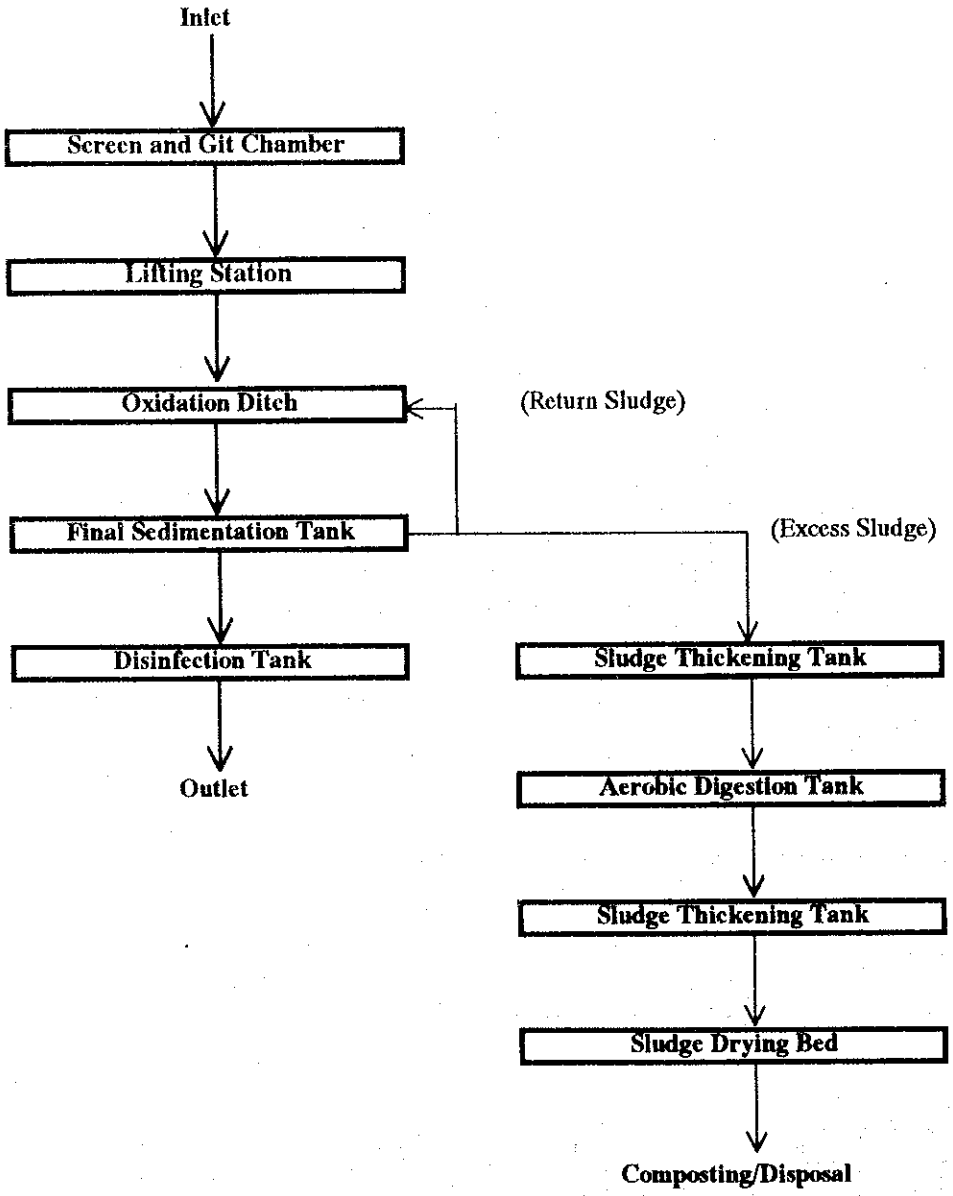
1-3 Design Sewage Flow

ITEM	m3/day	m3/hr	m3/min	m3/sec
Daily Average	13,700	570.8	9.51	0.159
Daily Maximum	17,000	708.3	11.81	0.197
Hourly Maximum	23,030	959.6	15.99	0.267

1-4 Design Sewage Quality

ITEM	INFLUENT (mg/L)	EFFLUENT (mg/L)	REMOVAL RATIO (%)	REMARKS
BOD	240	30	88	
SS	250	50	80	

1-5 Flow Chart (Oxidation Ditch)



1-6 Design Criteria for Oxidation Ditch

ITEMS	UNIT	Formula or Value	Application
1-6-1 Grit Chamber			
(1) Water Surface Load	m3/m2/sec	< 1800	1,800
(2) Average Velocity	m/sec	< 0.3	0.3
1-6-2 Oxidation Ditch			
(1) BOD-SS Load	kg/kg/day	0.03 - 0.05	0.05
(2) MLSS Concentration	mg/l	3,000 - 4,000	4,000
(3) Return Sludge Ratio	%	100 - 200	150
(4) Water Depth	m	1.0 - 3.0	Same as Left
(5) Width	m	2.0 - 6.0	Same as Left
(6) Retention Time	hour	24 -48	Same as Left
(6) Oxygen Requirement	kgO2/kgBOD	1.4 - 2.2	2.0
(7) Sludge Age	day	8 - 50	Same as Left
1-6-3 Final Sedimentation Tank			
(1) Water Surface Load	m3/m2/day	8 - 12	8 - 12
(2) Retention Time	hour	6.0 - 12.0	Same as Left
(3) Water Depth	m	3.0 - 4.0	3.0
1-6-4 Disinfection Tank			
(1) Retention Time	min.	> 15	15
(2) Dosage	mg/l	2.0 - 4.0	3.0
1-6-5 Sludge Thickening Tank			
(1) Solid Matter Load	kg/m2/day	60 - 90	70
(2) Water Depth	m	Approximately 4.0	4.0
1-6-6 Aerobic Digestion Tank			
(1) Retention Time	day	10.0 - 15.0	Same as Left
(2) Solid Matter Load	kg/m2/day	1.60 - 4.81	Same as Left
1-6-7 Sludge Drying Bed			
(1) Drying Period	day	15 - 30	20
(2) Depth of Bed	m	0.3 - 1.0	0.3

2 CAPACITY CALCULATION

2-1 Grit Chamber and Screen (Hourly Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Parallel Flow Type	
Design Flow	Q1	m3/day	-	23,030
	Q2	m3/sec	-	0.27
Water Surface Load	WSL	m3/m2/day	-	1,800
Required Surface Area	RSA	m2	Q1/WSL	12.794
Basin Number (Total)	BN	basin	-	6
Basin Number (Stand-By)	BNS	basin	-	2
Average Velocity	V	m/sec	-	0.30
Depth	H	m	-	0.80
Width	W1	m	Q2/(V*H)	1.111
Therefore	W2	m	-	1.20
Length	L1	m	RSA/W2/(BN-BNS)	2.666
Therefore	L2	m	-	2.70
Dimension (W)	W	m	W2	1.20
(L)	L	m	L2	2.70
(Basin)	-	basin	BN	4
(Stand-By)	-	stand-by	BNS	2
Screen Type	-	-	Fine Bar Screen	
Screen Set Number	SSN	set	BN	6
Check		UNIT	APPLICATION	RESULT
Water Surface Load		m3/m2/day	< 1800	1,777
Average Velocity		m/sec	< 0.3	0.07

2-2 Oxidation Ditch (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Re-circulation Flow Type	
Design Flow	Q1	m3/day	-	17,000
	Q2	m3/hr	-	708.3
Basin Number	BN	Basin	-	6
Inlet BOD Quality	C	mg/L	-	240
Inlet SS Quality	S	mg/L	-	250
Inlet BOD Matter	M	kg/day	Q1*C*10^-3	4,080
BOD-SS Load	BS	kg/kg/day	-	0.05
MLSS Concentration	SS	mg/L	-	4,000
Required Volume	V1	m3	M/(SS*BS*10^-3)	20,400
Therefore	V2	m3	-	20,400
Retention Time	T	hr	(V2/Q1)*24	28.8
Return Sludge Ratio	R1	%	-	150
	R2	-	R1/100	1.5
Return Sludge Quality	RS1	mg/L	(SS*(1+R2)-C)/R2	6,507
Therefore	RS2	mg/L	-	6,510
Sludge Age	SA	day	SS*V2/(Q1*S)	19.2
Width	W	m	-	6.0
Water Depth	H	m	-	3.0
Length	L1	m	(V2/BN)/(W*H)	188.9
Therefore	L2	m	-	190.0
Dimension (Width)	W	m	W	6.0
(Depth)	H	m	H	3.0
(Length)	L	m	L2	190.0
(Basin Number)	-	basin	BN	6
Required Oxygen	O2-day	kgO2/day	Q1*C*10^-3*2.0	8,160.0
	O2-hr	kgO2/hr	(O2-day)/24	340.0
Aerator Motor Output	-	kW	O2-hr/1.9	178.9
	-	kW	-	180.0
Aerator Type	-	-	Slanting Shaft Screw Aerator	

Check		UNIT	APPLICATION	RESULT
Retention Time		hour	24 -48	29.0
Oxygen Supply		kgO2/kg	1.4 - 2.2	2.0
Sludge Age		day	8 - 50	19.2

2-3 Final Sedimentation Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Radial Flow Circular Type	
Design Flow	Q1	m3/day	-	17,000
	Q2	m3/sec	-	708.33
Basin Number	BN	Basin	-	6
Water Surface Load	L	m3/m2/day	4.14*10^4*T^0.95*SS^-1.35	11.4
Therefore	L	m3/m2/day		12.0
Required Surface Area	A1	m2	Q1/L	1416.7
	A2	m2/Basin	A1/BN	236.1
Water Depth	H	m	-	3.0
Diameter	D1	m	(A2/3.14)^0.5*2	17.3
Therefore	D2	m	-	16.0
Dimension (Dian	D	m	D2	16.0
(Depth)	H	m	H	3.0
(Basin Number)	-	Basin	BN	6
Sludge Collector Type	-	-	Central Drive Type	
Check		UNIT	APPLICATION	RESULT
Water Surface Load		m3/m2/day	8 - 12	14.1
Retention Time		hour	6.0 - 12.0	4.3

2-4 Disinfection Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Chemical Type	-	-	Chlorination Type	
Design Flow	Q1	m3/day	-	17,000
	Q2	m3/min	-	11.81
Retention Time	T	min.	-	15.0
Basin Number	BN	basin	-	2
Required Volume	V	m3	Q2*T	89
Width	W	m	-	3.00
Water Depth	H	m	-	1.50
Length	L1	m	V/(W*H)	19.676
therefore	L2	m	-	20.00
Dosage	D	mg/L	-	3.0
Required Chemical	RC1	kg/day	Q1*D*10^-3/C	51.00
Therefore	RC2	kg/hr	RC1/24	2.13
Dimension (W	W	m	W	3.0
(Length)	L	m	L2	20.0
(Depth)	H	m	H	1.5
(Basin)	BN	basin	-	2
Chlorine Feeder	-	unit	including 1 for stand-by	3
Check		UNIT	APPLICATION	RESULT
Retention Time		min.	15	15.2

2-5 Sludge Thickening Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Radial Flow Circular Type	
Design Flow	Q1	m3/day	-	17,000
	Q2	m3/hr	-	570.8
Basin Number	BN	Basin	-	2
Inlet SS Quality	C	mg/L	-	250
Removal Ratio	R1	%	-	80
	R2	-	R1/100	0.80
Sludge Generation Ratio	SG1	%	-	75
(Oxidation Ditch)	SG2	-	SG1/100	0.75
Inlet SS Matter	M	kg/day	Q1*C*R2*SG2*10^-3	2,550
Solid Matter Load	L	kg/m2/day	-	70.0
Required Surface Area	A1	m2	M/L	36.4
	A2	m2/Basin	A1/BN	18.2
Water Depth	H	m	-	4.0
Diameter	D1	m	(A2/3.14)^0.5*2	4.8
Therefore	D2	m	-	5.0
Dimension	D	m	D2	5.0
(Depth)	H	m	H	4.0
(Basin)	Basin	Basin	BN	2
Check		UNIT	APPLICATION	RESULT
Solid Matter Load		kg/m2/day	70	65.0

2-6 Aerobic Sludge Digestion Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Circular Type	
Basin Number	BN	Basin	-	2
Design Flow	Q1	m3/day	-	17,000
Inlet SS Matter	M	kg/day	-	2,550
Moisture Content	G	%	-	97.5
Sludge Volume	V1	m3/day	M*100/(100-G)	102.0
Temperature - Summer	TS	°C	-	26.5
- Winter	TW	°C	-	23.6
Temperature - Sludge Age	TSA	day-°C	VolatileSolidReduction=40%	470
Sludge Age	SA	day	TSA/TS	19.9
Total Mass of VSS	VSS	kg/day	0.8*M	2,040
VSS Reduction - Summer (41%)	VRS	kg/day	VSS*0.4	816.0
- Winter (40%)	VRW	kg/day	VSS*0.41	836.4
Required Volume	V	m3	V1/0.7/(0.125*0.8+1/SA)	485
Water Depth	H	m	-	4.0
Diameter	D1	m	(A2/3.14)^0.5*2	12.4
Therefore	D2	m	-	13.0
Dimension	D	m	D2	13.0
(Depth)	H	m	H	4.0
(Basin)	Basin	Basin	BN	2
Required Oxygen	RO	kgO2/day	2.3*VRS	1876.8
Required Air	RA	kg-Air/hr	RO/(0.1*0.233*1.293)/1440	2,595.7
Check		UNIT	APPLICATION	RESULT
Retention Time		day	10.0 - 15.0	5.2
Solid Matter Load		kg/m3/day	1.60 - 4.81	9.6

2-7 Sludge Thickening Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Radial Flow Circular Type	
Basin Number	BN	Basin	-	2
Inlet SS Matter to Digestion	M1	kg/day	-	2,550
Removal Ratio at Digestion	R1	%	-	40%
Inlet SS Matter	M2	kg/day	M1*(1-R1)	1530
Moisture Content	G	%	-	99.0
Sludge Volume	V1	m3/day	M2*100/(100-G)	153.0
Solid Matter Load	L	kg/m2/day	-	70.0
Required Surface Area	A1	m2	M/L	21.9
	A2	m2/Basin	A1/BN	10.9
Water Depth	H	m	-	4.0
Diameter	D1	m	(A2/3.14)^0.5*2	3.7
Therefore	D2	m	-	5.0
Dimension	D	m	D2	5.0
(Depth)	H	m	H	4.0
(Basin)	Basin	Basin	BN	2
Check		UNIT	APPLICATION	RESULT
Solid Matter Load		kg/m2/day	70	39.0

2-8 Sludge Drying Bed (Daily Maxmum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Design Flow	Q1	m3/day	-	17,000
Inlet SS Matter	M1	kg/day	Q1*C*R2*10^-3	1,530
	M2	t/day	M1/1000	1.53
Moisture Content	G	%	-	97.0
Sludge Volume	V1	m3/day	M2*100/(100-G)	51.0
Drying Period	P	day	-	10
Required Volume	V2	m3/day	V1*P	510.0
Depth of Bed	H	m	-	0.3
Required Area	A	m2	V2/H	1,700
Unit Number	UN	Unit	-	20
Width per Unit	W	m	-	6.0
Length per Unit	L1	m	A/(UN*W)	14.2
Therefore	L2	m	-	14.5
Dimension (Width	W	m	W	6.0
(Length)	L	m	L2	14.5
(Depth)	H	m	H	0.3
(Basin)	Basin	Basin	BN	20.0
Check		UNIT	APPLICATION	RESULT
Drying Period		day	20	10.2

Appendix 12.4.3 Sewage Treatment Plant - Capacity Calculation

CAPACITY CALCULATION OF FACILITIES
Alternative 2 - Katugasutota (Dual Power Aerated Lagoon)

1 BASIC CONDITIONS

1-1 BASIC ITEMS

(1) Name : Katugastota Sewage Treatment Plant

(2) Land Area : Approximately 1.20 ha

(3) Elevation : 475.950 m

(4) Inlet Pipe Level : 472.447 m

(5) Pipe Diameter : 300 m

(6) Land Use : -

(7) Collection System : Seperate Type

(8) Treatment Method : Sewage Treatment : Aerated Lagoon Method
Sludge Treatment : Pond Accumulation

(9) Effluent Point : Mahaweli Ganga

(10) Effluent Point Water Level : 446.4 m

(11) Target Year : Year 2005 (Phase 1), Year 2015 (Phase 2)

(12) Lowest Monthly Average Temperature 23.6 °C (January)

1-2 Design Population

Design Population : 5,260 Persons

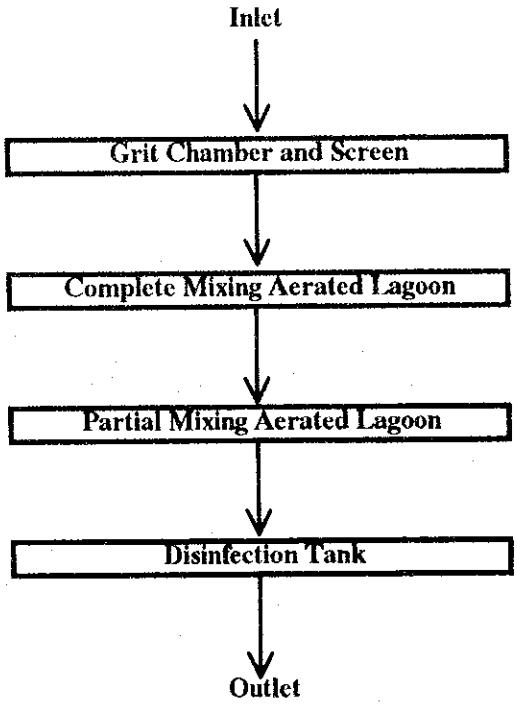
1-3 Design Sewage Flow

ITEM	m3/day	m3/hr	m3/min	m3/sec
Daily Average	1,500	62.5	1.04	0.017
Daily Maximum	1,700	70.8	1.18	0.020
Hourly Maximum	2,500	104.2	1.74	0.029

1-4 Design Sewage Quality

ITEM	INFLUENT (mg/L)	EFFLUENT (mg/L)	REMOVAL RATIO (%)	REMARKS
BOD	240	30	88	
SS	250	50	80	

1-5 Flow Chart (Dual Power Aerated Lagoon)



1-6 Design Criteria for Dual Power Aerated Lagoon

ITEMS	UNIT	Formula or Value	Application
1-6-1 Grit Chamber			
(1) Water Surface Load	m3/m2/day	> 1800	1,800
(2) Average Velocity	m/scc	> 0.3	0.3
1-6-2 Complete Mixing Aerated Lagoon			
(1) Retention Time	day	1.5 - 2.5	1.50
(2) Water Depth	m	3.0 - 4.0	3.0
(3) Power Requirement for Mixing	W/m3	> 6.0	6.0
1-6-3 Partial Mixing Aerated Lagoon			
(1) Retention Time	day	2.0	2.0
(2) Water Depth	m	2.0 - 4.0	3.0
(3) Power Requirement for Mixing	W/m3	> 1.0	1.0
(4) Number of Cell	Cell/Basin	1 - 3	3
1-6-4 Storm Water Settling Tank			
(1) Water Depth	m	1.5 - 3.0	1.5
(2) Retention Time (Hourly Max. - Rain)	hour	> 0.5	0.5
(3) Water Surface Load (Hourly Max. - Rain)	m3/m2/day	75 - 150	150.0
1-6-5 Disinfection Tank			
(1) Retention Time	min.	> 15	15.0
(2) Dosage	mg/l	2.0 - 4.0	3.0

2 CAPACITY CALCULATION

2-1 Grit Chamber and Screen (Hourly Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Parallel Flow Type	
Design Flow	Q1	m3/day	-	2,500
	Q2	m3/sec	-	0.029
Water Surface Load	WSL	m3/m2/day	-	1,800
Required Surface Area	RSA	m2	Q1/WSL	1.389
Basin Number (Total)	BN	basin	-	2
Basin Number (Stand-By)	BNS	basin	-	1
Average Velocity	V	m/sec	-	0.30
Depth	H	m	-	0.20
Width	W1	m	Q2/(V*H)	0.482
Therefore	W2	m	-	0.50
Length	L1	m	RSA/W2/(BN-BNS)	2.778
Therefore	L2	m	-	3.00
Dimension (W)	W	m	W2	0.50
(L)	L	m	L2	3.00
(Basin)	-	basin	BN	1
(Stand-By)	-	stand-by	BNS	1
Screen Type	-	-	Fine Bar Screen	
Screen Set Number	SSN	set	BN	2
Check		UNIT	APPLICATION	RESULT
Water Surface Load		m3/m2/day	> 1800	1,667
Average Velocity		m/sec	> 0.3	0.29

2-2 Complete Mixing Aerated Lagoon (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Rectangular Type	
Design Flow	Q1	m3/day	-	1,700
	Q2	m3/hr	-	70.83
Retention Time	T1	day	-	1.50
Inlet BOD Quality	So	mg/L	-	240
Required Volume	V1	m3/basin	Q1*T	2,550
Basin Number	BN	basin	-	2
Required Volume per Basin	VBN	m3/basin	Q1*T/BN	1,275
Water Depth	H	m	-	3.00
Required Surface Area	A	m2	V/H	425
Width	W	m	-	30.00
Length	L1	m	A/W	14.167
Therefore	L2	m	-	15.00
Oxygen Demand Rate	PR1	kg/h	(4.16*10^-5)*r*Q1*So	25
-max. oxygen uptake	r	W/m3	-	1.5
Aeration Unit Power Rate	PRO	kg/h	1000*PR1/(N*Q1*T1)	5.25
Therefore	PRO	W/m3	-	5.6
-aeration performance	N	W/m3	-	1.9
Power Requirement	P1	kW	-	16.0
1) Oxygen Requirement	P1O	kW	PR1/N	13.4
2) Mixing Power	P1M	kW	V1*P0*10^-3	15.3
Dimension (Width)	W	m	W	30.00
(Length)	L	m	L2	15.00
(Depth)	H	m	H	3.00
(Basin)	-	basin	BN	2
Aerator Type	-	-	Slanting Shaft Screw Aerator	

Check		UNIT	APPLICATION	RESULT
Retention Time		day	1.5 - 2.5	1.59

2-3 Partial Mixing Aerated Lagoon (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Rectangular Type	
Design Flow	Q1	m3/day	-	1,700
	Q2	m3/hr	-	70.83
Retention Time	T2	day	-	2.00
Required Volume	V2	m3/basin	Q2*T	3,400
Basin Number	BN	basin	-	2
Cells Number	CN	cell/basin	-	3
Stand-by Cell Number	CNS	basin	-	1
Sludge Accumulation	SA	m3/year	365*Q1*Xi/(x*10^6)	853
-inert solid concentration	Xi	mg/l	-	55
-weight fracrion of solids	x	-	-	0.04
No. of Cells Cleaned per Year	CNC	basin	-	3
Total Sludge Accumulation	TSA	m3	-	1,280
Required Volume	V	m3/cell	(Q1*T+TSA)/(BN*CN-CNS)	936
Water Depth	D	m	-	4.00
Required Surface Area	A	m2/cell	V/H	234
Width	W	m	-	30.00
Length	L1	m	A/W	7.800
Therefore	L1	m	-	8.00
Power Requirement	P2	kW	-	4.0
1) Mixing Power	P2M	kW	Q1*T2*CN*10^-3	3.4
Dimension (Width)	W	m	W	30.00
(Length)	L	m	L1	8.00
(Depth)	H	m	H	4.00
(Basin)	-	basin	BN	2
(Cell)	-	cell/basin	CN	3
(Stand-by Cell)	-	cell	-	1
Aerator Type	-	-	Slanting Shaft Screw Aerator	
Check		UNIT	APPLICATION	RESULT
Surface Area		m2	-	1,440
Retention Time		day	2.0	2.07

2-6 Disinfection Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Chemical Type	-	-	Chlorination Type	
Design Flow	Q1	m3/day	-	1,700
	Q2	m3/min	-	1.18
Retention Time	T	min.	-	15.0
Basin Number	BN	basin	-	1
Required Volume	V	m3	Q2*T	18
Width	W	m	-	1.00
Water Depth	H	m	-	1.00
Length	L1	m	V/(W*H)	17.708
therefore	L2	m	-	18.00
Dosage	D	mg/L	-	3.0
Required Chemical	RC1	kg/day	Q1*D*10^-3/C	5.10
Therefore	RC2	kg/hr	RC1/24	0.21
Dimension (Width)	W	m	W	1.00
(Length)	L	m	L2	18.00
(Depth)	H	m	H	1.00
(Depth)	BN	basin	-	1
Chlorine Feeder	-	unit	including 1 for stand-by	3
Check		UNIT	APPLICATION	RESULT
Retention Time		min.	> 15	15.2

Appendix 12.5 Summary of Construction Cost

Kandy Exchange Rate = 1.8 Yen/Rs

Construction Cost - Master Plan : Alternatives

Facilities	Alternative 1				Alternative 2			
	Specifications	Civil	M & E	Total	Specifications	Civil	M & E	Total
1. Sewer								
Sub-Total		777,683		777,683		747,251		747,251
2. Pumping Station								
Kandy								
P/S 1	0.74*27*2	918	2,185		0.74*27*2	918	2,185	
P/S 2-1	1.74*48*2	1,383	4,211					
P/S 2-2	1.74*48*2	1,383	4,211					
STP-1	9.0*14*4	7,211	12,050		8.2*14*4	7,211	11,275	
STP-2	4.5*14*4	0	3,661		4.1*14*4	0	3,454	
Katugastota								
STP					1.74*24*2	1,210	2,438	
Sub-Total		10,895	26,317	37,212		9,339	19,351	28,690
3. Sewage Treatment Plant								
Kandy	18,000m3/day	358,896	666,558		17,000m3/day	344,809	636,899	
Katugastota					1,700m3/day	45,428	35,242	
Sub-Total		358,896	666,558	1,025,454		390,237	672,141	1,062,378
Total		1,147,474	692,875	1,840,349		1,146,827	691,492	1,838,319

Construction Cost - Feasibility Study

Facilities	M/P (Alternative 2)				F/S (Phase 1)				Phase 2			
	Specifications	Civil	M & E	Total	Specifications	Civil	M & E	Total	Specifications	Civil	M & E	Total
1. Sewer												
Sub-Total		747,251		747,251		463,191		463,191		284,060		284,060
2. Pumping Station												
Kandy												
L/S 1	0.74*27*2	918	2,185		0.74*27*2	918	2,185					
STP-1	8.2*14*2	7,211	11,275		8.2*14*2	7,211	8,137		8.2*14*2	0	3,137	
STP-2	4.1*14*2	0	3,454		4.1*14*2	0	1,727		4.1*14*2	0	1,727	
Katugastota												
STP	1.74*24*2	1,210	2,438			0	0		1.74*24*2	1,210	2,438	
Sub-Total		9,339	19,351	28,690		8,129	12,049	20,178		1,210	7,302	8,512
3. Sewage Treatment Plant												
Kandy	17,000m3/day	344,809	636,899		8,500m3/day	190,707	320,246		8,500m3/day	154,102	316,654	
Katugastota	1,700m3/day	45,428	35,242			0	0		1,700m3/day	45,428	35,242	
Sub-Total		390,237	672,141	1,062,378		190,707	320,246	510,953		199,530	351,896	551,426
Total		1,146,827	691,492	1,838,319		662,027	332,294	994,321		484,800	359,197	843,997

Appendix 12.6 Cost of Sewer

Alternative 2 (Applied) (Unit : Rs) **Master Plan** **Feasibility Study**

ITEM	DESCRIPTION	Depth	UNIT	RATE	QUANTITY	COST	QUANTITY	COST
Clay Pipe Laying	150 mm (Lateral)	1.5	m	5,498	9,300	51,131,400	4,500	24,741,000
	150 mm	1.5	m	5,498	4,651	25,571,198	4,651	25,571,198
	150 mm	2.5	m	7,871	793	6,241,703	793	6,241,703
	225 mm	1.5	m	7,142	1,527	10,905,834	1,527	10,905,834
	225 mm	2.5	m	9,603	1,859	17,851,977	1,509	14,490,927
	225 mm	3.5	m	12,459	691	8,609,169	691	8,609,169
	225 mm	7.5	m	27,832	100	2,783,200	0	0
	300 mm	1.5	m	10,593	1,942	20,571,606	1,942	20,571,606
	300 mm	2.5	m	13,173	680	8,957,640	680	8,957,640
	300 mm	3.5	m	16,147	80	1,291,760	80	1,291,760
	300 mm	7.5	m	31,994	80	2,559,520	80	2,559,520
	400 mm	1.5	m	15,652	2,590	40,538,680	840	13,147,680
	400 mm	2.5	m	18,373	548	10,068,404	348	6,393,804
	400 mm	4.5	m	25,001	200	5,000,200	0	0
	450 mm	1.5	m	17,475	75	1,310,625	75	1,310,625
	500 mm	1.5	m	20,461	288	5,892,768	288	5,892,768
	500 mm	2.5	m	23,318	70	1,632,260	70	1,632,260
	600 mm	1.5	m	33,513	312	10,456,056	312	10,456,056
	600 mm	2.5	m	36,508	55	2,007,940	55	2,007,940
HP Pipe Laying	675 mm	1.5	m	16,046	500	8,023,000	500	8,023,000
	675 mm	2.5	m	19,178	180	3,452,040	180	3,452,040
	675 mm	3.5	m	22,704	120	2,724,480	120	2,724,480
	675 mm	4.5	m	26,626	190	5,058,940	190	5,058,940
	675 mm	5.5	m	30,942	100	3,094,200	100	3,094,200
	750 mm	2.5	m	21,242	150	3,186,300	150	3,186,300
	825 mm	1.5	m	20,005	400	8,002,000	400	8,002,000
	825 mm	2.5	m	23,413	480	11,238,240	480	11,238,240
	825 mm	4.5	m	31,416	700	21,991,200	700	21,991,200
	825 mm	7.5	m	46,382	50	2,319,100	50	2,319,100
DI Pipe Laying	100 mm	1.5	m	6,242	650	4,057,300	650	4,057,300
	150 mm		m	7,358	-	-	-	-
Manhole	Type 1		Nr	80,181	517	41,453,577	369	29,586,789
	Type 2		Nr	93,941	57	5,354,637	57	5,354,637
	Type 3		Nr	109,418	-	-	-	-
Connection Pipe	100mmPVC ,L=4m		Nr	25,712	12,402	318,880,224	5,794	148,975,328
Inspection Pit	RC,300×300		Nr	5,098	12,402	63,225,396	5,794	29,537,812
Siphon		4.5	Nr	868,712	1	868,712	1	868,712
Siphon Pipe	450mm×2	4.5	m	27,024	40	1,080,960	40	1,080,960
Siphon		7.5	Nr	1,053,558	1	1,053,558	1	1,053,558
Siphon Pipe	450mm×2	7.5	m	40,127	40	1,605,080	40	1,605,080
Road Crossing	Jacking(675mm)		m	240,000	30	7,200,000	30	7,200,000
TOTAL	Sewer Main + Lateral				29,361	747,250,884	21,961	463,191,166
	Sewer Main				20,061		17,461	

Alternative 1 (Unit : Rs) **Master Plan** **Feasibility Study**

ITEM	DESCRIPTION	Depth	UNIT	RATE	QUANTITY	COST	QUANTITY	COST
Clay Pipe Laying	150 mm (Lateral)	1.5	m	5,498	9,300	51,131,400		
	150 mm	1.5	m	5,498	4,651	25,571,198		
	150 mm	2.5	m	7,871	793	6,241,703		
	225 mm	1.5	m	7,142	1,527	10,905,834		
	225 mm	2.5	m	9,603	1,859	17,851,977		
	225 mm	3.5	m	12,459	691	8,609,169		
	225 mm	7.5	m	27,832	100	2,783,200		
	300 mm	1.5	m	10,593	1,268	13,431,924		
	300 mm	2.5	m	13,173	320	4,215,360		
	300 mm	7.5	m	31,994	80	2,559,520		
	400 mm	1.5	m	15,652	2,590	40,538,680		
	400 mm	2.5	m	18,373	548	10,068,404		
	400 mm	4.5	m	25,001	200	5,000,200		
	450 mm	1.5	m	17,475	674	11,778,150		
	450 mm	2.5	m	20,263	360	7,294,680		
	450 mm	3.5	m	23,446	80	1,875,680		
	600 mm	1.5	m	33,513	363	12,165,219		
	600 mm	2.5	m	36,508	70	2,555,560		
HP Pipe Laying	675 mm	1.5	m	16,046	632	10,141,072		
	675 mm	2.5	m	19,178	55	1,054,790		
	675 mm	3.5	m	22,704	120	2,724,480		
	675 mm	4.5	m	26,626	100	2,662,600		
	675 mm	5.5	m	30,942	100	3,094,200		
	750 mm	1.5	m	17,972	180	3,234,960		
	750 mm	2.5	m	21,242	330	7,009,860		
	750 mm	4.5	m	28,964	90	2,606,760		
	825 mm	1.5	m	20,005	400	8,002,000		
	825 mm	2.5	m	23,413	480	11,238,240		
	825 mm	4.5	m	31,416	700	21,991,200		
	825 mm	7.5	m	46,382	50	2,319,100		
DI Pipe Laying	100 mm	1.5	m	6,242	650	4,057,300		
	200 mm	1.5	m	8,514	2,600	22,136,400		
Manhole	Type 1		Nr	80,181	509	40,812,129		
	Type 2		Nr	93,941	65	6,106,165		
	Type 3		Nr	109,418	-	-		
Connection Pipe	100mmPVC ,L=4m		Nr	25,712	12,402	318,880,224		
Inspection Pit	RC,300x300		Nr	5,098	12,402	63,225,396		
Siphon		4.5	Nr	868,712	1	868,712		
Siphon Pipe	450mmx2	4.5	m	27,024	40	1,080,960		
Siphon		7.5	Nr	1,053,558	1	1,053,558		
Siphon Pipe	450mmx2	7.5	m	40,127	40	1,605,080		
Road Crossing	Jacking(675mm)		m	240,000	30	7,200,000		
TOTAL	Sewer Main + Lateral				31,961	777,683,044		
	Sewer Main				22,661			

Manhole Span	50	m	
Manhole Type	150 to 600 mm		Type 1
	700 to 900 mm		Type 2
	900 to 1200 mm		Type 3

Numbers of Service Connections

		Kandy	Reference
Size of Family (people/house)		6.65	
M/P Population (2015)		54,985	
Domestic (No. of Houses)		8,268	
Total (No. of houses)		12,402	Domestic x 1.5
F/S Population (2005)		19,262	
Domestic (No. of Houses)		2,897	
Total (No. of Connections)		5,794	Domestic x 2

Appendix 12.7 Unit Cost

Appendix 12.7.1 Unit Cost of Civil Works

[ ] are used for cost estimate.

Item		NWSDB Rate '97		Towns South - Ground Reservoir			Towns South - Pumping Station			Applied	Adjusted
			Overhead 20%	Local (Rs)	Forign(Yen)	Total (Rs)	Local (Rs)	Forign(Yen)	Total (Rs)		
1. Excavation											
Bulldozer (incl. Backfilling)		(Basement)	(Basement)								490.00
Backfoe (incl. Backfilling)		(Pit/Trench)	(Pit/Trench)	(150 mm)			(225 mm)				790.00
Rock excavation	m^3	1,469.00	1,763.00	69.00	544.38	371.43	1,716.00	195.27	1,824.48	1,808.99	1,990.00
2. Earth Filling											430.00
earth available at site	m^3	141.00	169.00							169.00	190.00
earth to be borrowed	m^3	324.00	389.00							389.00	430.00
3. Soil Disposal											310.00
On site	m^3	68.00	82.00							68.00	80.00
Off site	m^3	232.00	278.00							278.00	310.00
4. Piling											
On site 600 mm dia.	m			1,824.81	14,399.00	9,824.25				9,824.25	10,810.00
5. Concrete Work											7,840.00
Grade 10											
Foundations	m^3	3,743.00	4,492.00	76.07	600.18	409.50	514.80	58.58	547.34	7,123.19	
Grade 20/30		(Grade 20)		(Grade 30)			(Grade 30)			8,658.97	9,530.00
Columns	m^3	4,868.00	5,842.00	1,820.50	14,362.89	9,799.88	6,864.00	781.07	7,297.93	8,659.97	9,530.00
6. Form Work										960.43	1,060.00
7. Reinforcement										66,328.41	72,970.00
Tor steel		50,220.00	60,264.00	13,510.53	106,591.98	72,728.30	62,920.00	7,159.76	66,897.64	66,329.41	72,970.00
Mild steel	ton	46,920.00	56,304.00	11,312.83	89,253.07	60,897.87	62,920.00	7,159.76	66,897.64	66,329.41	72,970.00
8. Building											
Offices 2F, 126 m^2	m^2	9,600.00	11,520.00	13,494.97	1,535.61	14,348.09				14,226.22	15,700.00
Operating houses	m^2	8,600.00	10,320.00								20,000.00
Pumping Station BF, 181m^2							31,855.72	3,624.91	33,869.56	33,581.87	37,000.00
Chlorine House 1F, 24m^2	m^2			17,014.23	1,973.50	18,110.62				17,953.99	19,800.00
Store houses 1F, 24m^2	m^2	8,200.00	9,840.00	18,950.98	2,156.46	20,149.01				19,977.86	22,000.00
Quarters 1F, 100m^2	m^2			17,496.47	1,971.32	18,591.64				18,435.19	20,300.00
9. Pavement											
Reinstatement	m^2	-	-	206.58	1,629.82	1,112.04	(Actual payment to RDA Rs. 2000.00)			2,000.00	2,000.00
10. Miscellaneous											
Miscellaneous	%	-	-								5 to 20 %

Appendix 12.7.2 Unit Cost of Piping Materials

[ ] are used for cost estimate.

Diameter (mm)		NWSDB Rate '97		Beire Lake	Manufacturer	Towns South				Applied	Adjusted
		Rs/m	Overhead 20%	Rs/m	Rs/m	Local (Rs)	Forign(Yen)	C. D. (Rs)	Total (Rs)		
1. Water Supply											
DIP		(CIF+C.D.)									
200	mm	2,647.48	3,177.00								3,500.00
250	mm	2,981.44	3,578.00			65.58	6,467.59	661.72	3,807.10	3,807.10	4,190.00
300	mm	3,794.56	4,553.00			82.79	8,165.06	835.39	4,806.30	4,806.30	5,290.00
350	mm	4,537.50	5,445.00			103.27	10,234.03	1,041.95	6,018.57	6,018.57	6,630.00
400	mm	5,324.00	6,389.00			137.05	13,515.35	1,382.79	7,955.72	7,955.72	8,760.00
450	mm	6,352.50	7,623.00			144.09	14,210.53	1,453.92	8,364.93	8,364.93	9,210.00
500	mm	7,292.67	8,751.00			193.08	19,041.13	1,948.15	11,208.43	11,208.43	12,330.00
600	mm	9,075.00	10,890.00			223.43	22,034.08	2,254.36	12,970.21	12,970.21	14,270.00
700	mm	11,918.50	14,302.00								20,000.00
800	mm	14,762.00	17,714.00			462.19	45,580.63	4,663.47	26,830.72	26,830.72	29,520.00
900	mm	15,851.00	19,021.00								35,000.00
PVC (type 600)											(type 600)
63	mm	50.00	60.00			55.95	55.18		82.23	82.23	100.00
75	mm	78.00	94.00							114.78	130.00
90	mm	118.00	142.00			109.75	108.23		161.29	161.29	180.00
110	mm	173.00	208.00			161.15	158.93		236.83	236.83	270.00
160	mm	340.00	408.00			340.35	335.65		500.18	500.18	560.00
225	mm	655.00	786.00			667.15	657.94		980.45	980.45	1,080.00
2. Sewerage											
PVC (type 600)					(type 400)	(type 600)					(type 600)
110	mm	173.00	208.00			161.15	158.93		236.83	236.83	270.00
160	mm	340.00	408.00		786.95	340.35	335.65		500.18	500.18	510.00
225	mm	655.00	786.00		1,496.80	667.15	657.94		980.45	980.45	990.00
280	mm	1,013.00	1,216.00		2,294.65					2,294.65	2,300.00
315	mm				2,888.02					2,888.02	2,890.00
Hume Pipe											
150	mm	352.00	422.00		198.39						
225	mm	497.00	596.00		273.13						
250	mm										
300	mm	660.00	792.00		355.25					792.00	800.00
375	mm	900.00	1,080.00		516.73					1,080.00	1,080.00
400	mm										
450	mm	995.00	1,194.00		611.31	2,577.99	1,307.04		3,200.39	1,194.00	1,200.00
500	mm										
544	mm					4,124.78	2,091.26		5,120.62	(with inner lining)	
600	mm	1,386.00	1,663.00		847.07					1,663.00	1,670.00
675	mm			5,960.00						5,960.00	5,960.00
750	mm	1,868.00	2,242.00	6,790.00	1,092.52					6,790.00	6,790.00
825	mm			7,630.00	1,093.52					7,630.00	7,630.00
900	mm	2,542.00	3,050.00		1,495.76					3,660.00	3,660.00
1050	mm	3,300.00	3,960.00		3,820.13					4,752.00	4,760.00
Clay Pipe											
150	mm	410.00	492.00	730.88						730.88	740.00
225	mm	648.00	778.00	1,789.84						1,789.84	1,790.00
250	mm										
300	mm	1,235.00	1,482.00	4,464.66						4,464.66	4,470.00
400	mm			8,578.39						8,578.39	8,580.00
450	mm			9,959.28						9,959.28	9,960.00
500	mm			12,457.10						12,457.10	12,460.00
600	mm			24,476.30						24,476.30	24,480.00

Note : 1. For transmission mains of water supply, 20 % of the cost of pipes shall be add to compensate the cost of specials,valves etc.

2. For diatribution mains of water supply, 35 % of the cost of pipes shall be add to compensate the cost of specials,valves etc.

Appendix 12.7.3 Unit Cost of Pipe Laying

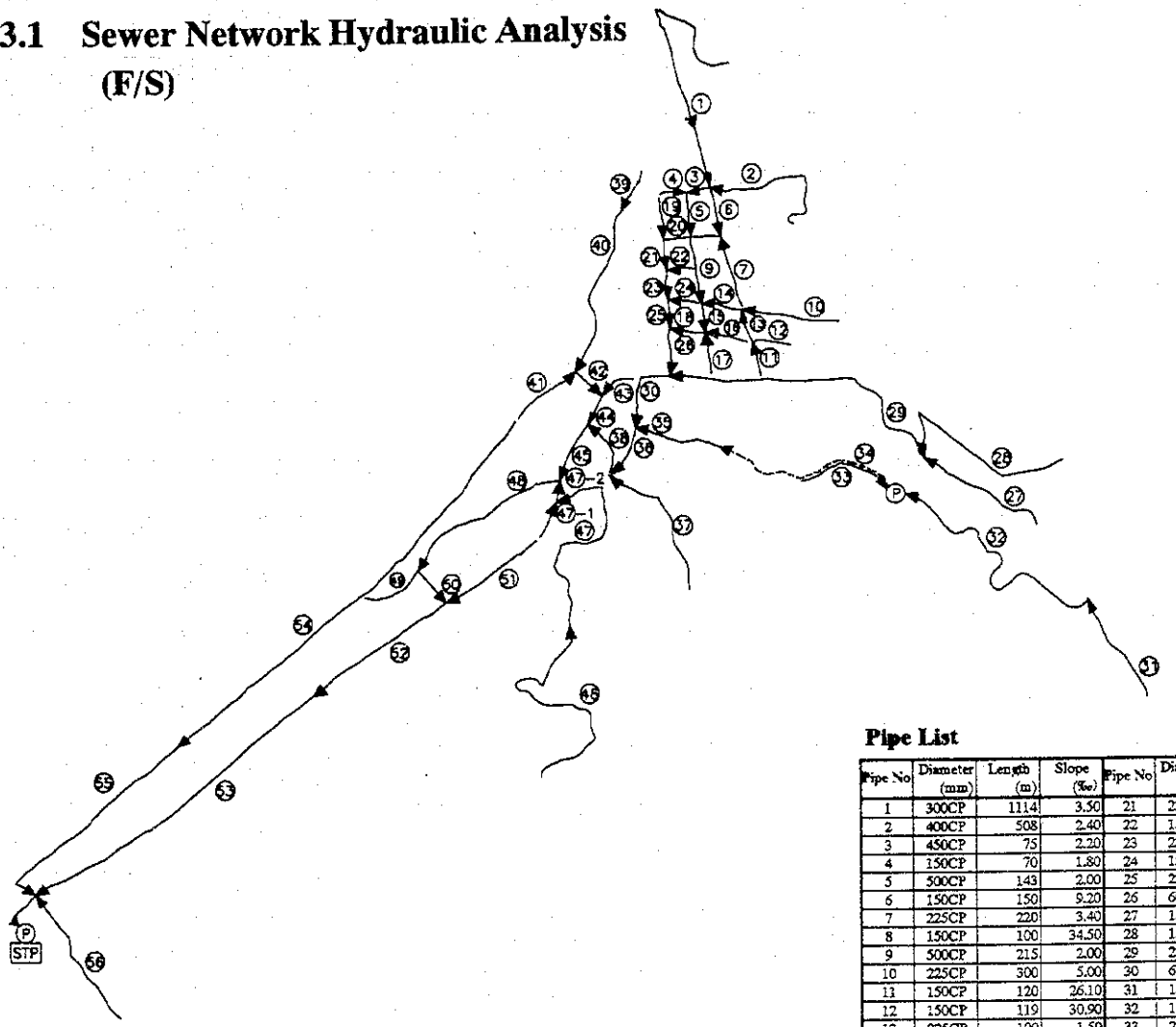
[ ] are used for cost estimate.

Diameter (mm)		NWSDB Rate '97		Towns South			Japan	Sri Lanka	Applied	Adjusted
		Rs/m	Overhead 20%	Local (Rs)	Forign(Yen)	Total (Rs)	Man-Day	Rs/m		
1. Laying									(only Pipe Laying)	
DIP		(with 1 to 2m excavation, backfilling etc.)								
200	mm	559.00	671.00				0.18	124.60	124.60	125.00
250	mm	580.00	696.00	100.06	789.40	475.96	0.22	154.00	154.00	154.00
300	mm	698.00	838.00	105.58	832.96	502.23	0.26	182.70	182.70	183.00
350	mm	740.00	888.00	123.73	976.16	588.57	0.32	222.60	222.60	223.00
400	mm	795.00	954.00	129.25	1,019.72	614.83	0.38	269.03	269.03	270.00
450	mm	852.00	1,022.00	149.53	1,180.10	711.48	0.45	316.87	316.87	317.00
500	mm	942.00	1,130.00	258.50	2,039.45	1,229.67	0.52	365.40	365.40	366.00
600	mm	1,077.00	1,292.00				0.66	463.87	463.87	464.00
700	mm	1,234.00	1,481.00				0.80	562.33	562.33	563.00
800	mm	1,395.00	1,674.00	385.00	3,037.48	1,831.42	0.96	672.00	672.00	672.00
900	mm	1,578.00	1,894.00				1.09	765.10	765.10	766.00
PVC		(only Pipe Laying)		(with 1 to 2m excavation, backfilling etc.)						
63	mm	11.76	14.00	29.04	229.11	138.14	0.04	30.10	30.10	31.00
75	mm	11.76	14.00	29.04	229.11	138.14	0.04	30.10	30.10	31.00
90	mm	13.94	17.00	29.04	229.11	138.14	0.06	39.90	39.90	40.00
110	mm	15.00	18.00	34.98	275.98	166.40	0.06	39.90	39.90	40.00
160	mm	15.00	18.00	38.94	307.22	185.24	0.07	51.80	51.80	52.00
225	mm	18.15	22.00	40.04	315.90	190.47	0.10	72.80	72.80	73.00
280	mm	18.74	22.00				0.14	98.00	98.00	98.00
315	mm						0.17	119.00	119.00	119.00
Hume Pipe/Clay Pipe		(with excavation, backfilling)		(depth is unknown)						
150	mm	134.00	161.00				0.32	224.00	112.00	112.00
225	mm	164.00	197.00				0.40	277.20	138.60	139.00
250	mm						0.46	319.20	159.60	160.00
300	mm	227.00	272.00				0.53	369.60	184.80	185.00
375	mm	270.00	324.00				0.60	420.00	210.00	210.00
400	mm						0.61	428.40	214.20	215.00
450	mm	330.00	396.00	2,033.77	2,883.18	3,406.71	0.84	588.00	294.00	294.00
500	mm						0.86	604.80	302.40	303.00
544	mm			2,033.77	2,883.18	3,406.71	0.96	672.00	336.00	336.00
600	mm	410.00	492.00				1.06	744.80	372.40	373.00
675	mm						1.12	784.00	392.00	392.00
750	mm	500.00	600.00				1.15	803.60	401.80	402.00
825	mm						1.20	840.00	420.00	420.00
900	mm	650.00	780.00				1.23	862.40	431.20	432.00
1050	mm	680.00	816.00				1.34	940.80	470.40	471.00
2. Excavation										
Backfoe										790.00
(incl. Backfilling)										
3. Soil Disposal										
Off site	m^3									310.00
4. Backfilling with sand										
with sand supply	m^3									1,000.00
5. Pavement										
Reinstatement	m^2									2,000.00

Chapter 13

Appendix 13.1 Sewer Network Hydraulic Analysis (F/S)
Appendix 13.2 Trunk Sewer Profile
Appendix 13.3 Pumping Equipment - Capacity Calculation
Appendix 13.4 Sewage Treatment Plant - Capacity Calculation
Appendix 13.5 Hydraulic Calculation
Appendix 13.6 Drawings
Appendix 13.7 Storage Capacity of Sewer (Kandy)

Appendix 13.1 Sewer Network Hydraulic Analysis (F/S)



Note : 54,55,56 Excluded from F/S Area.

Pipe List

Pipe No	Diameter (mm)	Length (m)	Slope (‰)	Pipe No	Diameter (mm)	Length (m)	Slope (‰)	Pipe No	Diameter (mm)	Length (m)	Slope (‰)
1	300CP	1114	3.50	21	225CP	100	1.50	41	150CP	250	21.20
2	400CP	508	2.40	22	150CP	90	15.80	42	300CP	100	3.50
3	450CP	75	2.20	23	225CP	95	5.00	43	150CP	250	13.60
4	150CP	70	1.80	24	150CP	100	11.20	44	300CP	80	3.50
5	500CP	143	2.00	25	225CP	92	5.00	45	675CP	200	1.40
6	150CP	150	9.20	26	600CP	152	1.60	46	225CP	1022	5.00
7	225CP	220	3.40	27	150CP	500	1.50	47	300CP	808	3.50
8	150CP	100	34.50	28	150CP	550	39.90	47-1	150CP	130	41.80
9	500CP	215	2.00	29	225CP	1000	5.00	47-2	300CP	70	3.50
10	225CP	300	5.00	30	675CP	270	1.40	48	675CP	450	1.40
11	150CP	120	26.10	31	150CP	350	31.00	49	150CP	294	28.50
12	150CP	119	30.90	32	150CP	900	3.40	50	750CP	150	1.20
13	225CP	100	1.50	33	225CP	500	1.50	51	150CP	350	25.60
14	300CP	130	3.50	34	100CP	650	0.01	52	825CP	500	1.20
15	600CP	95	1.60	35	150CP	269	50.00	53	825CP	1100	1.20
16	150CP	143	44.70	36	675CP	100	1.40	54	400CP	1500	2.40
17	150CP	140	40.60	37	150CP	580	7.30	55	400CP	650	2.40
18	600CP	120	1.60	38	675CP	70	1.40	56	225CP	450	5.00
19	150CP	126	31.90	39	225CP	198	5.00	57	825CP	50	1.20
20	150CP	93	1.50	40	300CP	550	3.50				

Sewage Flow Calculation Table (Kandy)

※Unit Sewage Flow : 0.324m3/capita·day

Pipe No.	Down stream	Service Area Sec.	Service Area Accum.	Length Sec.	Length Accum.	T	Storm Run-off Rainfall per ha	C	Storm Run-off Service Area Sec.	Storm Run-off Service Area Accum.	R.O.	Sewage Flow Pop/D	Sewage Flow Population Sec.	Sewage Flow Population Accum.	Sewage Flow Flow	Other Flow Sec.	Other Flow Accum.	Accum.	Design Sewer Dia.	Slope	V	Flow	G.L.	Level	D	Remarks
		ha	ha	m	m	min	m3/s·ha		ha	ha	m3/s	P/ha	P	P	m3/s	m3/s	m3/s	m3/s	mm	‰	m/s	m3/s	M	M	m	
1	3	499	499	1114	1114								3742	3742	00140	001143	001143	00254	ϕ 300	350	0809	00572	53550	533314	185	
																							50814	506804	100	
2		123	123	508	508								307	307	00012	003796	003796	00392	ϕ 400	240	0812	01020	54357	535567	756	
																							50814	505694	100	
3	5		622	75	1189									4049	00152	000086	005025	00655	ϕ 450	220	0841	01337	50814	505890	175	
																							50726	505725	104	
4				70	70											000086	000086	00009	ϕ 150	180	0368	00065	50739	506215	100	
																							50726	506089	100	
5	9		622	143	1332									4049	00152	000129	005240	00676	ϕ 500	200	0860	01689	50726	502980	372	
																							50297	501414	100	
7	8			220	220											000453	000453	00045	ϕ 225	340	0658	00262	50750	506252	100	
																							50675	505502	100	
6				150	150											000151	000151	00015	ϕ 150	920	0827	00146	50814	506631	134	
																							50675	505251	133	
8				100	320											000173	000777	00078	ϕ 225	3450	2098	00834	50975	505172	133	
																							50297	501722	100	
9	15		622	215	1547									4049	00152	000151	006168	00769	ϕ 500	200	0860	01689	50297	501414	100	
																							50134	500284	100	
10	14	227	227	300	300								385	385	00014	001035	001035	00118	ϕ 225	500	0799	00318	51100	509085	167	
																							50750	506252	100	

A-13.1-2

Sewage Flow Calculation Table (Kandy)

※Unit Sewage Flow : 0.324m3/capita·day

Pipe No.	Down stream	Service Area Sec.	Service Area Accum.	Length Sec.	Length Accum.	T	Storm Run-off: Rainfall per ha	C	Service Area Sec.	Service Area Accum.	R.O.	Sewage Flow: Pop/D	Population Sec.	Population Accum.	Flow	Other Flow Sec.	Other Flow Accum.	Accum.	Design Sewer: Dia.	Slope	V	Flow	G.L.	Level	D	Remarks
		ha	ha	m	m	min	m3/s·ha		ha	ha	m3/s	P/ha	P	P	m3/s	m3/s	m3/s	m3/s	mm	‰	m/s	m3/s	M	M	m	
11	13			120	120											00012	00012	00013	ϕ 150	2610	1392	00246	51064 50750	509074 505942	140 139	
12				119	119											00010	00010	00011	ϕ 150	3090	1515	00268	51118 50750	510009 505329	100 100	
13				100	220											00012	00036	00037	ϕ 225	150	0437	00174	50750 50750	505867 505717	139 154	
14			227	130	430									385	00014	00021	00161	00176	ϕ 300	350	0809	00572	50750 50184	503868 500504	330 100	
15	18		849	95	1642									4434	00166	00012	00791	00957	ϕ 600	160	0869	02456	50184 50153	500013 499861	116 100	
16	18			142	143											00015	00015	00015	ϕ 150	4470	1822	00322	50793 50153	506413 499887	135 147	
17				140	140											00015	00015	00015	ϕ 150	4060	1736	00307	50722 50153	505804 500015	125 134	
18	26		849	120	1762									4434	00166	00012	00834	01001	ϕ 600	160	0869	02456	50153 50004	498797 498371	206 100	
19	21			126	126											00015	00015	00015	ϕ 150	3190	1539	00272	50739 50336	505834 501614	159 138	
20				93	93											00008	00008	00009	ϕ 150	150	0334	00059	50297 50336	499034 498895	377 429	
21	23			100	226											00025	00049	00050	ϕ 225	150	0437	00174	50336 50177	498820 498570	429 285	

Sewage Flow Calculation Table (Kandy)

※Unit Sewage Flow : 0.324m3/capita·day

Pipe No.	Down stream	Service Area Sec.	Service Area Accum.	Length Sec.	Length Accum.	T	Storm Run-off Rainfall per ha	C	Storm Run-off Service Area Sec.	Storm Run-off Service Area Accum.	R.O.	Sewage Flow Pop/D	Sewage Flow Population Sec.	Sewage Flow Population Accum.	Sewage Flow Flow	Other Flow Sec.	Other Flow Accum.	Accum.	Design Sewer Dia.	Slope	V	Flow	G.L.	Level	D	Remarks
		ha	ha	m	m	min	m3/s-ha		ha	ha	m3/s	P/ha	P	P	m3/s	m3/s	m3/s	m3/s	mm	‰	m/s	m3/s	M	M	m	
22				90	90											000108	000108	00011	ϕ 150	1580	1083	00191	50320 50177	502021 500599	101 100	
23	25			95	321											000302	000906	00091	ϕ 225	500	0799	00318	50177 50072	498670 498195	285 228	
24				100	100											000086	000086	00009	ϕ 150	1120	0912	00161	50184 50072	500543 499423	113 113	
25				92	413											000324	001316	00132	ϕ 225	500	0799	00318	50072 50004	498195 497735	228 206	
26	30		849	152	1914									4434	00166	000302	009963	01162	ϕ 600	160	0869	02456	50004 50185	497360 497116	201 407	
28	29	590	590	550	550								1173	1173	00044			00044	ϕ 150	3990	1721	00304	53443 51248	533258 511309	100 100	
27		101	101	500	500								244	244	00009			00009	ϕ 150	150	0334	00059	51265 51248	511316 510484	116 183	
29		191	882	1000	1550								365	1782	00067	000388	000388	00106	ϕ 225	500	0799	00318	51243 50185	510409 500602	182 100	
30	36	97	1748	270	2184								43	6259	00235	000086	010437	01279	ϕ 675	140	0879	03145	50185 49979	497041 496463	408 259	
31		113	113	350	350								68	68	00003			00003	ϕ 150	3100	1517	00268	52688 51900	525709 514829	100 100	
32	34	352	465	900	1250								760	828	00031			00031	ϕ 150	340	0503	00089	51600 51287	513476 509161	235 354	

Sewage Flow Calculation Table (Kandy)

※Unit Sewage Flow : 0.324m3/capita-day

Pipe No.	Down stream	Service Area Sec.	Service Area Accum.	Length Sec.	Length Accum.	T	Storm Run-off Rainfall per ha	C	Storm Run-off Service Area Sec.	Storm Run-off Service Area Accum.	R.O.	Sewage Flow Pop/D	Population Sec.	Population Accum.	Flow	Other Flow Sec.	Other Flow Accum.	Accum.	Design Sewer Dia.	Slope	V	Flow	G.L.	Level	D	Remarks
		ha	ha	m	m	min	m3/s·ha		ha	ha	m3/s	P/ha	P	P	m3/s	m3/s	m3/s	m3/s	mm	‰	m/s	m3/s	M	M	m	
33		336	336	500	500								1043	1043	00039			00039	ø 225	150	0437	00174	51261 51287	511272 510477	109 215	
34			801	650	1900									1871	00070			00070	ø 100	001	0021	00002	51287 51422	511140 513110	152 100	Pumping Station
35		79	880	269	2169								218	2089	00078			00078	ø 150	5000	1927	00341	51422 49979	511463 495869	259 375	
36	38	09	2637	100	2284								141	8489	00318		010437	01362	ø 675	140	0879	03145	49979 49674	495147 495007	391 100	
37		110	110	580	580								360	360	00014			00014	ø 150	730	0736	00130	50100 49674	499825 495569	100 100	
38	45	06	2753	70	2354								38	8887	00333		010437	01377	ø 675	140	0879	03145	49674 49545	493815 493717	219 100	
39		126	126	198	198								2810	2810	00105			00105	ø 225	500	0799	00318	52377 51337	520889 512122	263 100	
40	42	384	510	550	748								2383	5193	00195			00195	ø 300	350	0809	00572	51337 49913	506922 496911	611 188	
41		315	315	250	250								2239	2239	00084			00084	ø 150	2120	1255	00222	50444 49913	503269 497959	100 100	
42	44	17	842	100	848								106	7538	00283			00283	ø 300	350	0809	00572	49913 49639	495382 495032	341 102	
43		12	12	250	250								49	49	00002			00002	ø 150	1360	1005	00178	49981 49639	498399 494999	124 122	

Sewage Flow Calculation Table (Kandy)

※Unit Sewage Flow : 0.324m3/capita·day

Pipe No.	Down stream	Service Area Sec.	Service Area Accum.	Length Sec.	Length Accum.	T	Storm Run-off Rainfall per ha	C	Storm Run-off Service Area Sec.	Storm Run-off Service Area Accum.	R.O.	Sewage Flow Pop/D	Population Sec.	Population Accum.	Flow	Other Flow Sec.	Other Flow Accum.	Accum.	Design Sewer Dia.	Slope	V	Flow	G.L.	Level	D	Remarks
		ha	ha	m	m	min	m3/s·ha		ha	ha	m3/s	P/ha	P	P	m3/s	m3/s	m3/s	m3/s	mm	‰	m/s	m3/s	M	M	m	
44		05	859	80	928								30	7617	00286			00286	ø 300	350	0809	00572	49639 49545	488171 487891	788 722	
45	48	09	3621	200	2554								60	16564	00621		010437	01665	ø 675	140	0879	03145	49545 49154	487516 487236	720 357	
46		255	255	1022	1022								2402	2402	00090	000492	000492	00139	ø 225	500	0799	00318	53327 52780	586529 526552	649 100	
47	47-2	81	316	808	1830								834	3236	00121		000492	00170	ø 300	350	0809	00572	52780 49274	522874 491404	459 100	
47-1		04	04	130	130								23	23	00001			00001	ø 150	4180	1762	00311	49818 49274	496482 490765	153 180	
47-2		08	328	70	1900								53	3312	00124		000492	00173	ø 300	350	0809	00572	49274 49154	490449 490204	196 100	
48		48	3997	240	2794								315	20191	00757		010929	01850	ø 675	140	0879	03145	49154 48797	487236 486237	357 100	
48-1			3997	20	2814									20191	00757		010929	01850	ø 450	220	0841	01337	48797 48794	482318 482274	515 517	
48-2	50		3997	190	3004									20191	00757		010929	01850	ø 675	140	0879	03145	48794 48800	486237 485971	097 130	
49		22	22	294	294								193	193	00007			00007	ø 150	2850	1455	00257	49639 48800	495025 486551	119 128	
50	52	11	4030	150	3154								91	20475	00768		010929	01861	ø 675	140	0879	03145	48800 48919	485971 485761	130 270	
51		65	65	350	350								489	489	00018			00018	ø 150	2560	1379	00244	49818 48919	497009 488019	100 100	

A-13.1-6

Sewage Flow Calculation Table (Kandy)

※Unit Sewage Flow : 0.324m3/capita-day

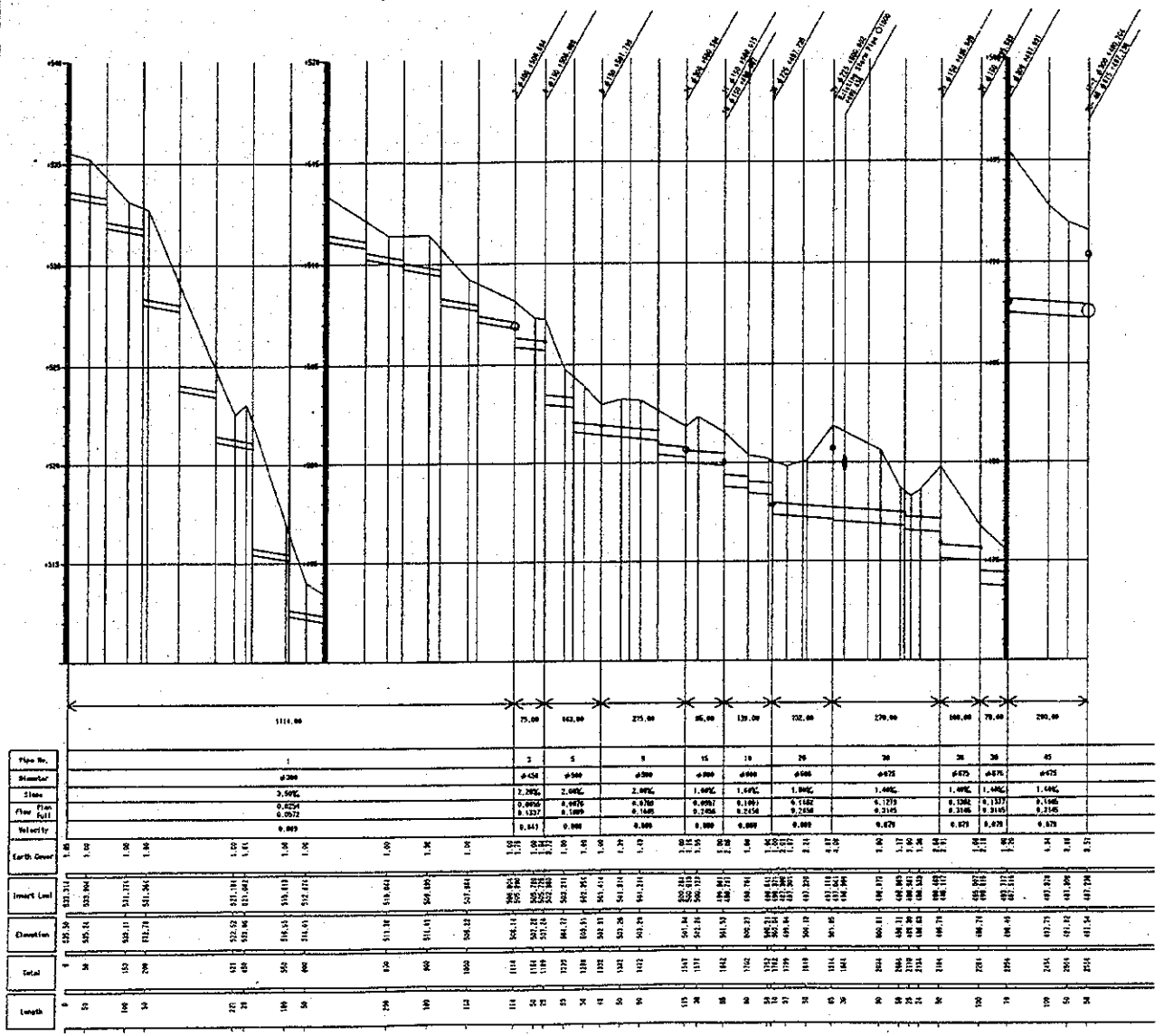
Pipe No.	Down stream	Service Area		Length		T	Storm Run-off				R.O.	Sewage Flow				Other Flow		Accum.	Design Sewer							Remarks
		Sec.	Accum.	Sec.	Accum.		Rainfall per ha	C	Service Area Sec.	Service Area Accum.		Pop/D	Population Sec.	Population Accum.	Flow	Sec.	Accum.		Dia.	Slope	V	Flow	G.L.	Level	D	
		ha	ha	m	m	min	m3/s·ha		ha	ha	m3/s	P/ha	P	P	m3/s	m3/s	m3/s	m3/s	mm	‰	m/s	m3/s	M	M	m	
52		248	4343	270	3424								2754	23718	00889		010929	01982					48919	485761	270	
																			φ 675	140	0879	03145	48577	484037	100	
52-1			4343	20	3444									23718	00889		010929	01982					48577	477781	749	
																			φ 450	220	0841	01337	48551	477737	727	
52-2			4343	210	3654									23718	00889		010929	01982					48551	481411	337	
																			φ 675	140	0879	03145	48285	481117	100	
53	57	396	4739	1100	4754								5816	29534	01108		010929	02201					48285	475114	292	
																			φ 750	130	0909	04014	47501	470817	338	
54		1155	1155	1500	1500								8473	8473	00318			00318					50444	501109	289	
																			φ 400	240	0812	01020	48777	484684	264	
55	57	479	1634	650	2150								2662	11135	00418			00418					48777	484684	264	
																			φ 400	240	0812	01020	47501	473564	100	
56		412	412	450	450								3054	3054	00115			00115					47500	473752	100	
																			φ 225	500	0799	00318	47501	466538	822	
57			6785	50	4804									43723	01640		010929	02733					47501	465938	818	To Kandy STP
																			φ 825	120	0930	04972	47300	465878	823	

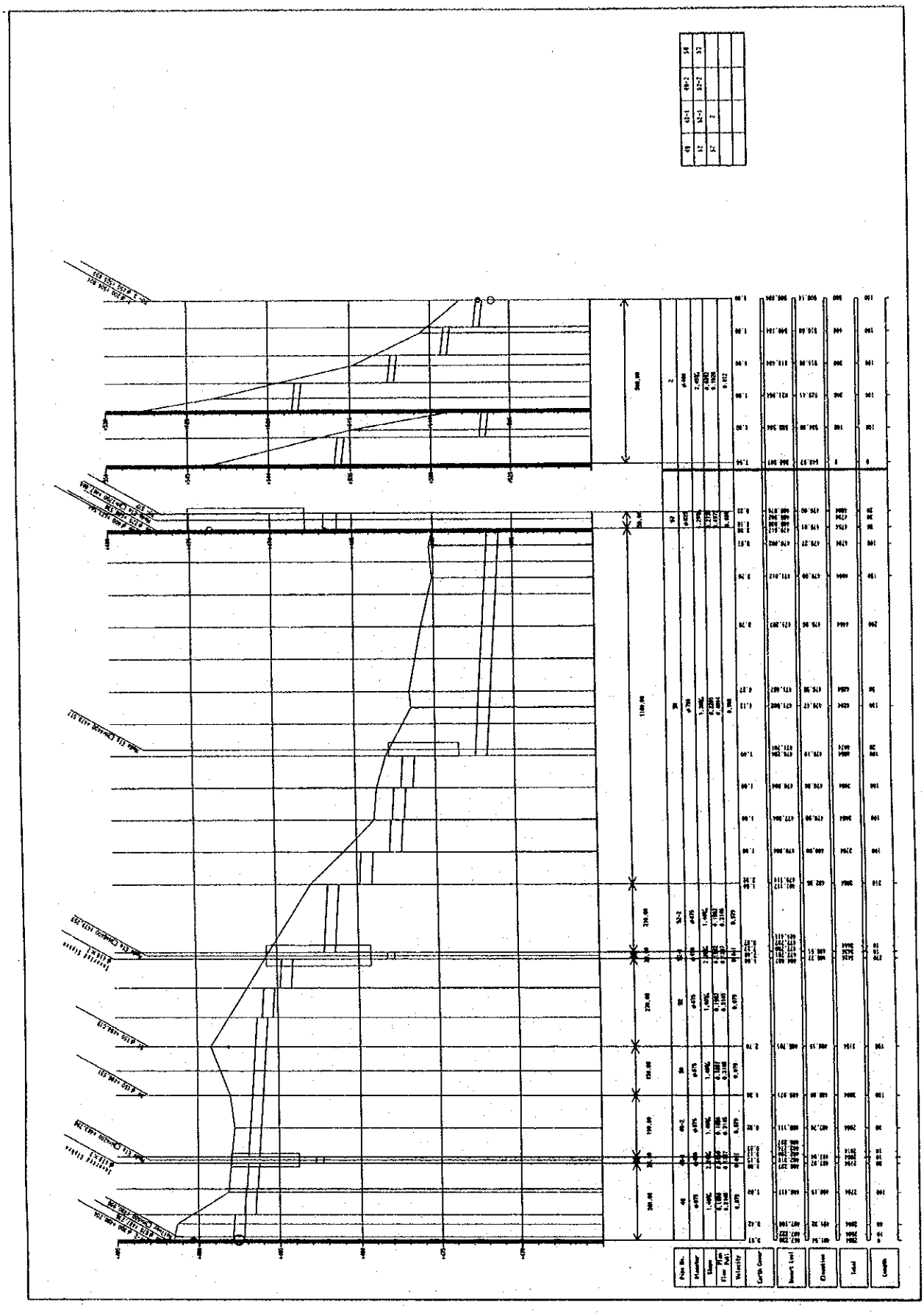
Sewage Flow Calculation Table (Katogastota)

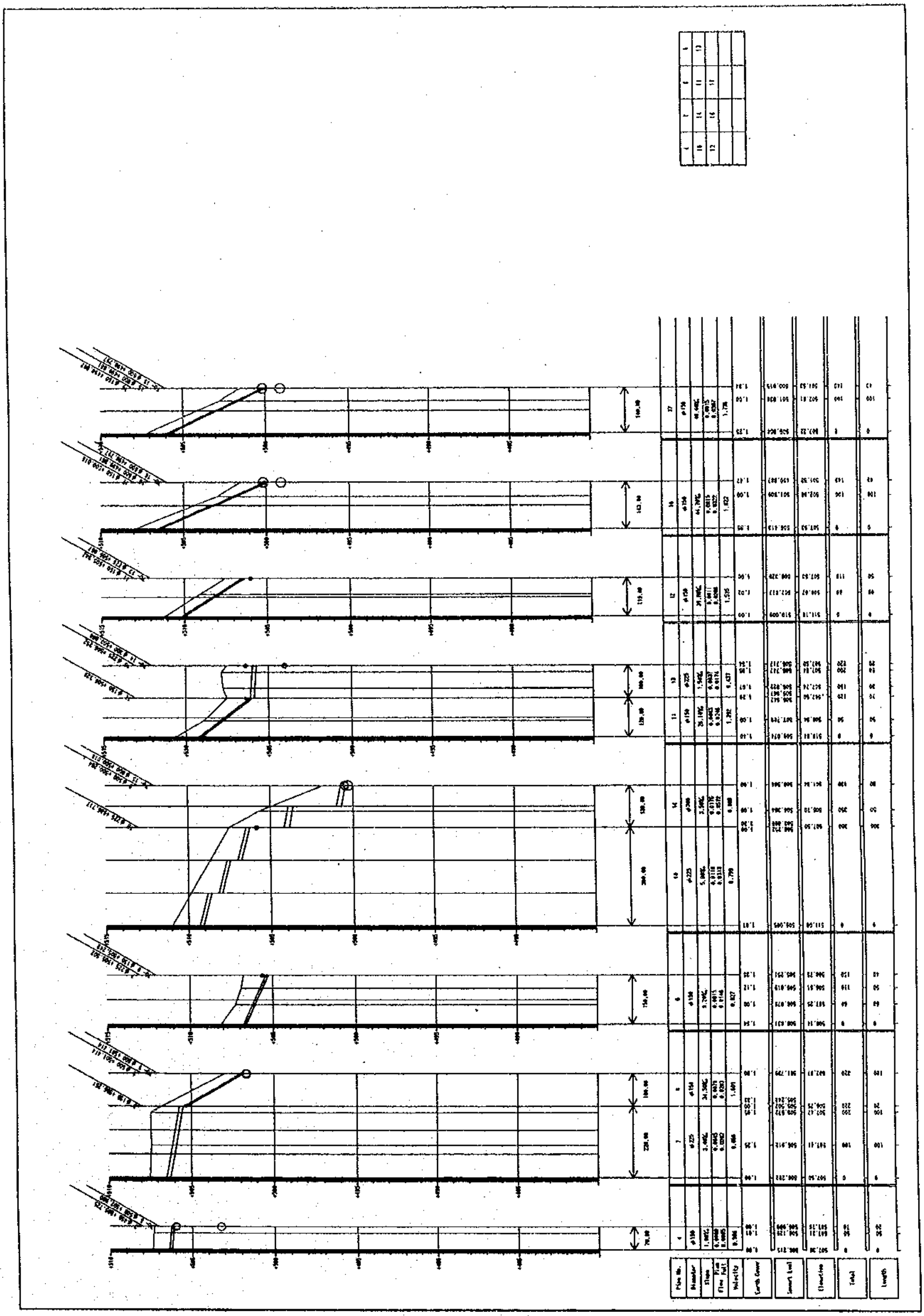
※Unit Sewage Flow : 0.324m3/capita-day

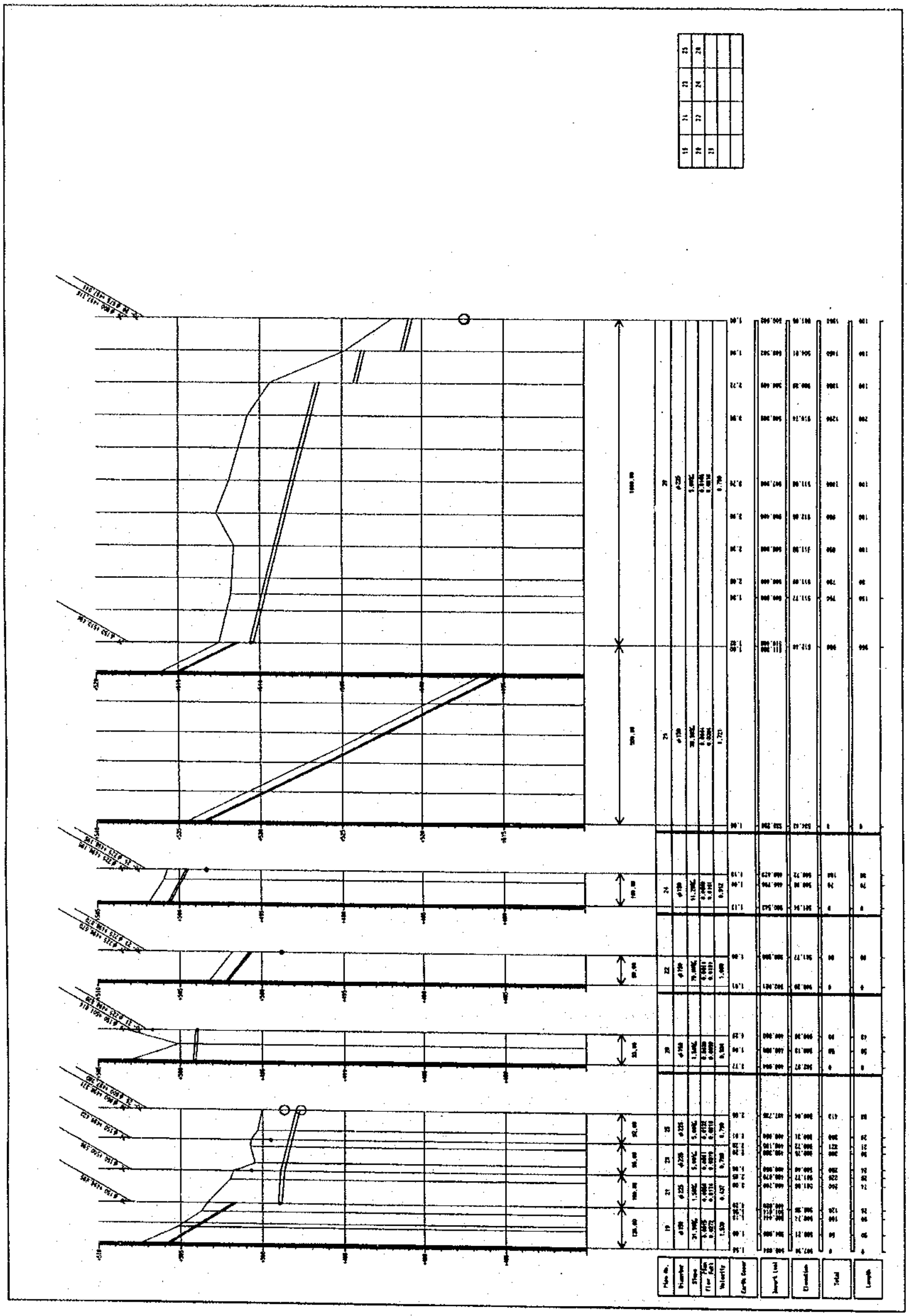
Pipe No.	Down stream	Service Area Sec.	Service Area Accum.	Length Sec.	Length Accum.	T	Storm Run-off: Rainfall per ha	C	Storm Run-off: Service Area Sec.	Storm Run-off: Service Area Accum.	R.O.	Sewage Flow: Pop/D	Sewage Flow: Population Sec.	Sewage Flow: Population Accum.	Sewage Flow: Flow	Other Flow Sec.	Other Flow Accum.	Accum.	Design Sewer: Dia.	Slope	V	Flow	G.L.	Level	D	Remarks
		ha	ha	m	m	min	m3/s-ha		ha	ha	m3/s	P/ha	P	P	m3/s	m3/s	m3/s	m3/s	mm	‰	m/s	m3/s	M	M	m	
1		311	311	620	620								5260	5260	00197			00197	ø 300	350	0809	00572	47595 47595	474614 472447	100 317	

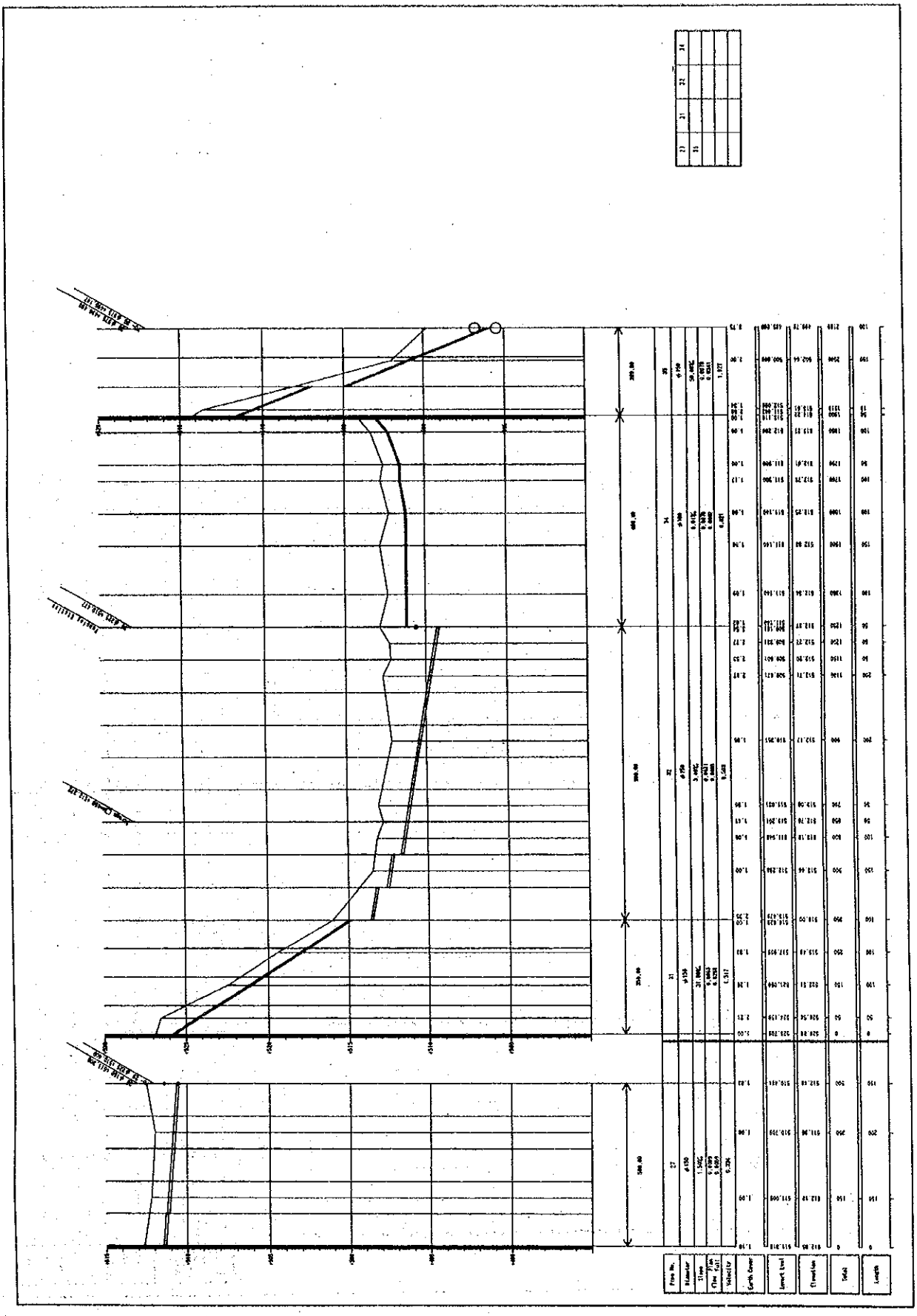
Appendix 13.2 Trunk Sewer Profile

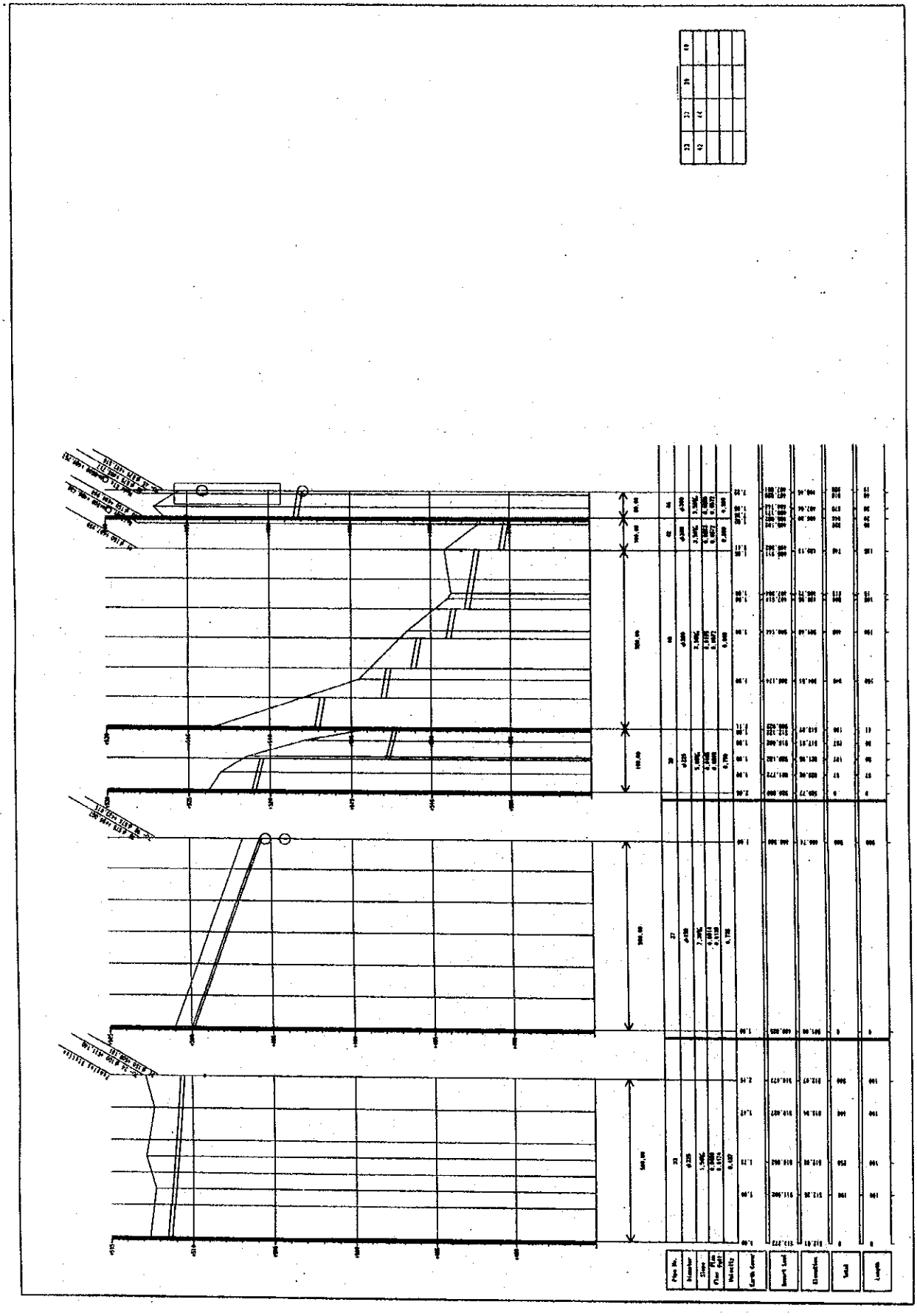


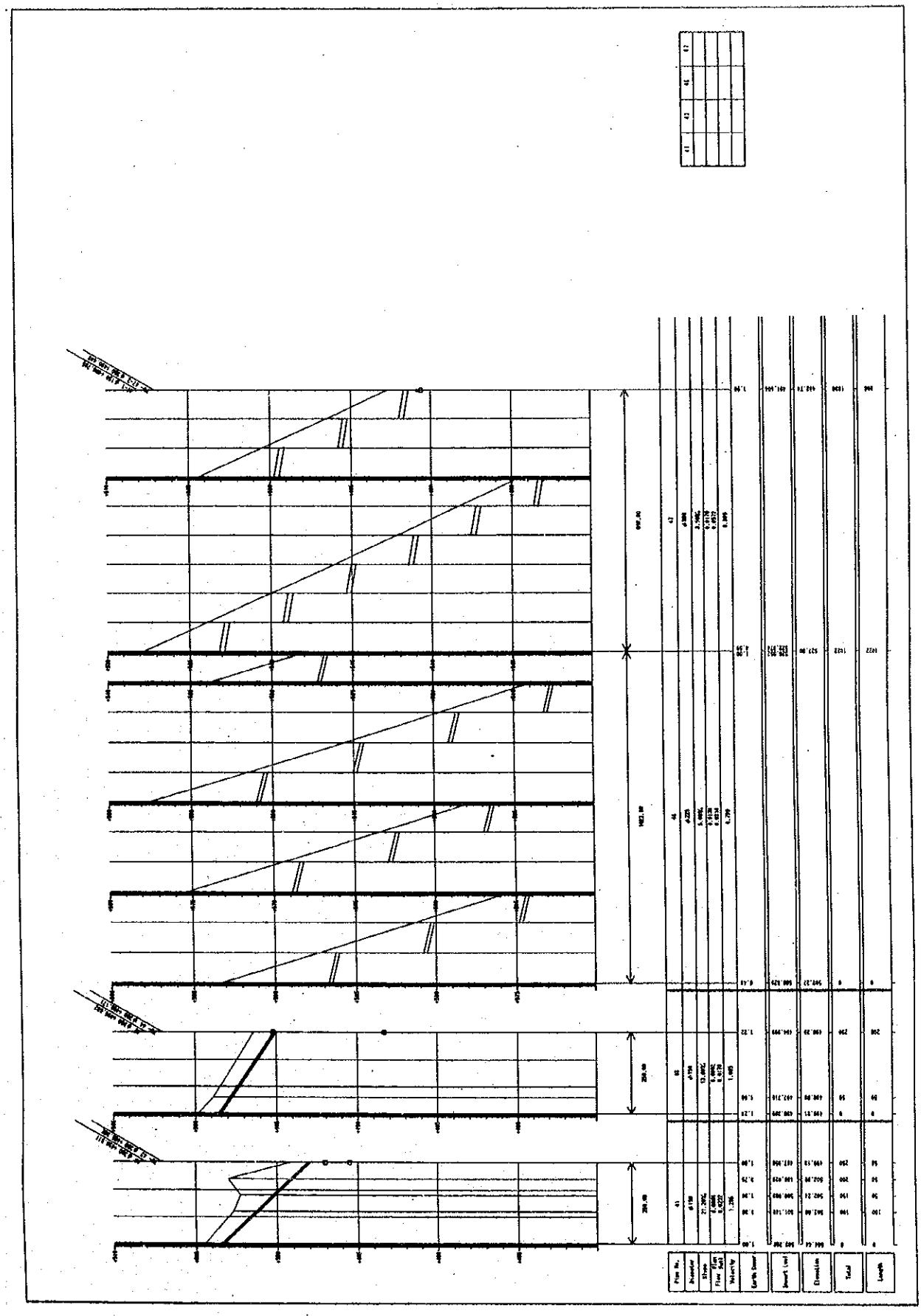


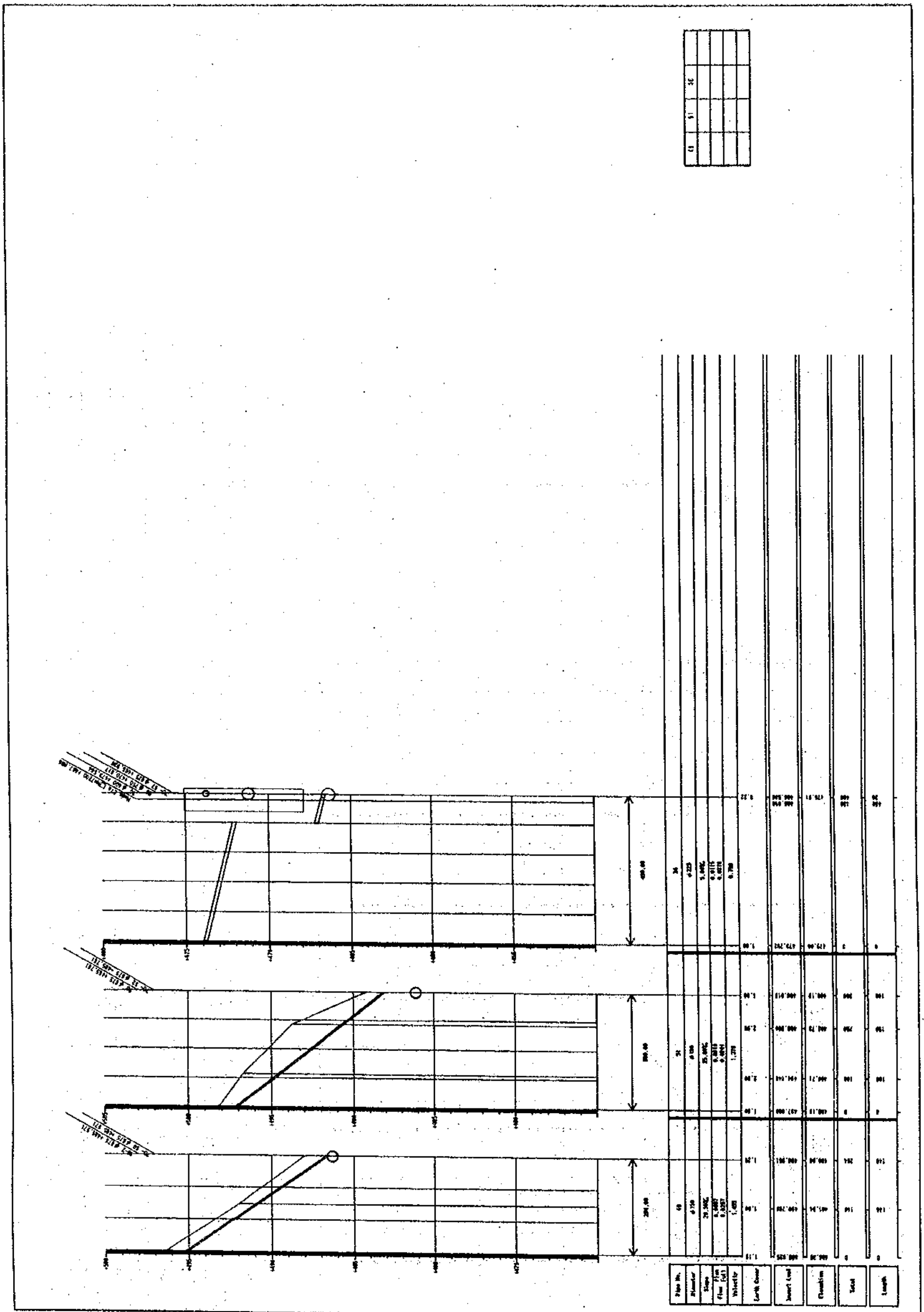


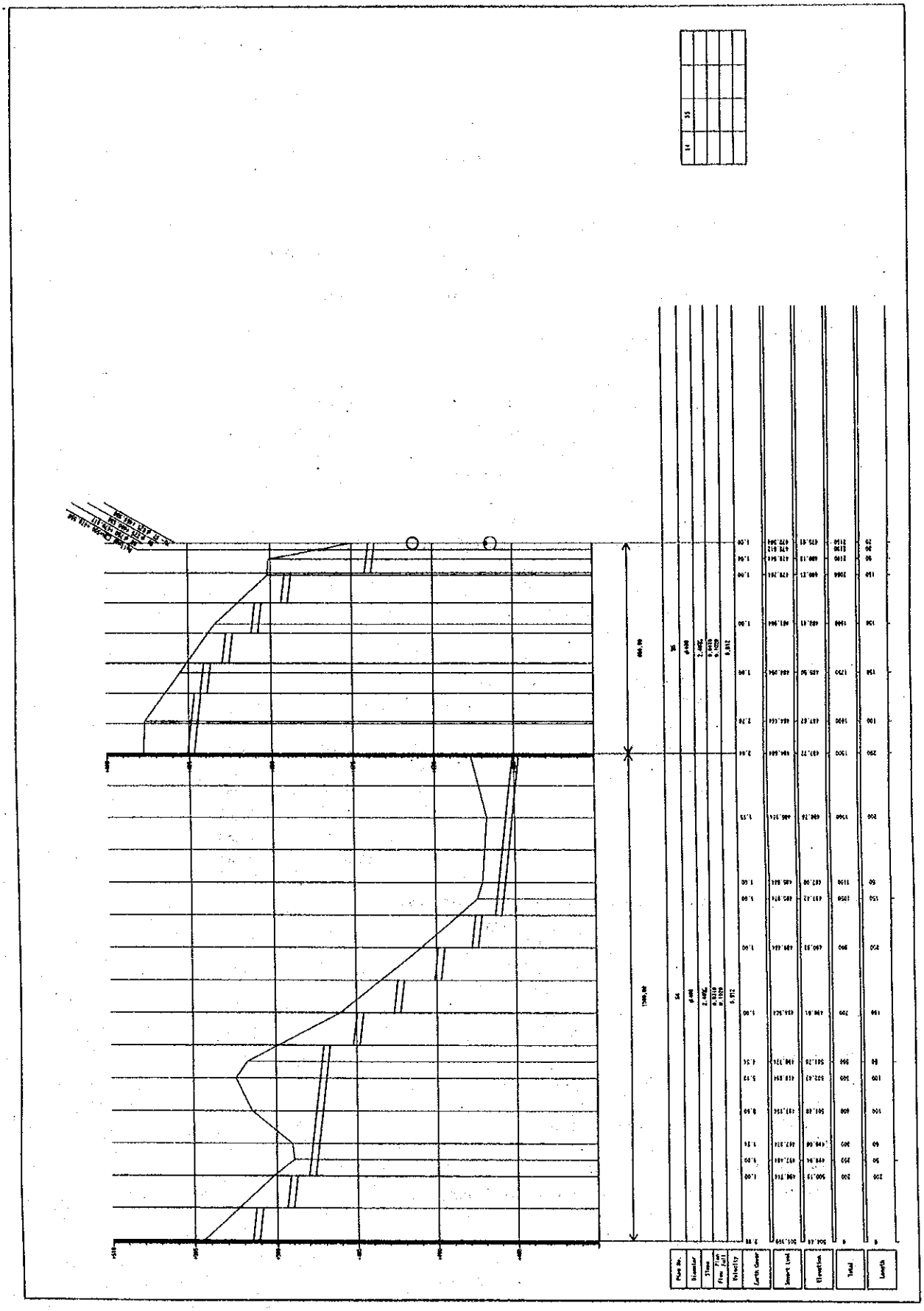












Appendix 13.3 Pumping Equipment-Capacity Caluculation
Kandy

1. Pumping Station No.2 (Kandy Lake)

Total Capacity 605 m3/day= 0.42 m3/min
Quantity of pump 1 sets + 1 set for stand-by
Pump Capacity 605 m3/day
Q = 0.420 m3/min
q = 0.0070 m3/sec

Diameter
Diameter = 146*(Q/v)^(1/2)
= 77 mm to 55 mm
= 65 mm
where,v= 1.50 to 3.00

Total Head
Total Head H=h1+h2+h3= 12.3 m
= 14.0 m
actual head h1 = hd - hs = 4.45 m
suction level hs= 508.66 m
delivery level hd= 513.11 m
friction loss (Hazen Williams) :straight pipe
h2 = 10.666*c^-1.85*D^-4.87*q^1.85*L
= 6.51 m
where, c= 130
D = 100 mm dia /1000
L = 650 m
(v= 0.892 m/sec)
friction loss : fittings
h3 = f * (v ^ 2 / 2 * g)
= 1.34 m
where, v = 2.11 m/sec

where,	Q'ty	f/pc	f
check valve	1	1.50	1.50
sluice valve	2	0.10	0.20
increase	0	0.15	0.00
90deg	5	0.18	0.90
tee	2	1.15	2.30
outlet	1	1.00	1.00
		total	5.90

Motor Output
Motor Output = (0.163*r*Q*H/e)*(1+a)
= 1.8 kW
= 2.2 kW
where,r= 1.00
e= 0.60
a= 0.15

Specification

Type	Submersible Sewage Pump
Diameter	65 mm
Capacity	0.42 m3/min
Head	14.0 m
Motor Output	2.2 kW
Quantity	1 sets + 1 set for standby

2. Sewage Treatment Plant (Large)

Total Capacity 23,613 m3/day= 16.40 m3/min
Quantity of pump 2 sets + 1 set for stand-by
Pump Capacity 11,807 m3/day
Q = 8.199 m3/min
q = 0.1366 m3/sec

Diameter
Diameter = 146*(Q/v)^(1/2)
= 341 mm to 241 mm
= 250 mm
where,v= 1.50 to 3.00

Total Head
Total Head H=h1+h2+h3= 12.2 m
= 14.0 m
actual head h1 = hd - hs = 9.62 m
suction level hs= 465.38 m
delivery level hd= 475.00 m
friction loss (Hazen Williams) :straight pipe
h2 = 10.666*c^-1.85*D^-4.87*q^1.85*L
= 0.29 m
where, c= 130
D = 450 mm dia /1000
L = 50 m
(v= 1.718 m/sec)
friction loss : fittings
h3 = f * (v ^ 2 / 2 * g)
= 2.33 m
where, v = 2.78 m/sec

where,	Q'ty	f/pc	f
check valve	1	1.50	1.50
sluice valve	2	0.10	0.20
increase	0	0.15	0.00
90deg	5	0.18	0.90
tee	2	1.15	2.30
outlet	1	1.00	1.00
		total	5.90

Motor Output
Motor Output = (0.163*r*Q*H/e)*(1+a)
= 35.9 kW
= 37.0 kW
where,r= 1.00
e= 0.60
a= 0.15

Specification

Type	Submersible Sewage Pump
Diameter	250 mm
Capacity	8.2 m3/min
Head	14.0 m
Motor Output	37 kW
Quantity	2 sets + 1 set for standby

3. Sewage Treatment Plant (Small)

Total Capacity		23,613	m3/day=	16.40	m3/min
Quantity of pump		4	sets + 1 set for stand-by		
Pump Capacity		5,903	m3/day		
	Q =	4.099	m3/min		
	q =	0.0683	m3/sec		

Diameter

Diameter = 146*(Q/v)^(1/2)
= 241 mm to 171 mm
= 200 mm
where,v= 1.50 to 3.00

Total Head

Total Head H=h1+h2+h3= 11.3 m
= 14.0 m
actual head h1 = hd - hs = 9.62 m
suction level hs= 465.38 m
delivery level hd= 475.00 m
friction loss (Hazen Williams) :straight pipe
h2 = 10.666*c^-1.85*D^-4.87*q^1.85*L
= 0.29 m
where, c= 130
D = 450 mm dia /1000
L = 50 m
(v= 1.718 m/sec)
friction loss : fittings
h3 = f * (v ^ 2 / 2 * g)
= 1.42 m
where, v = 2.17 m/sec

where,	Q'ty	f/pc	f
check valve	1	1.50	1.50
sluice valve	2	0.10	0.20
increase	0	0.15	0.00
90deg	5	0.18	0.90
tee	2	1.15	2.30
outlet	1	1.00	1.00
		total	5.90

Motor Output

Motor Output = (0.163*r*Q*H/e)*(1+a)
= 17.9 kW
= 18.5 kW
where,r= 1.00
e= 0.60
a= 0.15

Specification

Type	Submersible Sewage Pump
Diameter	200 mm
Capacity	4.1 m3/min
Head	14.0 m
Motor Output	18.5 kW
Quantity	4 sets + 1 set for standby

Appendix 13.4 Sewage Treatment Plant - Capacity Calculation

CAPACITY CALCULATION OF FACILITIES
(Oxidation Ditch)

1 BASIC CONDITIONS

1-1 BASIC ITEMS

(1) Name : Kandy Sewage Treatment Plant

(2) Land Area : Approximately 1.00 ha

(3) Elevation : 474.000 m

(4) Inlet Pipe Level : 465.883 m

(5) Pipe Diameter : 600 m

(6) Land Use : Paddy Field

(7) Collection System : Seperate Type

(8) Treatment Method : Sewage Treatment : Oxidation Ditch Method
Sludge Treatment : Sludge Digestion and Drying Bed

(9) Effluent Point : Mada Ela River

(10) Effluent Point Water Level : 470.640 m

(11) Target Year : Year 2005 (Phase 1)

(12) Lowest Monthly Average Temperature 23.6 °C (January)

1-2 Design Population

Design Population : 19,260 Persons (Total)

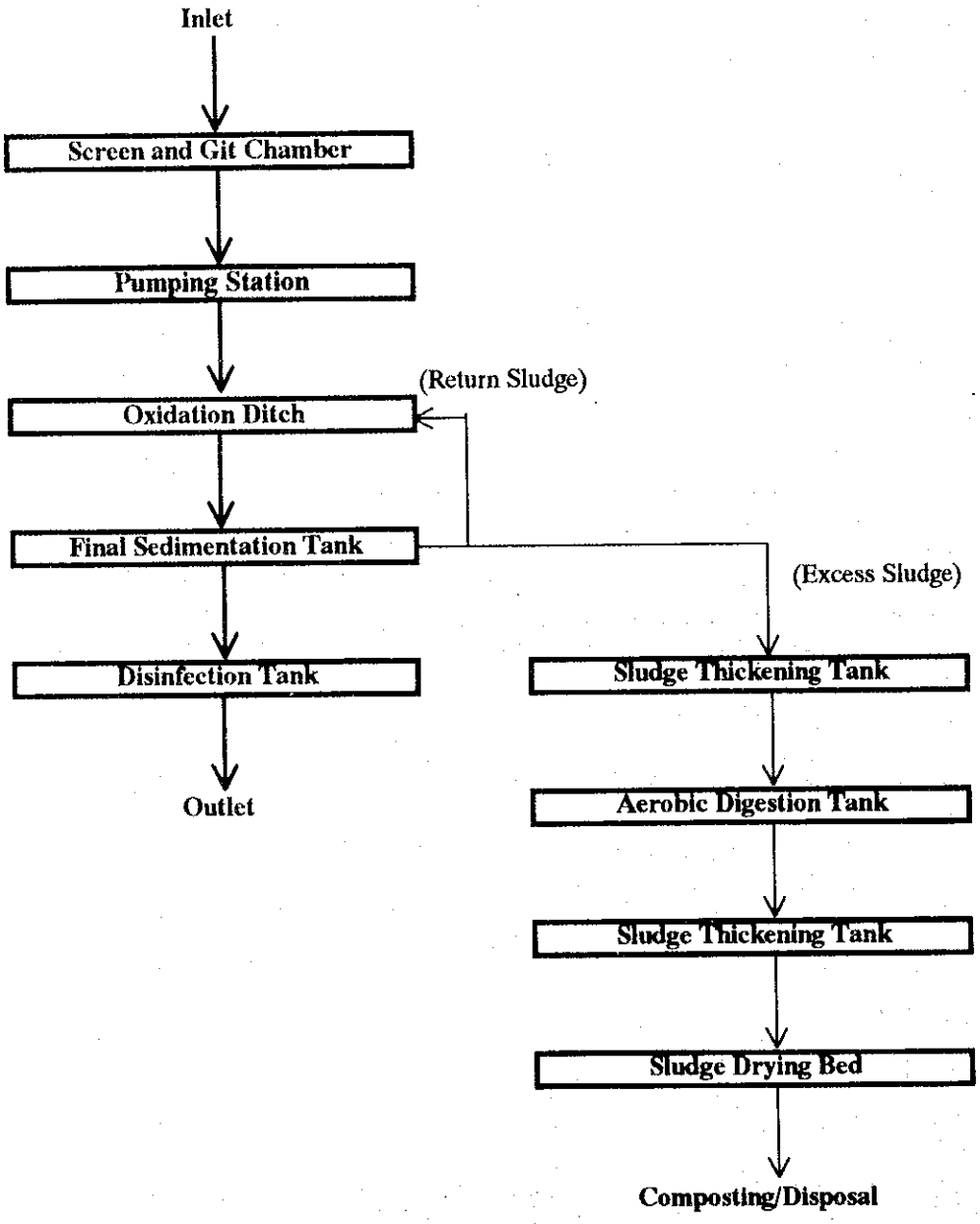
1-3 Design Sewage Flow

ITEM	m3/day	m3/hr	m3/min	m3/sec
Daily Average	6,950	289.6	4.83	0.080
Daily Maximum	8,500	354.2	5.90	0.098
Hourly Maximum	11,550	481.3	8.02	0.134

1-4 Design Sewage Quality

ITEM	INFLUENT (mg/L)	EFFLUENT (mg/L)	REMOVAL RATIO (%)	REMARKS
BOD	240	30	88	
SS	250	50	80	

1-5 Flow Chart (Oxidation Ditch)



1-6 Design Criteria for Oxidation Ditch

ITEMS	UNIT	Formula or Value	Application
1-6-1 Oxidation Ditch			
(1) BOD-SS Load	kg/kg/day	0.03 - 0.05	0.05
(2) MLSS Concentration	mg/l	3,000 - 4,000	4,000
(3) Return Sludge Ratio	%	100 - 200	150
(4) Water Depth	m	1.0 - 3.0	Same as Left
(5) Width	m	2.0 - 6.0	Same as Left
(6) Retention Time	hour	24 -48	Same as Left
(6) Oxygen Requirement	kgO2/kgBOD	1.4 - 2.2	2.0
(7) Sludge Age	day	8 - 50	Same as Left
1-6-2 Final Sedimentation Tank			
(1) Water Surface Load	m3/m2/day	8 - 12	8 - 12
(2) Retention Time	hour	6.0 - 12.0	Same as Left
(3) Water Depth	m	3.0 - 4.0	3.0
1-6-3 Disinfection Tank			
(1) Retention Time	min.	> 15	15
(2) Dosage	mg/l	2.0 - 4.0	3.0
1-6-4 Sludge Thickening Tank			
(1) Solid Matter Load	kg/m2/day	60 - 90	70
(2) Water Depth	m	Approximately 4.0	4.0
1-6-5 Aerobic Digestion Tank			
(1) Retention Time	day	10.0 - 15.0	Same as Left
(2) Solid Matter Load	kg/m2/day	1.60 - 4.81	Same as Left
1-6-6 Sludge Drying Bed			
(1) Drying Period	day	15 - 30	20
(2) Depth of Bed	m	0.3 - 1.0	0.3

2 CAPACITY CALCULATION

2-1 Oxidation Ditch (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Re-circulation Flow Type	
Design Flow	Q1	m3/day	-	8,500
	Q2	m3/hr	-	354.2
Basin Number	BN	Basin	-	3
Inlet BOD Quality	C	mg/L	-	240
Inlet SS Quality	S	mg/L	-	250
Inlet BOD Matter	M	kg/day	Q1*C*10^-3	2,040
BOD-SS Load	BS	kg/kg/day	-	0.05
MLSS Concentration	SS	mg/L	-	4,000
Required Volume	V1	m3	M/(SS*BS*10^-3)	10,200
Therefore	V2	m3	-	10,200
Retention Time	T	hr	(V2/Q1)*24	28.8
Return Sludge Ratio	R1	%	-	150
	R2	-	R1/100	1.5
Return Sludge Quality	RS1	mg/L	(SS*(1+R2)-C)/R2	6,507
Therefore	RS2	mg/L	-	6,510
Sludge Age	SA	day	SS*V2/(Q1*S)	19.2
Width	W	m	-	6.0
Water Depth	H	m	-	3.0
Length	L1	m	(V2/BN)/(W*H)	188.9
Therefore	L2	m	-	190.0
Dimension (Width)	W	m	W	6.0
(Depth)	H	m	H	3.0
(Length)	L	m	L2	190.0
(Basin Number)	-	basin	BN	3
Required Oxygen	O2-day	kgO2/day	Q1*C*10^-3*2.0	4,080.0
	O2-hr	kgO2/hr	(O2-day)/24	170.0
Aerator Motor Output	-	kW	O2-hr/1.9	89.5
	-	kW	-	90.0
Aerator Type	-	-	Slanting Shaft Screw Aerator	

Check		UNIT	APPLICATION	RESULT
Retention Time		hour	24 -48	29.0
Oxygen Supply		kgO2/kg	1.4 - 2.2	2.0
Sludge Age		day	8 - 50	19.2

2-2 Final Scdimentation Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Radial Flow Circular Type	
Design Flow	Q1	m3/day	-	8,500
	Q2	m3/sec	-	354.17
Basin Number	BN	Basin	-	3
Water Surface Load	L	m3/m2/day	4.14*10^4*T^0.95*SS^-1.35	11.4
Therefore	L	m3/m2/day		12.0
Required Surface Area	A1	m2	Q1/L	708.3
	A2	m2/Basin	A1/BN	236.1
Water Depth	H	m	-	3.0
Diameter	D1	m	(A2/3.14)^0.5*2	17.3
Therefore	D2	m	-	16.0
Dimension (Diam	D	m	D2	16.0
(Depth)	H	m	H	3.0
(Basin Number)	-	Basin	BN	3
Sludge Collector Type	-	-	Central Drive Type	
Check		UNIT	APPLICATION	RESULT
Water Surface Load		m3/m2/day	8 - 12	14.1
Retention Time		hour	6.0 - 12.0	3.4

2-3 Disinfection Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Chemical Type	-	-	Chlorination Type	
Design Flow	Q1	m3/day	-	8,500
	Q2	m3/min	-	5.90
Retention Time	T	min.	-	15.0
Basin Number	BN	basin	-	1
Required Volume	V	m3	Q2*T	89
Width	W	m	-	3.00
Water Depth	H	m	-	1.50
Length	L1	m	V/(W*H)	19.676
therefore	L2	m	-	20.00
Dosage	D	mg/L	-	2.0
Required Chemical	RC1	kg/day	Q1*D*10^-3/C	17.00
Therefore	RC2	kg/hr	RC1/24	0.71
Dimension (Wi	W	m	W	3.0
(Length)	L	m	L2	20.0
(Depth)	H	m	H	1.5
(Basin)	BN	basin	-	1
Chlorine Feeder	-	unit	including 1 for stand-by	3
Check		UNIT	APPLICATION	RESULT
Retention Time		min.	15	15.2

2-4 Sludge Thickening Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Radial Flow Circular Type	
Design Flow	Q1	m3/day	-	8,500
	Q2	m3/hr	-	289.6
Basin Number	BN	Basin	-	1
Inlet SS Quality	C	mg/L	-	250
Removal Ratio	R1	%	-	80
	R2	-	R1/100	0.80
Sludge Generation Ratio	SG1	%	-	75
(Oxidation Ditch)	SG2	-	SG1/100	0.75
Inlet SS Matter	M	kg/day	Q1*C*R2*SG2*10^-3	1,275
Solid Matter Load	L	kg/m2/day	-	70.0
Required Surface Area	A1	m2	M/L	18.2
	A2	m2/Basin	A1/BN	18.2
Water Depth	H	m	-	4.0
Diameter	D1	m	(A2/3.14)^0.5*2	4.8
Therefore	D2	m	-	5.0
Dimension (	D	m	D2	5.0
(Depth)	H	m	H	4.0
(Basin)	Basin	Basin	BN	1
Check		UNIT	APPLICATION	RESULT
Solid Matter Load		kg/m2/day	70	65.0

2-5 Aerobic Sludge Digestion Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Circular Type	
Basin Number	BN	Basin	-	1
Design Flow	Q1	m3/day	-	8,500
Inlet SS Matter	M	kg/day	-	1,275
Moisture Content	G	%	-	97.5
Sludge Volume	V1	m3/day	M*100/(100-G)	51.0
Temperature - Summer	TS	°C	-	26.5
- Winter	TW	°C	-	23.6
Temperature - Sludge Age	TSA	day-°C	VolatileSolidReduction=40%	470
Sludge Age	SA	day	TSA/TS	19.9
Total Mass of VSS	VSS	kg/day	0.8*M	1,020
VSS Reduction - Summer (41%)	VRS	kg/day	VSS*0.4	408.0
- Winter (40%)	VRW	kg/day	VSS*0.41	418.2
Required Volume	V	m3	V1/0.7/(0.125*0.8+1/SA)	485
Water Depth	H	m	-	4.0
Diameter	D1	m	(A2/3.14)^0.5*2	12.4
Therefore	D2	m	-	13.0
Dimension (	D	m	D2	13.0
(Depth)	H	m	H	4.0
(Basin)	Basin	Basin	BN	1
Required Oxygen	RO	kgO2/day	2.3*VRS	938.4
Required Air	RA	kg-Air/hr	RO/(0.1*0.233*1.293)/1440	1,297.8
Check		UNIT	APPLICATION	RESULT
Retention Time		day	10.0 - 15.0	10.4
Solid Matter Load		kg/m3/day	1.60 - 4.81	2.4

2-6 Sludge Thickening Tank (Daily Maximum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Type	-	-	Radial Flow Circular Type	
Basin Number	BN	Basin	-	1
Inlet SS Matter to Digestion	M1	kg/day	-	1,275
Removal Ratio at Digestion	R1	%	-	40%
Inlet SS Matter	M2	kg/day	M1*(1-R1)	765
Moisture Content	G	%	-	99.0
Sludge Volume	V1	m3/day	M2*100/(100-G)	76.5
Solid Matter Load	L	kg/m2/day	-	70.0
Required Surface Area	A1	m2	M/L	10.9
	A2	m2/Basin	A1/BN	10.9
Water Depth	H	m	-	4.0
Diameter	D1	m	(A2/3.14)^0.5*2	3.7
Therefore	D2	m	-	5.0
Dimension (	D	m	D2	5.0
(Depth)	H	m	H	4.0
(Basin)	Basin	Basin	BN	1
Check		UNIT	APPLICATION	RESULT
Solid Matter Load		kg/m2/day	70	39.0

2-7 Sludge Drying Bed (Daily Maxmum)

ITEM	SIGN	UNIT	CALCULATION	RESULT
Design Flow	Q1	m3/day	-	8,500
Inlet SS Matter	M1	kg/day	Q1*C*R2*10^-3	765
	M2	t/day	M1/1000	0.765
Moisture Content	G	%	-	97.0
Sludge Volume	V1	m3/day	M2*100/(100-G)	25.5
Drying Period	P	day	-	10
Required Volume	V2	m3/day	V1*P	255.0
Depth of Bed	H	m	-	0.3
Required Area	A	m2	V2/H	850
Unit Number	UN	Unit	-	10
Width per Unit	W	m	-	6.0
Length per Unit	L1	m	A/(UN*W)	14.2
Therefore	L2	m	-	14.5
Dimension (Width)	W	m	W	6.0
(Length)	L	m	L2	14.5
(Depth)	H	m	H	0.3
(Basin)	Basin	Basin	BN	10.0
Check		UNIT	APPLICATION	RESULT
Drying Period		day	20	10.2

Appendix 13.5 Hydraulic Calculation

1. Design Condition

1.1 Design Wastewater Quantity

Flow		m^3/day	m^3/hour	m^3/min	m^3/sec
Daily Average	Qd-ave	6,950	289.6	4.826	0.080
Daily Maxmum	Qd-max	8,500	354.2	5.903	0.098
Hourly Maximum	Qh-max	11,550	481.3	8.021	0.134

1.2 Unit and Capacity of Treatment Facilities

Facilities	Total	Duty	Stand-by	Capacity
Grit Chamber/Screen	2	2	1	Qhw-max
Oxydation Ditch	3	3	0	Qd-ave
Sedimentation Tank	3	3	0	Qd-ave
Disinfection Tank	1	1	0	Qd-ave

1.3 Discharge

Discharge Point Meda Ela

HWL 470.64 m

1.4 Formula for Hydraulic Calculation

a. Friction loss for streight pipe

Darcy-Weisbach

Head Loss $h = f * V ^ 2 / (2 * g)$

where, $f1 = (0.02 + 1 / (2000 * D)) * (L / D)$

b. Friction loss for fittings

Head Loss $h = f * V ^ 2 / (2 * g)$

where, $f2 = 1.00$ (Inlet)

$f3 = 0.50$ (Outet)

2. Hydraulic Calculation

2.1 Water Level of Disinfection Tank Effluent Chamber (WL1)

		Qd-ave	Qd-max	Qh-max	(Unit)
Design Flow	Q	6,950	8,500	11,550	m^3/day
	q	0.080	0.098	0.134	m^3/sec

Pipe Diameter 300 mm

Pipe Length 50.0 m

No. of Pipe 1 set

Velocity	V =	1.14	1.39	1.89	m/sec

Hydraulic Loss $h = f * V \wedge 2 / (2 * g)$

where, $f1 = (0.02 + 1 / (2000 * D)) * (L / D)$

$= 3.6111E-06$ (Straight Pipe)

$f2 = 1.00$ (Inlet)

$f3 = 0.50$ (Outet)

Hydraulic Loss	h1 =	0.099	0.148	0.274	m

WL1 = 470.640 + h1 = 470.788 470.914 m

say, **470.79** 470.92 m

(Qd-max) (Qh-max)

2.2 Water Level of Disinfection Tank (WL2)

Weir Width W = 1.0 m

No. of Weir 1 set

Weir level hw = 473.10 m

Overflow height $h = (Q / (1.84 * W))\wedge(2/3)$

	h2 =	0.124	0.142	0.174	m

WL2 = hw + h2 = 473.242 473.274 m

say, **473.25** 473.28 m

(Qd-max) (Qh-max)

2.3 Water Level of Settled Water Effluent Chamber (WL3)

Pipe Diameter 200 mm

Pipe Length 50.0 m

No. of Pipe 3 sets

Velocity	V =	0.85	1.04	1.42	m/sec

Hydraulic Loss $h = f * V \wedge 2 / (2 * g)$

where, $f1 = (0.02 + 1 / (2000 * D)) * (L / D)$

$= 5.625E-06$ (Straight Pipe)

$f2 = 1.00$ (Inlet)

$f3 = 0.50$ (Outet)

Hydraulic Loss	h3 =	0.056	0.083	0.154	m

WL3 = WL2 + + h3 = 473.333 473.434 m

say, **473.34** 473.44 m

(Qd-max) (Qh-max)

2.4 Water Level of Sedimentation Tank Trough (WL4)

No. of Sedimentation Tank		3	tanks		
Tank Diameter	D =	16.0	m		
Trough Length	L =	25.1	m		
Trough Width	B =	0.3	m	free fall	
Trough Level	hw =	473.50	m		
Critical Water Level	hcl =	((Q ^ 2) / (g * B ^ 2)) ^ (1 / 3)			
	hcl =	0.093	0.107	0.131	m
Hydraulic Loss	h4 =	(3) ^ (1/2) * hcl			
	h =	0.162	0.185	0.227	m
WL4 =	hw +	h4 =	473.685	473.727	m
		say,	473.69	473.73	m
			(Qd-max)	(Qh-max)	

2.5 Water Level of Sedimentation Tank (WL5)

No. of Sedimentation Tank		3	tanks		
Tank Diameter		16.0	m		
No. of Notches	(8 nos/m)	402	nos		
Weir level	hw =	473.98	m		
Hydraulic Loss	h5 =	((Q / n) / 1.42) ^ (2 / 5)			
	h =	0.019	0.020	0.023	m
WL5 =		hw + h5 =	474.000	474.003	m
		say,	474.00	474.01	m
			(Qd-max)	(Qh-max)	

2.6 Water Level of Oxidation Ditch Effluent Chamber (WL6)

Pipe Diameter		200	mm		
Pipe Length		50.0	m		
No. of Pipe		3	sets		
Velocity	V =	0.85	1.04	1.42	m/sec
Hydraulic Loss	h =	f * V ^ 2 / (2 * g)			
	where,	f1 =	(0.02 + 1 / (2000 * D)) * (L / D)		
		=	5.625E-06	(Straight Pipe)	
		f2 =	1.00	(Inlet)	
		f3 =	0.50	(Outet)	
Hydraulic Loss	h6 =	0.056	0.083	0.154	m
WL6 =	WL5 + +	h6 =	474.083	474.164	m
		say,	474.09	474.17	m
			(Qd-max)	(Qh-max)	

2.7 Water Level of Oxidation Ditch (WL7)

No. of Sedimentation Tank		3 tanks			
Weir Width	W =	1.0 m			
No. of Weir		1 set			
Weir level	hw =	474.33 m			
Overflow height	h =	(Q / (1.84 * W))^(2/3)			
	h2 =	0.060	0.068	0.084	m
WL7 =	hw + h7 =	474.398	474.414	m	
	say,	474.40	474.42	m	
		(Qd-max)	(Qh-max)		

2.8 Water Level of Distribution Chamber - Effluent (WL8)

Pipe Diameter		200 mm			
Pipe Length		50.0 m			
No. of Pipe		3 sets			
Velocity	V =	0.85	1.04	1.42	m/sec
Hydraulic Loss	h = f * V ^ 2 / (2 * g)				
	where,	f1 = (0.02 + 1 / (2000 * D)) * (L / D)			
		= 5.625E-06 (Straight Pipe)			
		f2 = 1.00 (Inlet)			
		f3 = 0.50 (Outet)			
Hydraulic Loss	h6 =	0.056	0.083	0.154	m
WL8 =	WL7 + + h8 =	474.483	474.574	m	
	say,	474.49	474.58	m	
		(Qd-max)	(Qh-max)		

2.9 Water Level of Distribution Influent (WL9)

No. of Sedimentation Tank		3 sets			
Weir Width	W =	1.0 m			
No. of Weir		1 set			
Weir level	hw =	474.70 m			
Overflow height	h =	(Q / (1.84 * W))^(2/3)			
	h2 =	0.060	0.068	0.084	m
WL9 =	hw + h9 =	474.768	474.784	m	
	say,	474.77	474.79	m	
		(Qd-max)	(Qh-max)		

2.10 Water Level of Grit Chamber Effluent Chamber (WL10)

Pipe Diameter		400 mm			
Pipe Length		50.0 m			
No. of Pipe		1 set			
Velocity	V =	0.64	0.78	1.06	m/sec
Hydraulic Loss	h = f * V ^ 2 / (2 * g)				

	where,		f1 = (0.02 + 1 / (2000 * D)) * (L / D)			
			= 2.6563E-06 (Straight Pipe)			
			f2 = 1.00 (Inlet)			
			f3 = 0.50 (Outet)			
Hydraulic Loss	h6 =	0.031	0.047	0.087	m	
WL10 =	WL9 +	+ h10 =	474.817	474.877	m	
		say,	474.82	474.88	m	
			(Qd-max)	(Qh-max)		

2.11 Water Level of Grit Chamber Influent Chamber (WL15)

No. of Screens		3 sets including 1for standby			
Head loss	h11 =	0.10 m			
WL11 =	WL10 +	h11 =	474.920	474.980	m
		say,	474.92	474.98	m
			(Qd-max)	(Qh-max)	

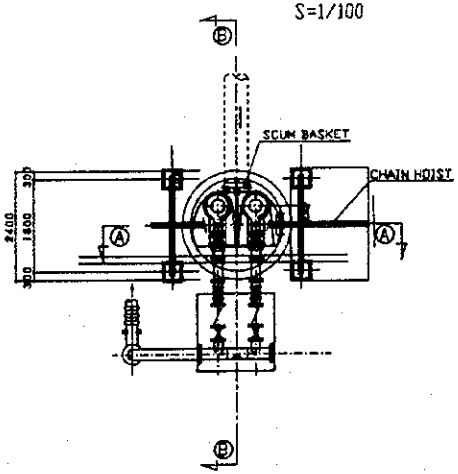
Appendix 13.6 DRAWING

DRAWING LIST

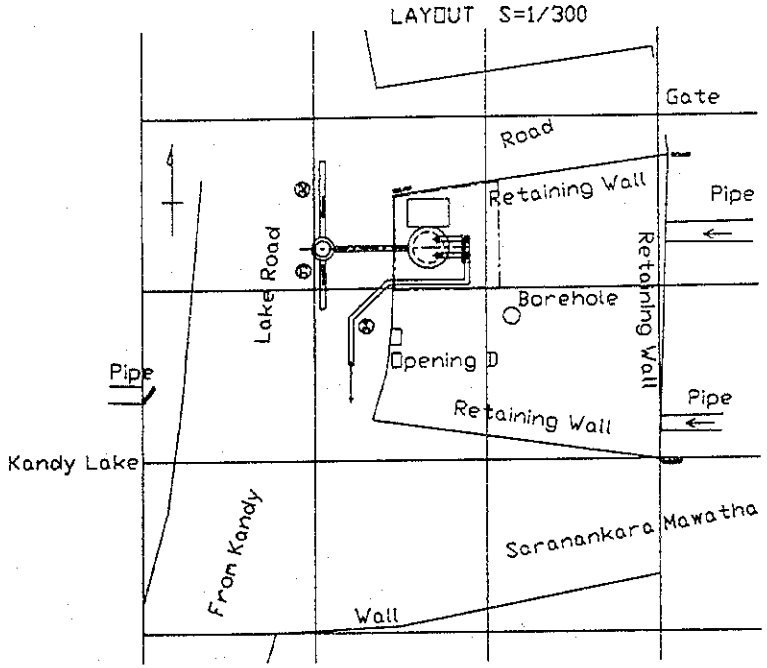
No.	DRAWING NAME
S.1-1	PUMP STATION (LAKE)
S.2-1	SEWAGE TREATMENT PLANT LAYOUT
S.2-2	HYDRAULIC PROFILE
S.2-3	FLOW DIAGRAM (1)
S.2-4	FLOW DIAGRAM (2)
S.2-5	PUMPING STATION (1)
S.2-6	PUMPING STATION (2)
S.2-7	OXIDATION DITCH
S.2-8	SEDIMENTATION BASIN
S.2-9	DISINFECTION TANK
S.2-10	RETURN SLUDGE PUMP ROOM
S.2-11	SLUDGE THICKENING TANK
S.2-12	AEROBIC SLUDGE DIGESTION TANK
S.2-13	SLUDGE DRYING BED LAYOUT
S.2-14	SLUDGE DRYING BED

PLAN

S=1/100

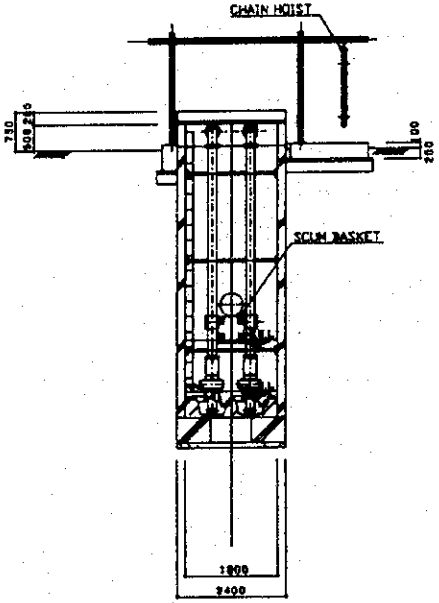


LAYOUT S=1/300



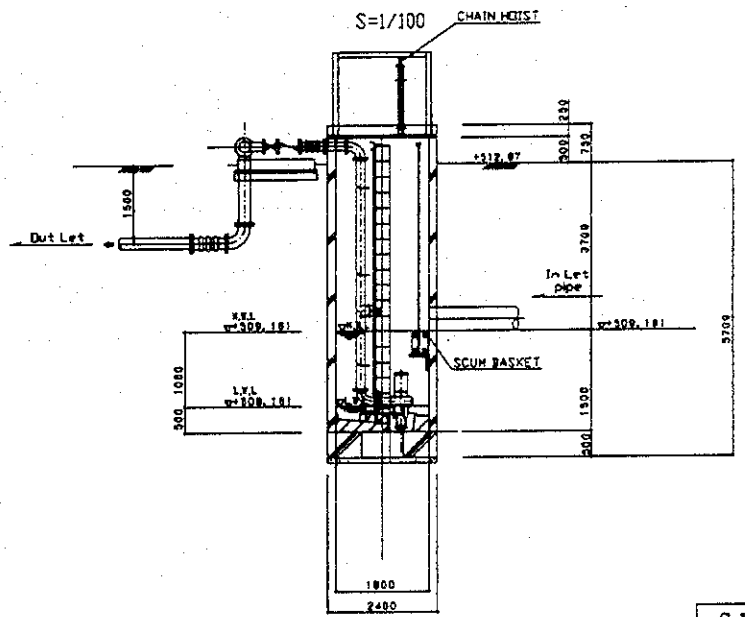
SECTION A-A

S=1/100



SECTION B-B

S=1/100



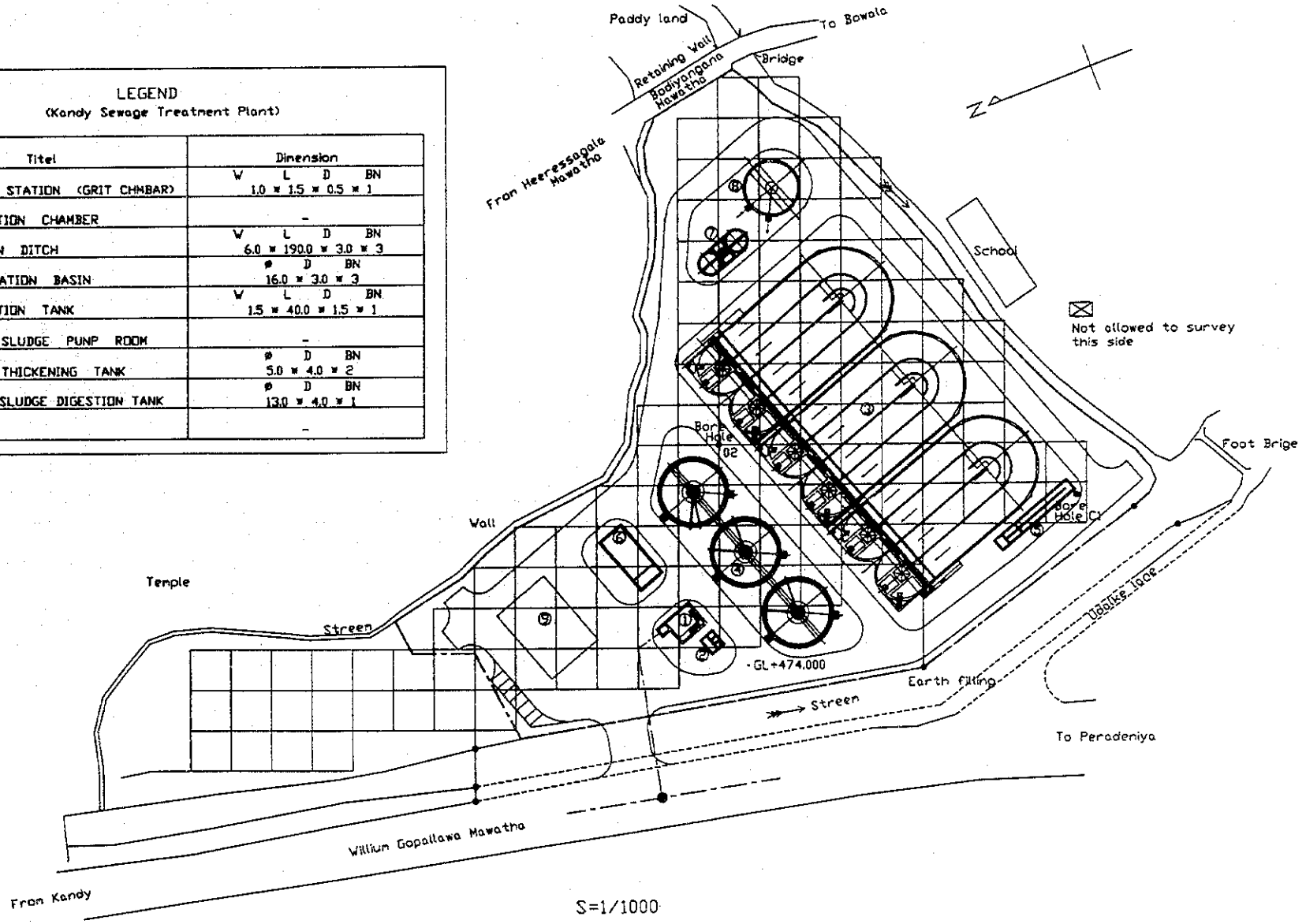
S.1-1
PUNPING STATION
(LAKE)

A-13.6-3

LAYOUT

LEGEND
(Kandy Sewage Treatment Plant)

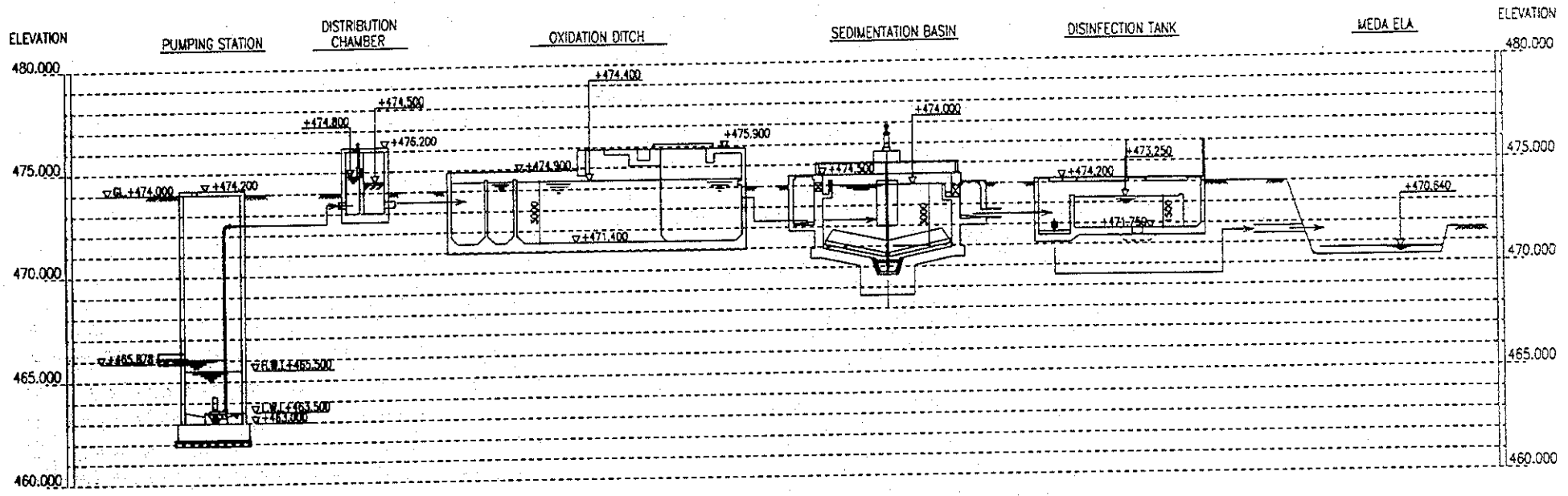
No.	Titel	Dimension
①	POMPING STATION (GRIT CHMBAR)	W L D BN 1.0 × 1.5 × 0.5 × 1
②	DISTRIBUTION CHAMBER	-
③	OXIDATION DITCH	W L D BN 6.0 × 190.0 × 3.0 × 3
④	SEDIMENTATION BASIN	ø D BN 16.0 × 3.0 × 3
⑤	DISINFECTION TANK	W L D BN 1.5 × 40.0 × 1.5 × 1
⑥	RETURN SLUDGE PUMP ROOM	-
⑦	SLUDGE THICKENING TANK	ø D BN 5.0 × 4.0 × 2
⑧	AEROBIC SLUDGE DIGESTION TANK	ø D BN 13.0 × 4.0 × 1
⑨	OFFICE	-



PROPOSED SEWERAGE TREATMENT PLANT
SITE SURVEY AT BOWALA

S.2-1
SLUDGE DRYING BED LAYOUT

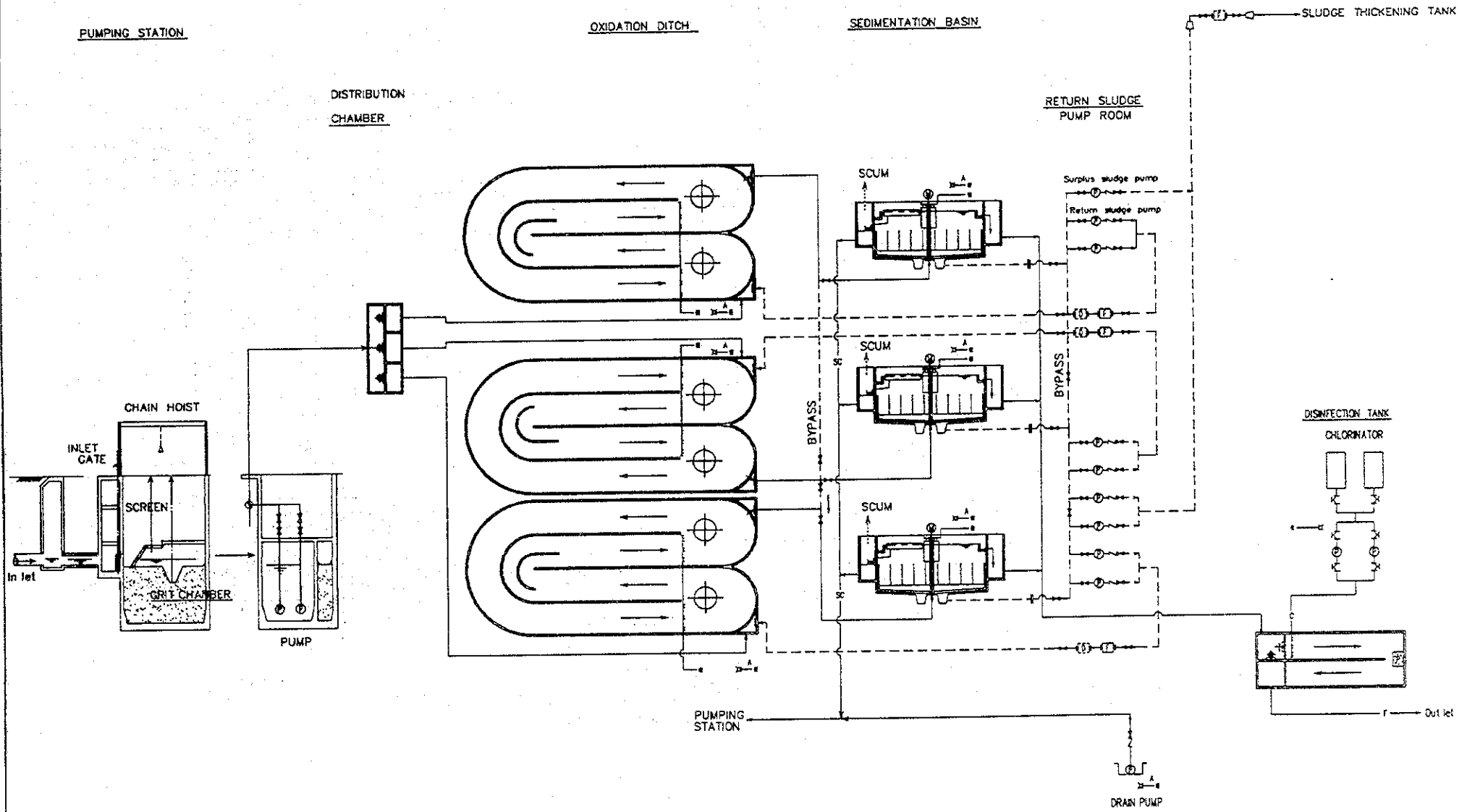
HYDRAULIC PROFILE



S.2-2
HYDRAULIC PROFILE

A-13.6-4

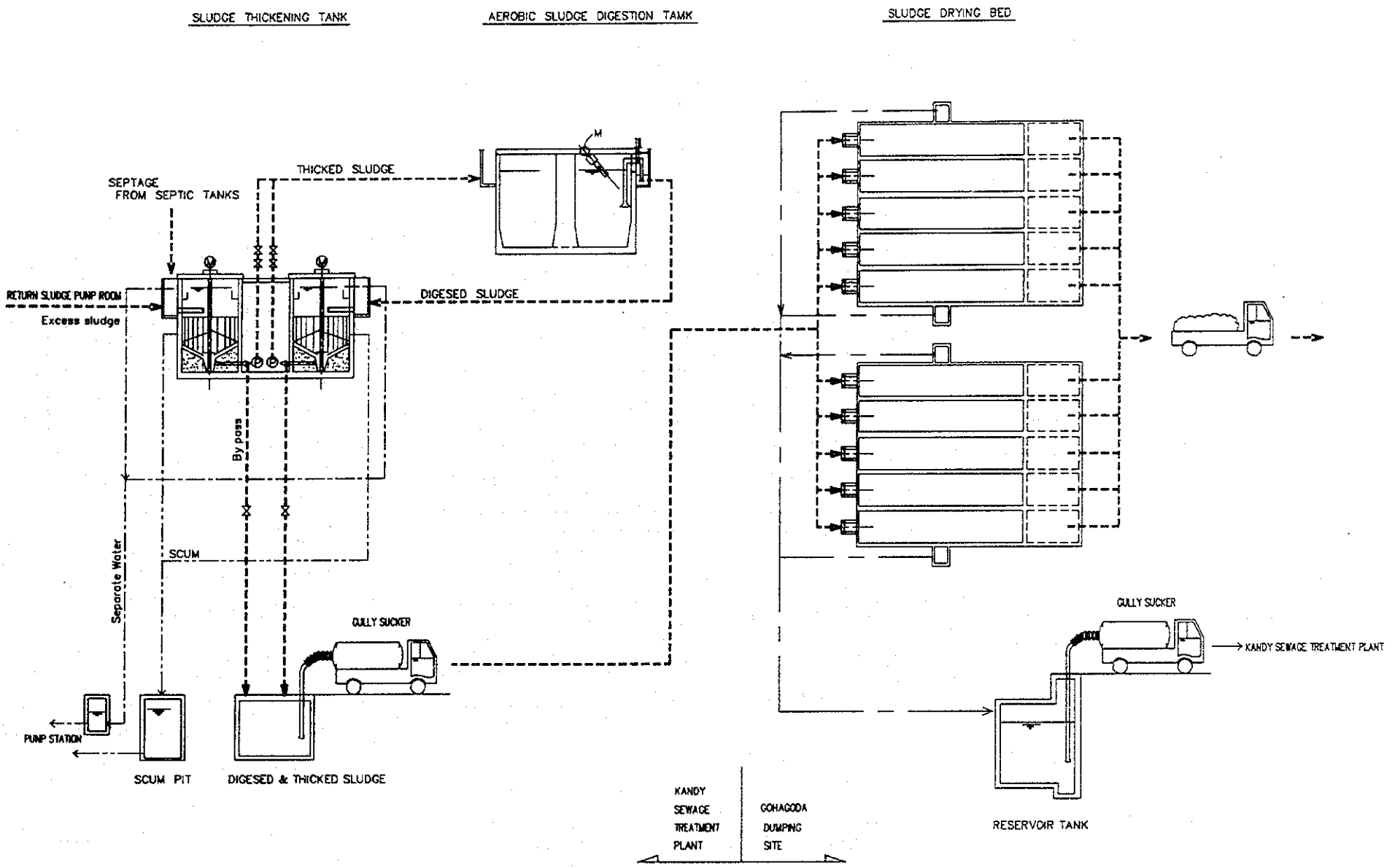
FLOW DIAGRAM (1)



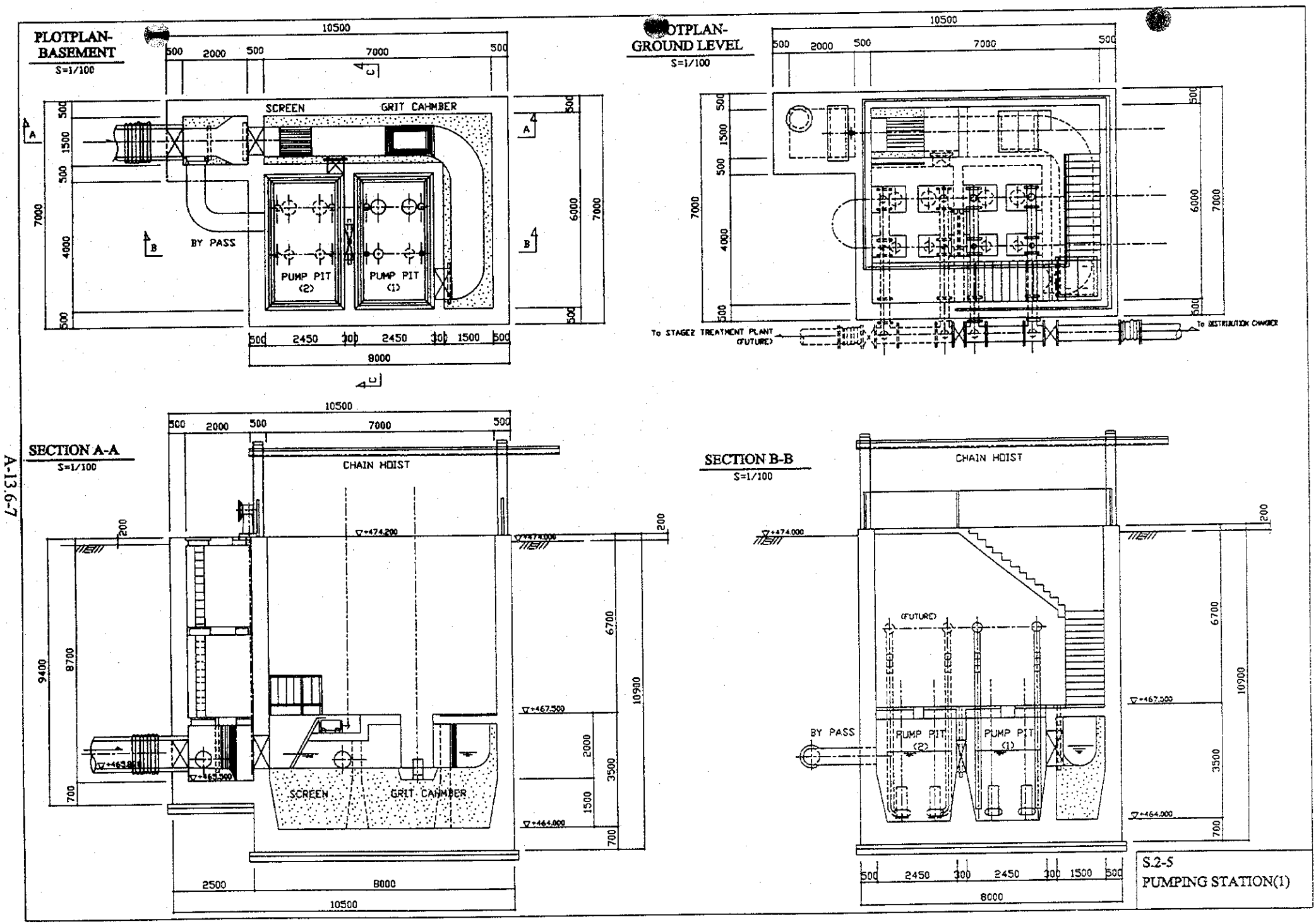
S.2-3
FLOW DIAGRAN (1)

A-13.6-6

FLOW DIAGRAM(2)



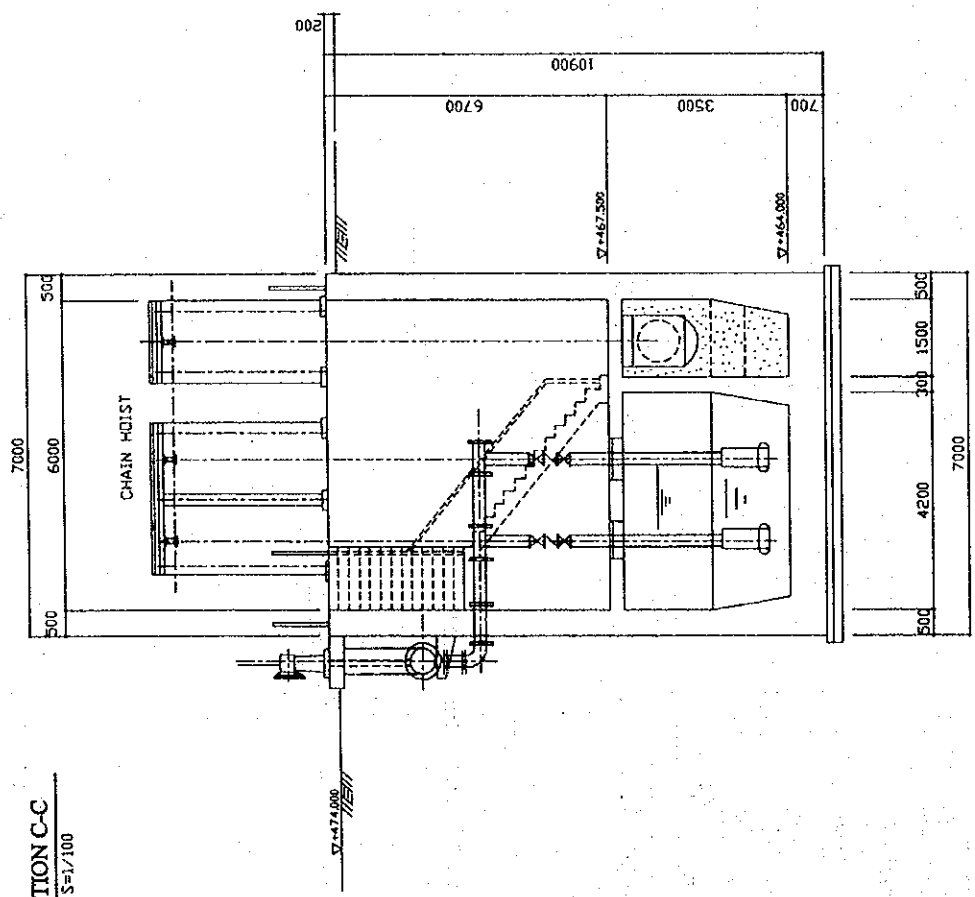
S.2-4
FLOW DIAGRAM (2)



A-13.6-7

S.2-5
PUMPING STATION(1)

S.2-6
PUMPING STATION (2)

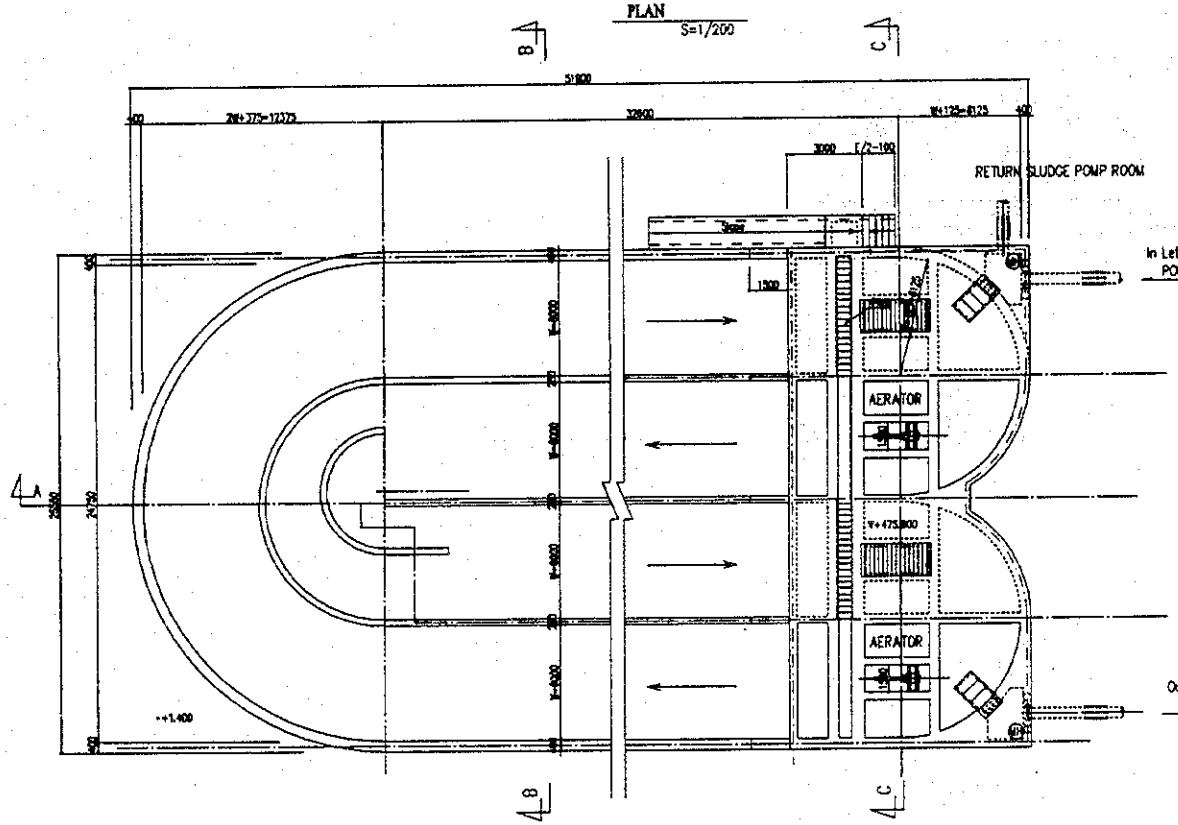


SECTION C-C
S=1/100

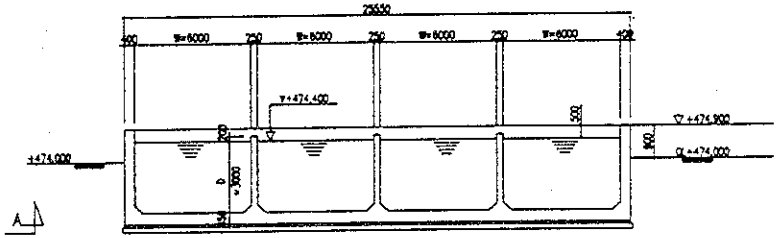
A-13.6-9

OXIDATION DITCH

PLAN
S=1/200



SECTION B-B
S=1/200



SECTION A-A
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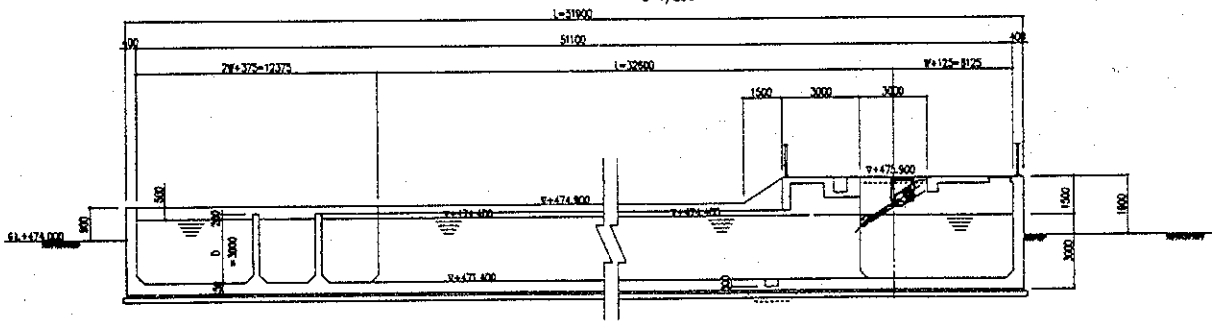

SECTION C-C
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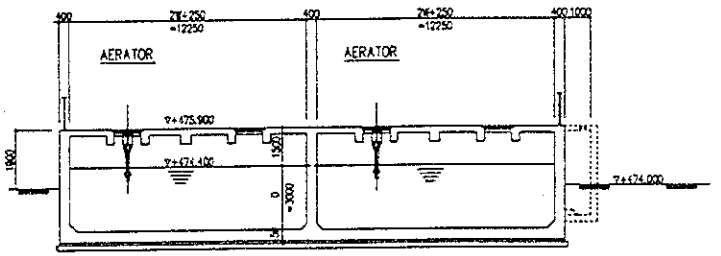

S.2-7
OXIDATION DITCH

SEDIMENTATION BASIN

PLAN
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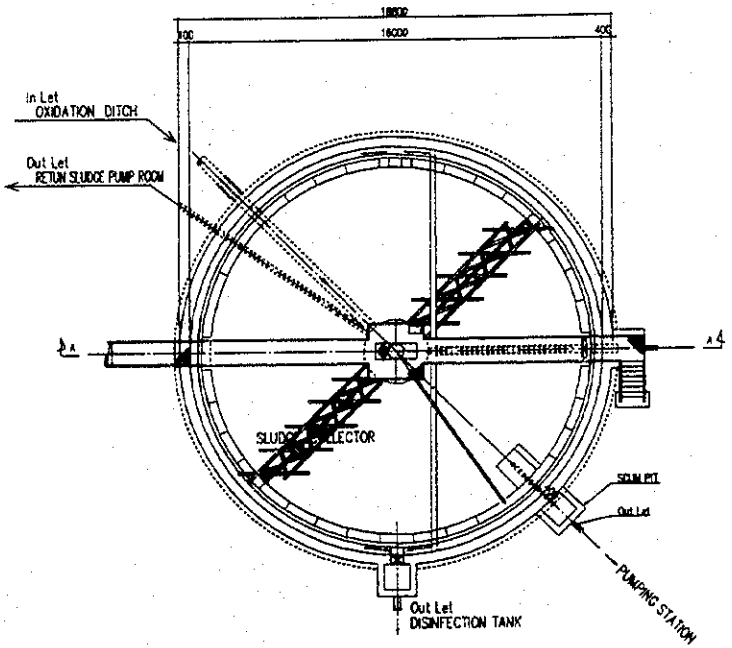
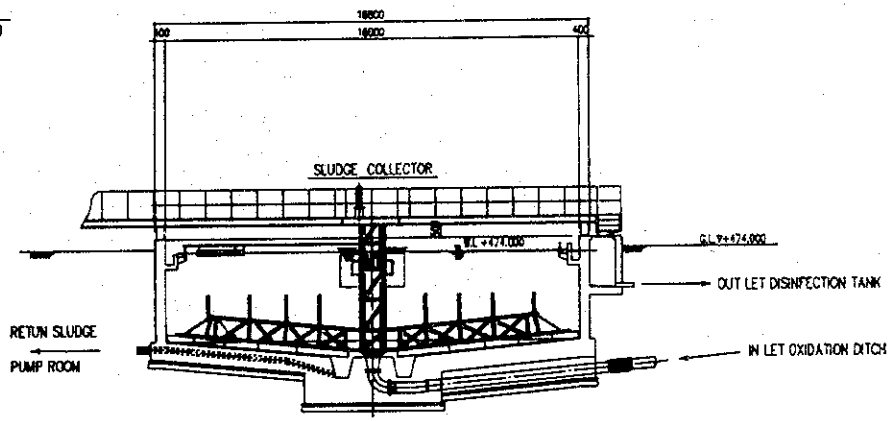


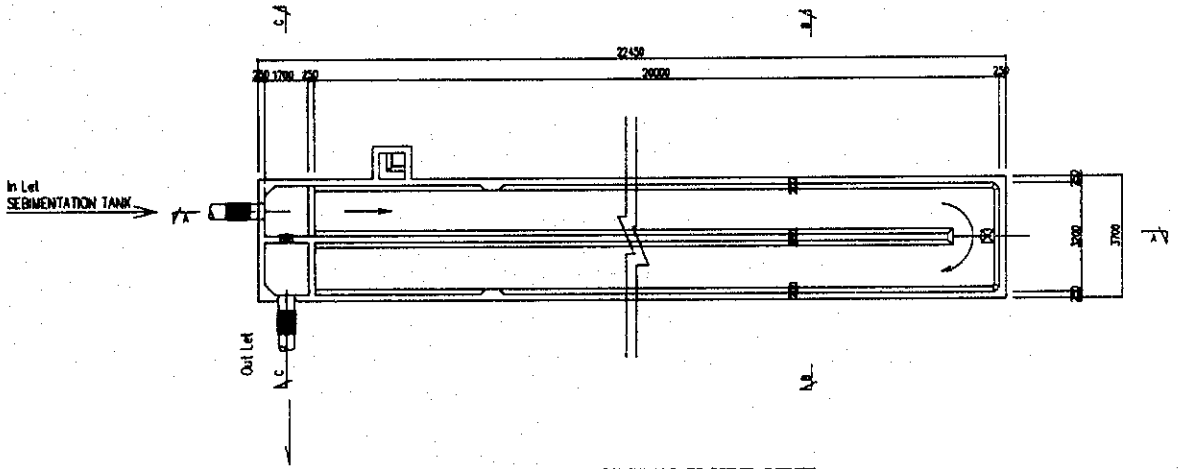
SECTION A-A
S=1/200



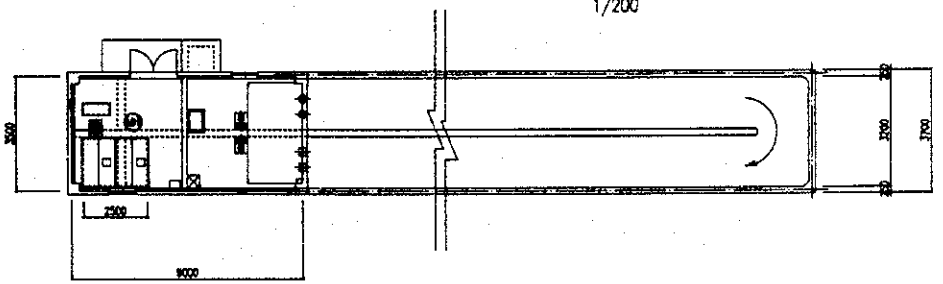
S.2-8
SEDIMENTATION BASIN

DISINFECTION TANK

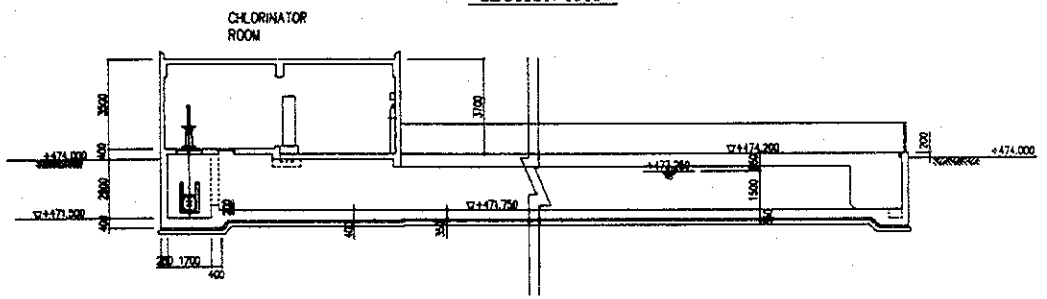
PLOT PLAN BASEMENT
1/200



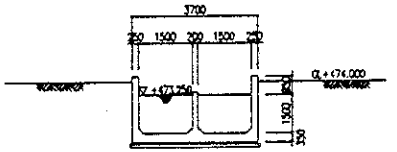
PLOT PLAN GROUND LEVEL
1/200



SECTION A-A



SECTION B-B



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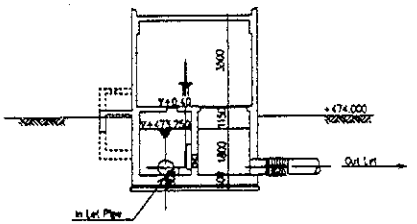
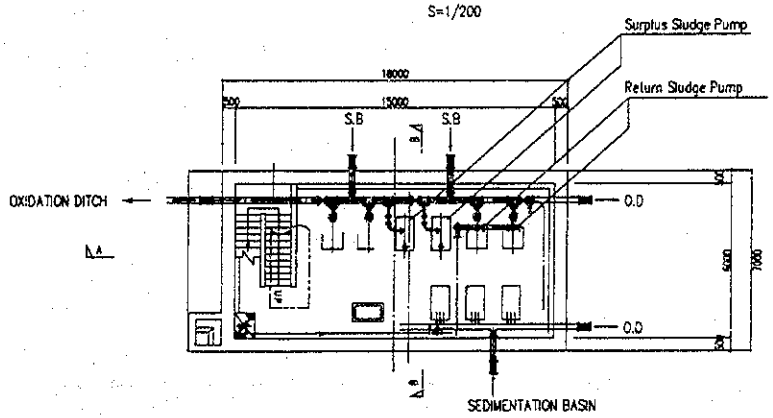


S.2-9
DSINFECTION TANK

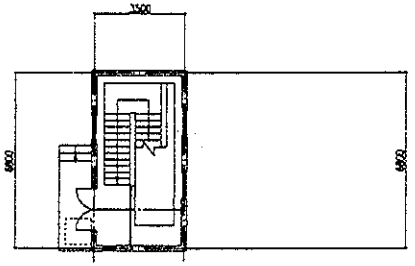
A-13.6-11

RETURN SLUDGE PUMP ROOM

PLOT PLAN BASEMENT
S=1/200



PLOT PLAN GROUND LEVEL
S=1/200



SECTION A-A
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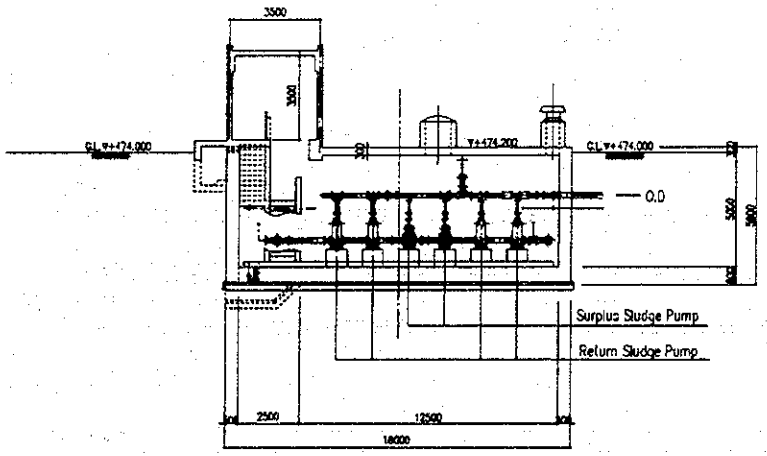
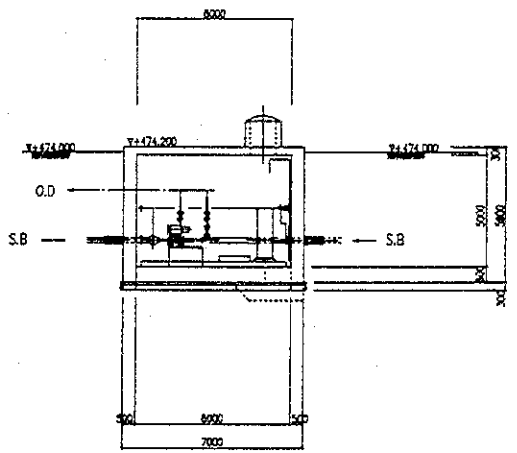


SECTION B-B
S=1/200



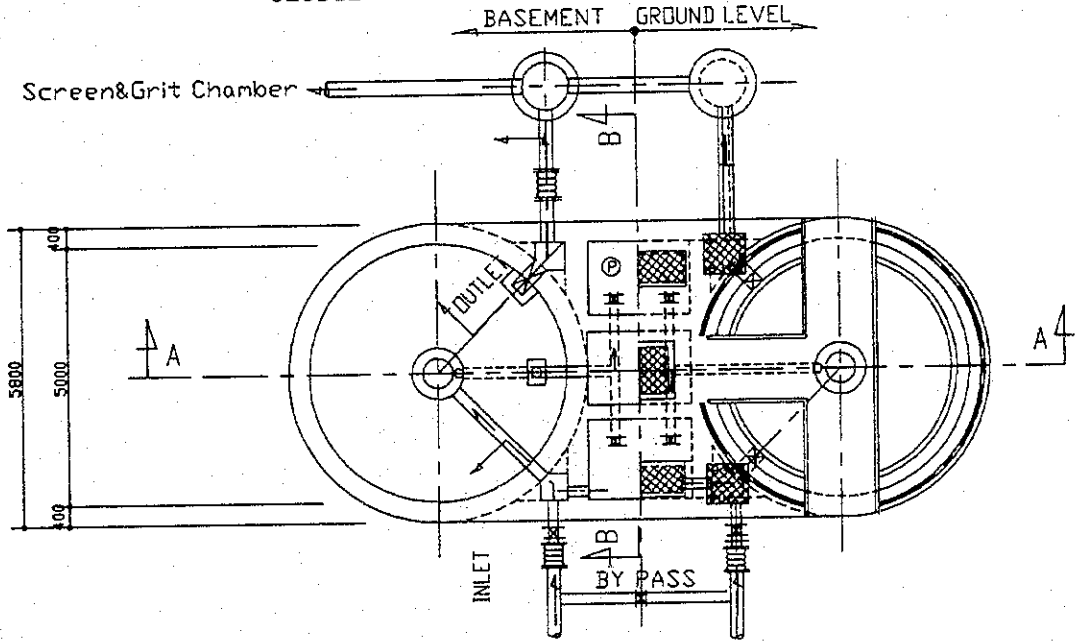
S.2-10
RETURN SLUDGE PUNP ROOM

A-13.6-12

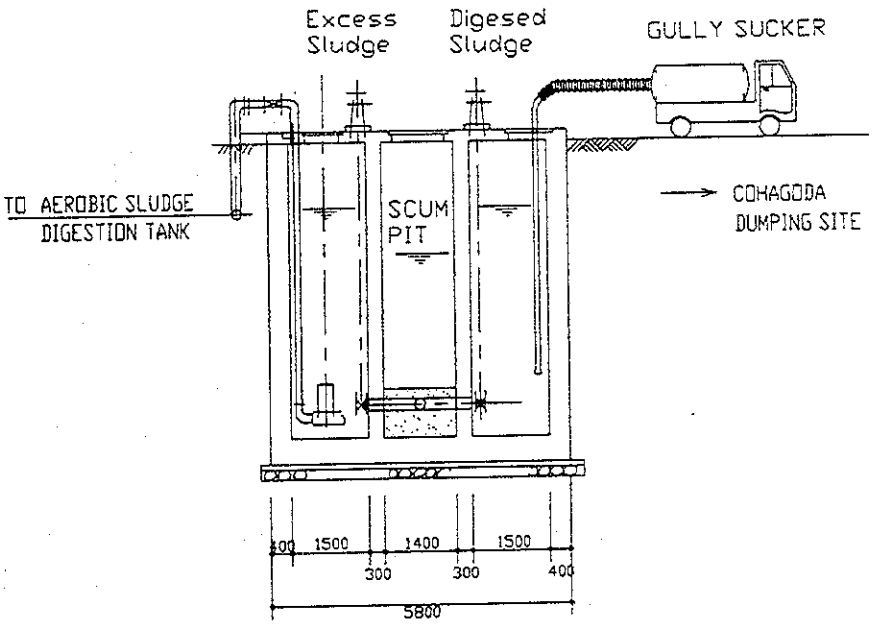
A-13.6-13

PLOT PLAN

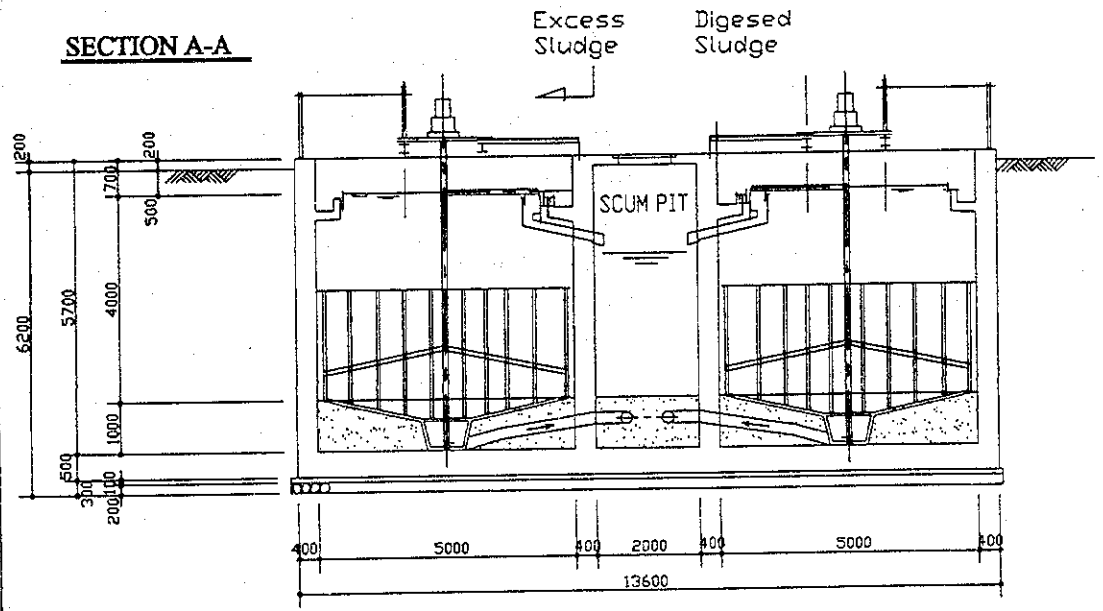
SLUDGE THICKEING TANK AEROBIC SLUDGE DIGESTION TANK



SECTION B-B



SECTION A-A



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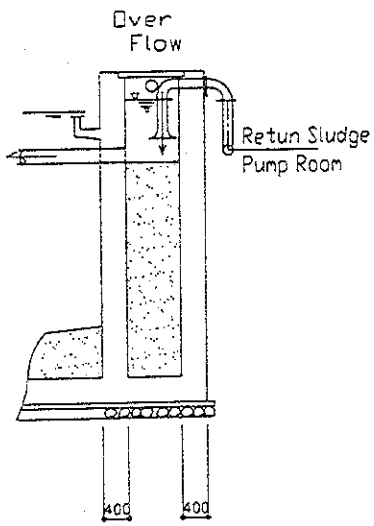
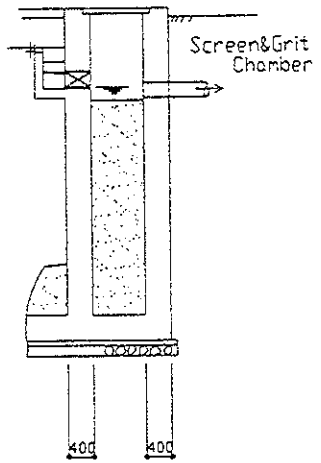


OUTLET

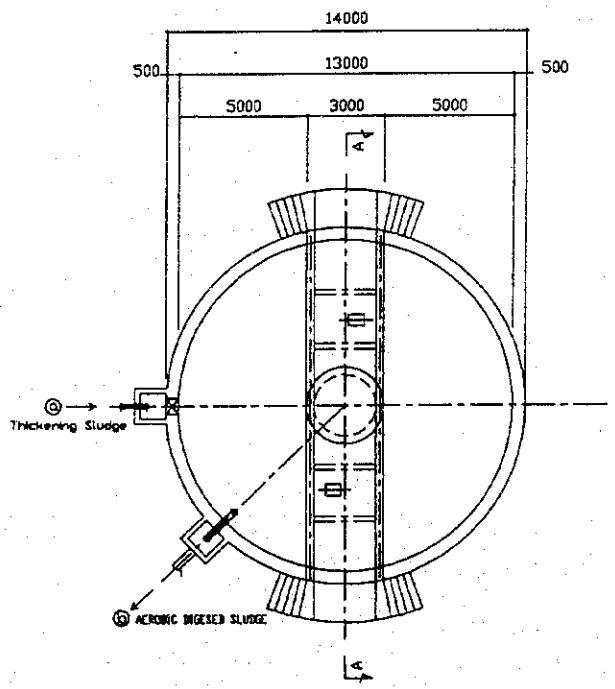


S.2-11
SLUDGE THICKENING TANK

AEROBIC SLUDGE DIGESTION TANK

PLOTPLAN

S=1/200



SECTION A-A

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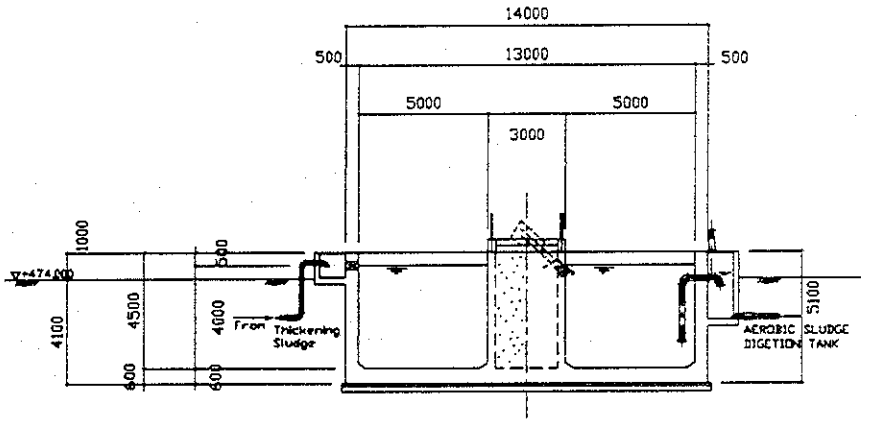
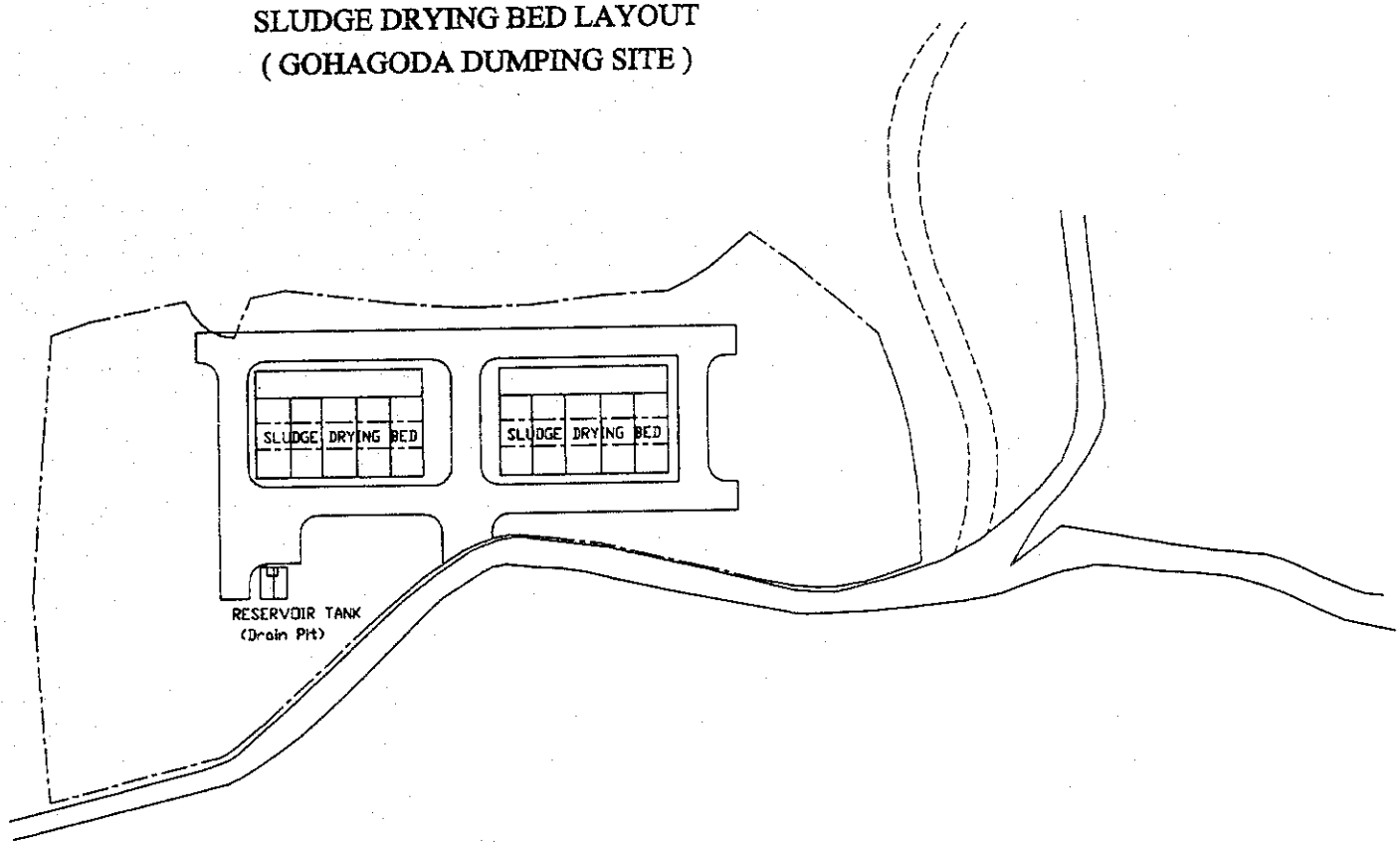
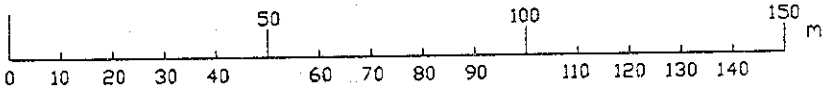


S.2-12
AEROBIC SLUDGE DIGESTION TANK

A-13.6-14

SLUDGE DRYING BED LAYOUT
(GOHAGODA DUMPING SITE)





S=1/1000

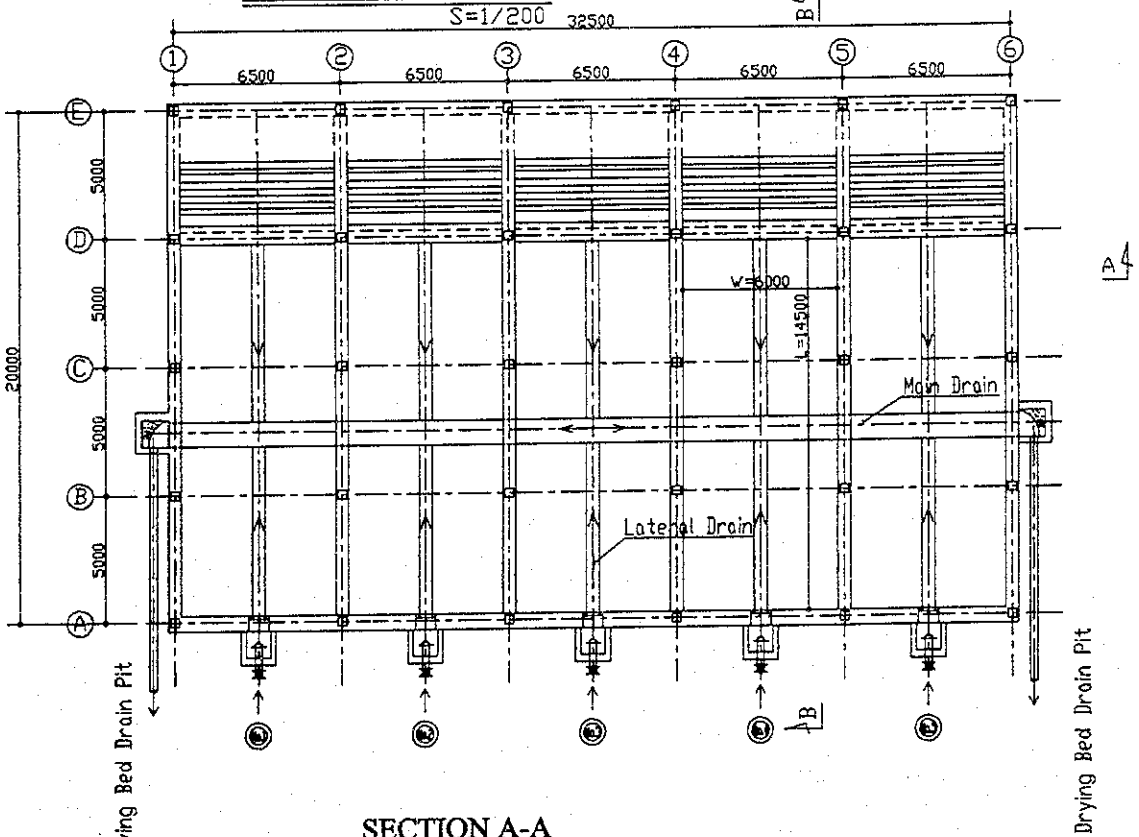
S.2-13
SLUDGE DRYING BED LAYOUT

A-13.6-15

A-13.6-16

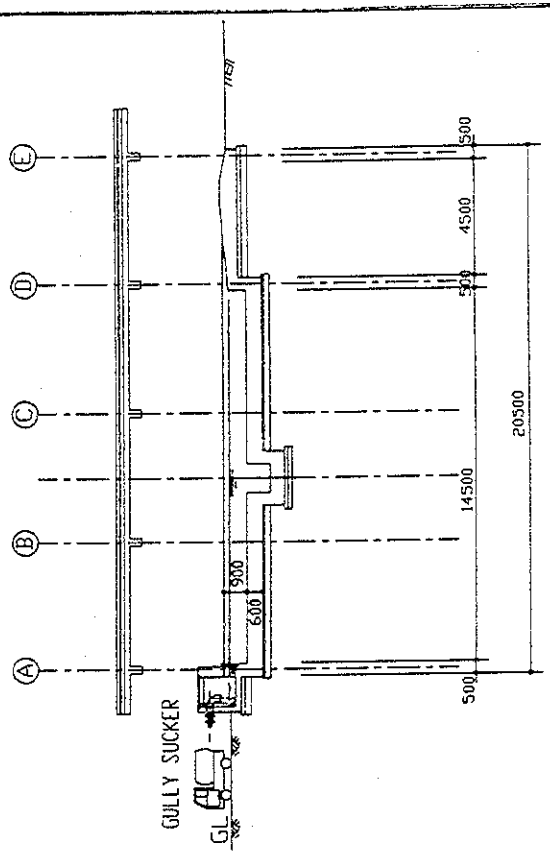
PLOT PLAN

S=1/200



SECTION B-B

S=1/200



SECTION A-A

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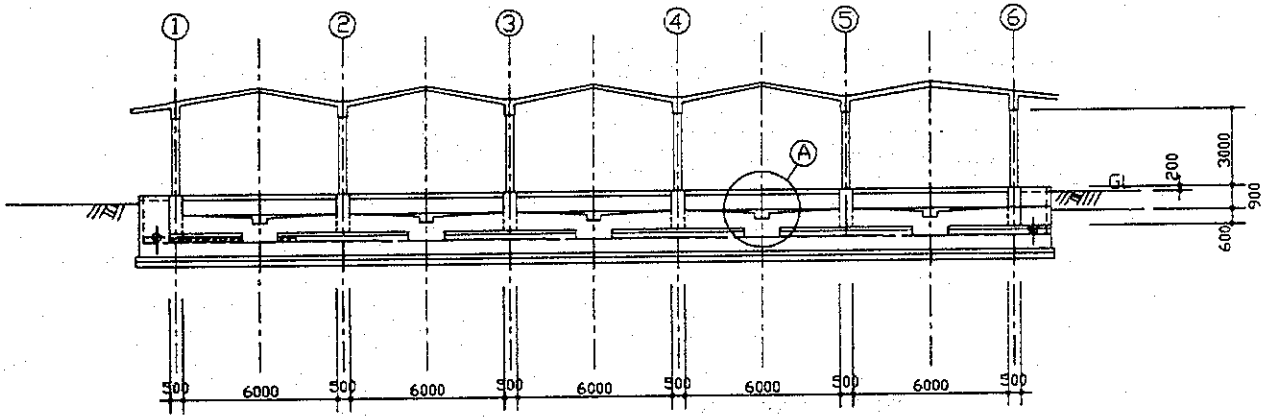
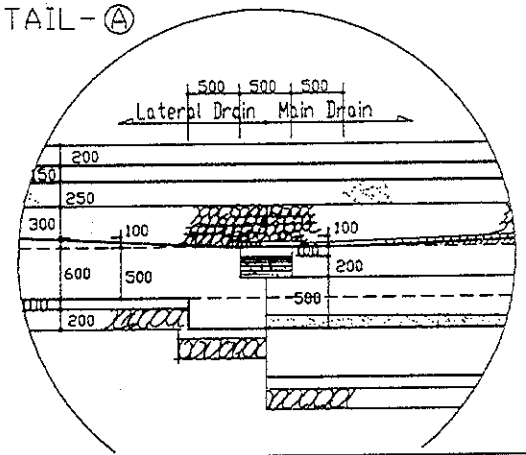


DETAIL-Ⓐ



S.2-14
SLUDGE DRYING BED

Appendix 13.7 Storage Capacity of Sewer (Kandy)

Phase 1 (2005)

1 Pumping Station in Kandy STP

(1) Sewage Flow

Q_{HM} = 12,200 m^3/day = 508 m^3/hour (Hourly Maximum Sewage Flow to STP)

(2) Sewer to be used for Sewage

Since Pumping Station is located at GL+474m, sewers with invert level of +473m is considered to use for sewer storage. Length and Pipe Nos. of these sewers are as follows;

No. 57 ϕ825. L= 50m (Allowance 50%)

No. 53 ϕ750. L= 750m (Allowance 50%)

(3) Manhole

Nos. of Manhole $\frac{50+750}{50} = 16$ (50m pitch)

Manhole Depth 475.01−470.817 = 4.2m

(up to No.53)

(4) Calculation of Storage Capacity

a) Sewer

$$\left[\frac{0.825^2 \times 3.14}{4} \times 50 + \frac{0.75^2 \times 3.14}{4} \times 750 \right] \times \left(1 - \frac{1}{1.5}\right) = 119.3\ m^3$$

b) Manhole

$$\frac{1.2^2 \times 3.14}{4} \times (4.2 - 0.825) \times 16 = 61.0 m^3$$

Total 180.3m^3

(5) Storage Time

$$\frac{180.3 m^3}{508 m^3/hour} = \mathbf{0.35\ hour = \underline{20.9\ min}}$$

2. Kandy Lake Pumping Station

(1) Sewage Flow

Q_{HM} = 0.0031 m^3/sec = 11.16 m3/hour

(Hourly Maximum Sewage Flow to Kandy Lake PS)

(2) Sewer to be used for Sewage

Since Pumping Station is located at GL+512.87m, sewers with invert level of +512.5m is considered to use for sewer storage. Length and Pipe Nos. of these sewers are as follows;

No.32. ϕ150 L = 750m (Allowance 50%)

(3) Manhole

Nos. of Manhole $\frac{750}{50} = 15$ (50m pitch)

Manhole Depth 512.17 — 510.351 = 1.8

(Center of No. 32)

(4) Calculation of Storage Capacity

a) Sewer

$$\frac{0.15^2 \times 3.14}{4} \times 750 \times \left(1 - \frac{1}{2.0}\right) = \quad 6.6m^3$$

b) Manhole

$$\frac{0.9^2 \times 3.14}{4} \times (1.8 \times 0.15) \times 15 \quad = 15.7m^3$$

Total $22.3m^3$

(5) Storage Time

$$\frac{22.3\ m^3}{11.16\ m^3/hour} = \textbf{2.0 hour} = \textbf{120.0 min}$$