Table F.12.1 Outlet of Main Combined Sewer by each Sub-zone

Sub-zone	Type of outlet	Dimension (m) H	W	D	Area (m2)	Number
Tau Hu - Ben Nghe canal, left bank East side	F-5			0.8	0.63	1
	F-3			1.0	0.79	1
	E-4			1.0	0.79	4
	K-7	1.2	0.8		0.80	2
	K-6	1.4	0.8		0.93	4
	E-3			1.2	0.94	2
	F-2			1.2	0.94	1
	K-5	1.6	0.8		1.07	1
	E-2			1.5	1.18	4
	F-1			1.5	1.18	1
	K-4	1.8	0.8		1.22	1
	E-1			2.0	1.57	1
	J-1	2.3	2.1		3.85	1
Sub total						24
Tau Hu - Ben Nghe canal, left bank West side	B-5	1.0			0.54	1
	A-11	1.0	0.6		0.58	1
	F-5			0.8	0.63	1
	A-10	1.1	0.6		0.64	1
	A-7	1.4	0.6		0.78	1
	F-3			1.0	0.79	1
	K-7	1.2	0.8		0.80	1
	K-6	1.4	0.8		0.93	2
	K-5	1.6	0.8		1.07	1
	F-1			1.5	1.18	1
	A-5	1.4	0.8		1.45	1
Sub total						12
Hung Phu	-			0.4	0.31	1
	-			0.6	0.47	5
	-			0.8	0.63	1
Sub total						7
Tung Thien Vuong	-			0.4	0.31	3
	-			0.6	0.47	10
	-			0.8	0.63	6
	-			1.0	0.79	2
Sub total						21
Rach Ong	-			0.6	0.47	1
	-			0.8	0.63	2
	-			1.0	0.79	2
	-			1.2	0.94	1
Sub total						6
Pham The Hien	-			0.8	0.63	1
Sub total						1
Khanh Hoi	-			0.4	0.31	16
	-			0.5	0.39	2
	-			0.6	0.47	2
	-			0.8	0.63	5
	-			1.0	0.79	5
	K-6	1.4	0.8		0.93	1
	-	2.0	3.0		6.00	1
Sub total						32
Grand total						103

Table F.13.1(1/2) Comparison of Conveyance Route Study

Item	Description				Route A	Route B	Route C
Canal Crossing	Main Feature	Length (km)			0.8 km	1.0 km	1.3 km
		Construction Method			Pipe Jacking & Shield Tunneling	Pipe Jacking & Shield Tunneling	Pipe Jacking & Shield Tunneling
	Advantage				- Shortest distance - 1 place of canal crossing	- Little traffic along Tran Tuan Khai road - Sufficient space for work yard is available	- 1/2 of the total length running under the Chanh Hung road
	Disadvantage				- Difficulty with construction of conveyance near to the Y Bridge - Heavy traffic along Nguyen Bieu road which will be occupied for a vertical shaft - Available space for work yard is limited	- 2 places of canal crossing	- Longest distance - 2 places of canal crossing
	Evaluation	Work yard			1	3	2
		Workability			2	3	2
		Sub-Total			3	6	4
Conveyance Route from PS to WTP	Main Feature	Total Length (km)			6.45 km	5.40 km	5.55 km
		Existing Condition along the Route	Existing Road		3.27 km	2.22 km	2.90 km
			Paddy Field		0.53 km	0.53 km	-
			Same Stretch	Paddy Field	2.50 km		
				River Crossing	2 places 0.10 km + 0.05 km =0.15 km		
	Advantage				-	- Shortest distance to WTP	- 52 % of the total length running under the existing main road - Shorter distance - Little interference with installation of conveyance along Pham The Hiem road which has heavy traffic with a wide width of about 15 m
	Disadvantage				- Longest distance to WTP - Difficulty with installation of conveyance with Open Cut Method along Pham The Hiem road which has heavy traffic with a narrow width of about 7 m - Running across paddy field with a length of approx. 3 km.	- Running across paddy field with a length of Approx. 3 km	- Running across paddy field with a length of Approx. 3 km - Far from the 1st priority area
	Evaluation	Workability			2	3	2
		Sub-Total			2	3	2

Table F13.1(2/2) Comparison of Conveyance Route Study

Item	Description		Route A	Route B	Route C
Pumping Station	Main Feature	Existing Land Use	Da Nam Park	Open Space	Open Space
		Land Condition	Park	Wetland	Wetland
		Available Space (ha)	approx. 0.4 ha	approx. 2 ha	approx. 0.5 ha
		Character of Neighborhood	Residential Area	Open Space	Residential Area
	Advantage		- Main roads are running around the site - Invert level is shallower than other PSs because of shorter distance to downtown	- Shortest distance - Less impact upon the surroundings - No constraint on layout of PS because of larger available area	- Sufficient area is available
	Disadvantage		- The site is being utilized as a memorial park - Surroundings are residential area. - Cast in situ diaphragm wall may be applied due to a limit of work space - Restoration work is necessary.	- Improvement of land condition and a access road to PS are necessary	- Improvement of land - The surroundings are residential and newly developed areas. - The area is next to a school and football stadium.
	Evaluation	Land Acquisition	2	3	2
		Construction Method and Cost	1	2	2
		Restoration Work	1	2	2
		Advantage over O/M	2	3	2
		Sub-Total	6	10	8
Total			11	19	14

Table F.15.1 Comparative Study of Design Criteria for Wastewater Treatment

Source	Conventional Activated Sludge Process			Effluent Disinfection
	Primary Sedimentation	Aeration Tank	Secondary Sedimentation	
Wastewater Engineering (Metcalf/Eddy Inc.)	Overflow Rate: 32 ~ 48m³ /m² •d Removal Efficiency BOD: 25~40% SS: 50~70% Bacteria: 25~70%	MLSS: 1200 ~ 3000 mg/l FM radio: 0.2 ~ 0.4 Recirculation Ratio: 0.2 ~ 0.75 HTR: 4 ~ 8 hr Volumetric Loading 0.32 ~ 0.64 kg •BOD/m³ •d	Overflow Rate 16 ~ 33m³ /m² •d Solid loading 3.9 ~ 5.9 kg/m hr	Typical Chlorine Dosage Raw Wastewater: 6 ~ 25 mg/l Primary Effluent: 5~20 mg/l Activated sludge Effluent: 2 ~ 8 mg/l Filtered Effluent: 1~5 mg/l
WEF Manual & ASCE Manual	—	MLSS: 1500~3000 mg/l FM ratio: 0.2 ~ 0.4 Recirculation Reatio: 0.2 ~ 0.5 HTR: 4 ~ 8 hr Volumetric Loading 0.3 ~ 0.6 kg •BOD/m³ •d	Overflow Rate 16 ~ 29m³ /m² •d Solid loading 4 ~ 6 kg/m hr	—
Japanese Design Maunal	Overflow Rate 25 ~ 50m³ /m² •d Removal Efficiency BOD: 30% SS: 40%	MLSS: 1500~2000 mg/l BOD-SS Loading: 0.2 ~ 0.4 Recirculation Reatio: 0.25 ~ 0.4 HTR: 6 ~ 8 hr Volumetric Loading: 0.3 ~ 0.8 kg BOD/m³ •d	Overflow Rate: 20 ~ 30m³ /m² •d	Activated sludge Effluent: 2 ~ 4 mg/l Nos. of Fecal Coli. <3,000 per cm
Cerro de la Estrella (WWTP in Mexico DF)	Overflow Rate: 48 m³ /m² •d Design Removal Efficiency BOD: 13% SS: 49%	MLSS: 1650 mg/l BOD-SS Loading: 0.35 Recirculation Ratio: 0.25 Return Sludge Concentlation: 8,000 mg/l	Overflow Rate: 36m³ /m² •d	

Table F.15.2(1/2) Comparative Study of Design Criteria for Sludge Treatment

Source	Gravity Thickening				Centrifugal Thickening	Anaerobic Digestion	Lime Stabilization
	Type of Sludge	Feed Solids Concentration	Thickened Sludge Concentration	Solid Loading (kg/m² •d)			
Wastewater Engineering (Metcalf/Eddy Inc.)	Primary (PRI) Trickling Filter (T/F) PRI + T/F PRI + Activated sludge (AS) AS + T/F	2~7 % 1~4 % 2~6 % 2~5 % 0.5~2.5 %	5~10% 3~6% 4~9% 2~8% 2~4%	89~136 34~49 59~98 39~78 12~34	Thickened Concentration: 4~6%	Solids Residence Time: for 24°C - 20 days for 30°C - 14 days for 35°C - 10 days for 45°C - 10 days	Typical Lime Dosage for stabilizing liquid sludge Ca (OH)2 /dry solids for PRI 0.12 ~ 0.34 for AS 0.42 ~ 0.86
WEF Manual & ASCE Manual	Primary (PRI) Trickling Filter (T/F) PRI + iron PRI + T/F PRI + AS AS + TF (PRI + iron) + AS	2.0 ~ 7.0% 1.0 ~ 4.0% 2.0% 2.0 ~ 6.0% 0.5 ~ 1.5% 1.8%	5.0 ~ 10% 3.0 ~ 6.0% 4.0% 5.0 ~ 9.0% 4.0 ~ 6.0% 2.0 ~ 4.0% 3.6%	97~145 69~48 29 58~97 24~68 19~34 29	Thickened Concentration: (Reported operating results) 1.8 ~ 10%	Solids Residence Time: 20 days	Pilot study determination of lime dosage Ca (OH)2 /dry solids for PRI 0.10 ~ 0.15 for AS 0.30 ~ 0.50
	Overflow Rate for PRI Sludge: 16 ~ 32 m³ / m² •d						
Japanese Design Manual	Thickened Solids Concentration: 2.0 ~ 4.0% Solids Loading: 60 ~ 90 kg/m² •d Effective Depth: 4.0m				Thickened Concentration: 4%	Detentiom Time 20 days (operating temperature 30°C ~ 35 °C)	—

Table F.15.2(2/2) Comparative Study of Design Criteria for Sludge Treatment

<table>
<tr><th rowspan="2">Source</th><th colspan="4">Mechanical Dewatering (Belt filter press)</th><th colspan="2">Open Drying Bed</th><th rowspan="2">Drying Lagoon</th></tr>
<tr><th>Type of Sludge</th><th>Feed Solids (%)</th><th>Cake Solids (%)</th><th>Loading per belt width (kg/hr •m)</th><th>Type of Sludge</th><th>Solids Loading Rate (kg/m² •Yr)</th></tr>
<tr><td rowspan="2">Wastewater Engineering (Metcalf/Eddy Inc.)</td><td rowspan="2">PRI
PRI + AS
PRI + TF
AS
Anaerobically Digested (PRI + AS)</td><td rowspan="2">3~7
3~6
3~6
1~4
3~6</td><td rowspan="2">28~44
20~35
20~35
12~20
20~25</td><td rowspan="2">-
-
-
-
-</td><td>PRI
PRI + TF digested
PRI + AS digested
PRI + chemical coagulation</td><td>122~146
88~122
59~98
98~161</td><td rowspan="2">- Not suitable for untreated sludges/ limed sludges
- Sludge depth: 0.75~1.25m
- Solids Loading: 36~39 kg/m yr
- Typical cycle time: 2 years</td></tr>
<tr><td colspan="2">Corresdonding area for covered beds Vary from 70 to 75% of open beds</td></tr>
<tr><td rowspan="2">WEF Manual & ASCE Manual</td><td rowspan="2">PRI
PRI + AS
PRI + TF
AS
Anaerobically Digested (PRI + AS)
AS</td><td rowspan="2">3~7
3~6
3~6
1~4
3~6
3~4</td><td rowspan="2">28
23
25
15
22
15</td><td rowspan="2">360~550
180~320
180~320
45~180
180~320
45~135</td><td>Type of sludge</td><td>Solids Loading Rate (kg/m² •Yr)</td><td rowspan="2">—</td></tr>
<tr><td>PRI digested
PRI + TF digested
PRI + AS digested
PRI + chemical coagulation</td><td>134
110
73
110</td></tr>
<tr><td>Japanese Design Manual</td><td colspan="4">Cake Solids Concentration: 25%
Operation Results:
- loading per meter belt width: 90 ~ 150 kg/hr
- cake solids 20 ~ 25%</td><td colspan="2">A = QT/D
where,
A: drying bed area (m)
Q: sludge volume feeded (m³ /d)
D: thickness of feeded sludge (m) 0.15~0.25
T: drying duration (days) 15 ~ 20</td><td>—</td></tr>
</table>

Table F.16.1 Sewerage Tariff Collection Efficiency

HHs/office by type	District									
	Q-1	Q-3	Q-4	Q-5	Q-6	Q-8	Q-10	Q-11	Tan Binh	Total
Area (ha)	760.0	480.0	400.0	417.1	700.0	1,880.0	570.0	500.0	3,850.0	
Gross Number of HHs, Offices and Institutions by Type										
Households	57,760	53,635	37,620	51,736	56,572	70,362	52,923	49,712	126,723	557,043
Governmental offices	129	124	58	54	44	62	48	75	69	663
Industrial establishments	375	763	523	1,421	2,754	1,137	973	3,274	3,828	15,048
Commercial enterprises	1,009	473	104	516	181	173	304	277	389	3,426
Cultural facilities	13	6	2	2	4	0	3	4	1	35
Medical facilities	337	194	78	158	107	71	225	188	319	1,677
Educational faqcilities	66	70	40	57	38	47	52	49	112	531
Density (Number/ha)										
Households	76.000	111.740	94.050	124.037	80.817	37.427	92.847	99.424	32.915	
Governmental offices	0.170	0.258	0.145	0.129	0.063	0.033	0.084	0.150	0.018	
Industrial establishments	0.493	1.590	1.308	3.407	3.934	0.605	1.707	6.548	0.994	
Commercial enterprises	1.328	0.985	0.260	1.237	0.259	0.092	0.533	0.554	0.101	
Cultural facilities	0.0171	0.0125	0.0050	0.0048	0.0057	0.0000	0.0053	0.0080	0.0003	
Medical facilities	0.443	0.404	0.195	0.379	0.153	0.038	0.395	0.376	0.083	
Educational faqcilities	0.087	0.146	0.100	0.137	0.054	0.025	0.091	0.098	0.029	
Ranking Points										
Households	3	8	6	9	4	2	5	7	1	
Governmental offices	8	9	6	5	3	2	4	7	1	
Industrial establishments	1	5	4	7	8	2	6	9	3	
Commercial enterprises	9	7	4	8	3	1	5	6	2	
Cultural facilities	9	8	4	3	6	1	5	7	2	
Medical facilities	9	8	4	6	3	1	7	5	2	
Educational faqcilities	4	9	7	8	3	1	5	6	2	
Total points	43	54	35	46	30	10	37	47	13	
Ranking Points Adjusted by Recommended Tariff										
Households	3	8	6	9	4	2	5	7	1	
Governmental offices	15	16	11	9	5	4	7	13	2	
Industrial establishments	2	9	7	13	15	4	11	16	5	
Commercial enterprises	37	29	16	33	12	4	20	25	8	
Cultural facilities	16	15	7	5	11	2	9	13	4	
Medical facilities	16	15	7	11	5	2	13	9	4	
Educational faqcilities	7	16	13	15	5	2	9	11	4	
Adjusted total points	96	108	68	95	58	19	75	94	27	
Weighted points	65	12	60	95	13	7	38	28	1	

Note : Adjustment factors-

12,500 (VND for households)

51,100 (VND for Commercial enterprises)

22,800 (VND for industrial establishments and others)

Table F.16.2 Sewerage Tariff Collection Efficiency Presented by Ponit

Sub-zone	District									
	Q-1	Q-3	Q-4	Q-5	Q-6	Q-8	Q-10	Q-11	Tan Binh	Total
East part of left bank of Ben Nghe canal										
1	17									17
2	18	0								18
3	3									3
4	9									9
5	8	1								10
6	6									6
7	3	10		17			12			42
8	1			8						9
9				8			1			9
10				5						5
Sub-total	65	12	0	38	0	0	12	0	0	127
West part of left bank of Tau Hu canal										
11				9			5			14
12				3						3
13				30			17	3		50
14				13	1		3	14	0	32
15				1	3			10	1	15
16					9					9
Sub-total	0	0	0	56	13	0	25	28	1	123
Isolated area by Tau Hu, Ben Nghe - Doi, Te canals										
Khanh Hoi			59							59
Ong Kieu			1							1
Hung Phu						1				1
Tung Thien Vuong						1				1
Binh Dong						0				0
Sub-total	0	0	60	0	0	2	0	0	0	62
Souther area of Doi, Te canal										
Ranch Ong						1				1
Phan The Hien						2				2
Bing Dang						2				2
Sub-total	0	0	0	0	0	5	0	0	0	5
Total	65	12	60	95	13	7	38	28	1	318

Table F.17.1(1/2) Project Cost of Each Wastewater Treatment Process

Treatment Capacity : 141,000 m^3/day
BOD_5 in : 180 mg/L

(Unit : million VND)

No.	Process	Effluent BOD_5 (mg/L)	Classification	Work Item	Construction Cost (DCB)	Total Construction Cost3) (DC)	Land Acquisition Cost4) (LC)	Engineering Cost DC x 0.07	Administration Cost (DC+LC) x 0.01	Physical Contingency DC x 0.1	Total Project Cost
1	Stabilization Pond and Drying Bed	50	(I) Direct Cost	Civil	332,557	624,282	19,500	43,700	9,657	62,428	759,566
				Building	19,199						
				Mechanical	32,448						
				Electricity	21,174						
				Others	48,645						
			(II) Indirect Cost[1]		113,506						
			(III) Head Office Expenses[2]		56,753						
2	Aerated Lagoon and Drying Bed	50	(I) Direct Cost	Civil	278,561	601,034	19,500	42,072	9,308	60,103	732,018
				Building	19,199						
				Mechanical	46,203						
				Electricity	49,835						
				Others	43,318						
			(II) Indirect Cost[1]		109,279						
			(III) Head Office Expenses[2]		54,639						
3	Primary Sedimentation + Stabilization Pond and Drying Bed	50	(I) Direct Cost	Civil	321,811	622,170	19,500	43,552	9,625	62,217	757,064
				Building	19,199						
				Mechanical	41,438						
				Electricity	21,558						
				Others	48,481						
			(II) Indirect Cost[1]		113,122						
			(III) Head Office Expenses[2]		56,561						
4	Modified Activated Sludge and Belt Press Filter	50	(I) Direct Cost	Civil	286,094	691,761	19,500	48,423	10,669	69,176	839,529
				Building	59,333						
				Mechanical	75,392						
				Electricity	49,367						
				Others	32,913						
			(II) Indirect Cost[1]		125,775						
			(III) Head Office Expenses[2]		62,887						

Table F.17.1(2/2) Project Cost of Each Wastewater Treatment Process

Treatment Capacity : 141,000 m^3/day
BOD_5 in : 180 mg/L

(Unit : million VND)

No.	Process	Effluent BOD_5 (mg/L)	Classification	Work Item	Construction Cost (DC_B)	Total Construction Cost[3] (DC)	Land Acquisition Cost[4] (LC)	Engineering Cost DC x 0.07	Administration Cost (DC+LC)x0.015	Physical Contingency DC x0.1	Total Project Cost
S-1	Conventional Activated Sludge and Drying Bed	20	(I) Direct Cost	Civil	535,459	1,001,241	19,500	70,087	15,311	100,124	1,206,263
				Building	19,199						
				Mechanical	77,996						
				Electricity	54,303						
				Others	41,217						
			(II) Indirect Cost[1]		182,044						
			(III) Head Office Expenses[2]		91,022						
S-2	Conventional Activated Sludge and Belt Press Filter	20	(I) Direct Cost	Civil	412,239	902,332	19,500	63,163	13,827	90,233	1,089,056
				Building	59,333						
				Mechanical	88,284						
				Electricity	59,240						
				Others	37,146						
			(II) Indirect Cost[1]		164,060						
			(III) Head Office Expenses[2]		82,030						
S-3	Primary Sedimentation and Drying Bed	125		Civil	243,006	496,941	19,500	34,786	7,747	49,694	608,668
				Building	19,199						
				Mechanical	64,801						
				Electricity	18,057						
				Others	16,350						
			(II) Indirect Cost[1]		90,353						
			(III) Head Office Expenses[2]		45,176						

(Remarks)
1) Temporary works and cost of safety and sanitary control : 25 % of (I) Direct cost
2) { (I)+(II) } x 10 %
3) (I) + (II) + (III)
4) Land acquisition of fish pond, so estimate the same cost as farmland (39,000 VND/m^2)

Table F.17.2 Power Equipment Comparison in Phase I

Treatment Capacity : 141,000 m^3/day
BOD_5 in : 180 mg/L

(Unit : million VND)

No.	Process	Effluent BOD_5 (mg/L)	Main Equipment	Required Power (kW) Normal	Building	Central Control	Outdoor Lighting	Others	Total
1	Stabilization Pond and Drying Bed	50	Lifting Pump	800	120	0	300	50	1,270
2	Aerated Lagoon and Drying Bed	50	Lifting Pump	800	120	0	200	50	2,989
			Aerator	1,800					
			Sludge Pump	19					
3	Primary Sedimentation + Stabilization Pond and Drying Bed	50	Lifting Pump	800	120	0	300	50	1,293
			Sludge Pump	23					
4	Modified Activated Sludge and Belt and Belt Press Filter	50	Lifting Pump	800	120	40	60	50	3,346
			Blower	1,760					
			Sludge Pump	415.4					
			Dewatering	101					
S-1	Conventional Activated Sludge and Drying Bed	20	Lifting Pump	800	120	40	60	50	3,257
			Blower	1,760					
			Sludge Pump	427					
S-2	Conventional Activated Sludge and Belt Press Filter	20	Lifting Pump	800	120	40	60	50	3,407
			Blower	1,760					
			Sludge Pump	435					
			Dewatering	142					
S-2	Primary Sedimentation and Drying Bed	125	Lifting Pump	800	120	20	60	50	1,083
			Sludge Pump	33					

Note : Aerated Lagoon, Conventional and Modified Activated Sludge Process will need High Voltage Intake Sub-Station.

Table F.17.3 Comparison of Maintenance Cost by Alternatives

No.	Process	Effluent BOD$_5$ (mg/L)	Power Consumption			Chemicals Cost						Total Cost (millionVND/day)
			Required Power[1] (kWh/day)	Unit cost (VND/kWh)	Cost (millionVND/day)	Chlorine[2] (kg/day)	Unit cost (VND/kg)	Cost (millionVND/day)	Polymer[3] (kg/day)	Unit cost (VND/kg)	Cost (millionVND/day)	
1	Stabilization Pond and Drying Bed	50	24,384	700	17.1	423	7,000	2.961	0	75,000	0	20.0
2	Aerated Lagoon and Drying Bed	50	57,389	700	40.2	423	7,000	2.961	0	75,000	0	43.1
3	Primary Sedimentation + Stabilization Pond and Drying Bed	50	24,826	700	17.4	423	7,000	2.961	0	75,000	0	20.4
4	Modified Activated Sludge and Belt Press Filter	50	62,074	700	43.5	423	7,000	2.961	237	75,000	17.8	64.3
S-1	Conventional Activated Sludge and Drying Bed	20	62,534	700	43.8	423	7,000	2.961	0	75,000	0	46.8
S-2	Conventional Activated Sludge and Belt Press Filter	20	65,318	700	45.7	423	7,000	2.961	300	75,000	22.5	71.2
S-3	Primary Sedimentation and Drying Bed	125	20,794	700	14.6	423	7,000	2.961	0	75,000	0	17.6

(Remarks)
1) Supply power x 0.8
2) 3 mg/L as chlorine
3) 1 % to solid of sludge

Table F.17.4 FEATURES OF WASTEWATER TREATMENT PROCESS

Alternative No.	1 Stabilization Pond and Drying Bed	2 Aerated lagoon and Drying Bed	3 Primary Sedimentation and Stabilization pond	4 Modified Activated sludge and Belt Press Filter	S-1 Conventional Activated sludge and Drying Bed	S-2 Conventional Activated sludge and Belt Press Filter	S-3 Primary Sedimentation and Drying Bed
Effluent BOD_5 (mg/L)	50	50	50	50	20	20	125
Construction Cost	Moderate	Moderate	Relatively high	Relatively High	Highest	High	Cheapest
Facility Maintenance	Easy *Need algae removal in *facultative pond	Relatively easy *Need maintenance of aerators	Relatively easy *Need maintenance of sludge pumps *Need algae removal in facultative pond	Not easy *Need expert for maintenance blower, sludge pumps and belt press filter	Not easy *Need expert for maintenance blower and sludge pumps	Not easy *Need expert for maintenance blower, sludge pumps and belt press filter	Relatively Easy *Need maintenance of sludge *pumps
Operation Technology	Easy	Relatively easy *Need D.O check *Need sludge treatment after three years	Easy	Not easy *Need experts for maintenance of MLSS, solid separation, D.O check, sludge return and polymer for dewatering	Not easy *Need experts for maintenance of MLSS, solid separation, D.O check and sludge return	Not easy *Need experts for maintenance of MLSS, solid separation, D.O check, sludge return and polymer for dewatering	Relatively Easy
Power Consumption	Small	Relatively big *May need special high voltage intake facility.	Small	Relatively Big *May need special high voltage intake facility.	Big *May need special high voltage intake facility.	Biggest *May need special high voltage intake facility.	Smallest
Required Area	Very large	Large	Large	Small	Moderate	Small	Smallest
Possibility of Higher Effluent Quality	Impossible *No space left in any pond	Impossible *No space left in any pond	Impossible * No space left in any pond	Easy *Need expansion of facilities	Very Easy	Very Easy	Not easy *Need aeration tank and Secondary Sedimentation
Excess Sludge	Very small	Relatively big	Relatively small *Need thickener	Large *Need thickener and belt press	Large *Need thickener	Large *Need thickener and belt press	Relatively Small
Adaptability to Valuation	Moderate *Weaker to toxic due to anaerobic process *Strong to quantity change	Moderate *Weaker to toxic *Strong to quantity change	Moderate *Weaker to toxic due to anaerobic process *Strong to quantity change	Weak *Weak to change of quantity and quality due to short retention time	Weak *Weak to change of quantity and quality due to short retention time	Weak *Weak to change of quantity and quality due to short retention time	Weak *Weak to change of quantity and quality due to short retention time
Effluent Quality	Moderate	Moderate	Moderate	Moderate	Good	Good	Not good
Environmental Aspect	*Smell may occur in anaerobic pond and drying bed *Aeration may need to prevent odor in facultative pond once or twice a day. *Algae flowout	*Noise of aerator and smell in drying bed *Algae flowout	*Smell may occur in anaerobic pond *Aeration may need to prevent odor in facultative pond once or twice a day. *Algae flowout	*Noise of belt press	*Smell in drying bed	*Noise of belt press	*Smell in drying bed *Smell of effluent
Initial Performance	Very Bad *Need two or three month operation due to natural bio-process	Bad *Need two or three month operation due to natural bio-process	Very Bad *Need two or three month operation due to natural bio-process	Good *Only after two weeks, the process can give regular performance by seeding.	Good *Only after two weeks, the process can give regular performance by seeding.	Good *Only after two weeks, the process can give regular performance by seeding.	Good *Only physical process
Smoothness of switching to Conventional Activated Sludge Process with bigger capacity in the final stage.	*Need almost parts of land to be developed again	*Need almost parts of land to be developed and sludge tank again. *Aerators for this process are no use in A.S.	*Need almost parts of land to be developed again	*Easy to construct same structure and facilities without re-building sludge storage tank thickener and Dewatering room. *Part of roads should be re-built.	*Easy to construct same structure and facilities without re-building sludge storage tank and thickener. *Part of roads should be re-built. *Sludge treatment facilities are necessary.	*Easy to construct same structure and facilities without re-building sludge storage tank thickener and Dewatering room. *Part of roads should be re-built.	*Need aeration tanks and Secondary sedimentation. *No need of rebuilding sludge storage tank *Part of roads should be re-built. *Sludge treatment facilities are necessary.

Table F.17.5 Evaluation of Wastewater Treatment Process

Alternative No.	1	2	3	4-(1)	4-(2)	5	6
Process	Stabilization Pond and Drying Bed	Aerated lagoon and Drying Bed	rimary Sedimentatio and Stabilization pon and Drying Bed	onventional Activate Sludge + Drying Bed	onventional Activate Sludge + Belt Press Filter	rimary Sedimentatio and Drying Bed	Modified Activated Sludge + Belt Press Filter
Effluent BOD_5 (mg/L)	50	50	50	20	20	125	50
Construction Cost / Removal BOD_5	4	6	5	1	2	0	3
Facility Maintenance	5	4	5	3	2	4	2
Operation technology	5	3	4	2	1	4	1
Maintenance Cost	5	3	4	2	0	6	1
Required Area	0	2	1	3	5	4	6
Possibility of higher effluent quality with expansio	0	1	0	5	6	2	4
Excess Sludge generation	6	3	4	1	1	4	2
Adaptability to validation	3	4	3	2	2	3	2
Effluent quality	4	4	4	6	6	1	4
Environmental Aspect	2	3	2	4	5	1	4
Initial Performance	1	2	1	5	5	6	5
Smoothness of switching to conventional activated Sludge process with bigger capacity in the final sta	0	1	1	4	6	2	5
Total Evaluation	**35**	**36**	**34**	**38**	**41**	**37**	**39**
Conclusive Order	⑥	⑤	⑦	③	①	④	②

(Remark) As for the figures above, larger is better except conclusive order.

Table F.17.6 Evaluation of Wastewater Treatment Process

(1) Activated sludge processes are superior to pond processes such as Stabilization Pond, Aerated Lagoon and Stabilization Pond system after primary sedimentation, conclusively.

(2) Construction Cost per BOD_5 Removal
In alternative study, three kinds of effluent BOD_5 are proposed, namely 20 mg/L for Conventional activated sludge process, 50 mg/L for stabilization pond, aerated lagoon, primary sedimentation + stabilization pond, modified activated sludge and 125 mg/L for primary sedimentation.

To compare investment efficiency of each process, construction cost per BOD_5 removal is calculated as below.

- Wastewater Treatment Plant in the Phase I 141,000 m^3/day
- Inflow BOD_5 180 mg/L

Construction cost per BOD_5 Removal

Wastewater Treatment Process	BOD_5out (mg/L)	BOD_5 Removed (kg/day)	Construction Cos (million VND)	Construction Cost per BOD_5 Removal (million VND/kg-BOD_5/day)
Stabilization Pond Process and Drying Bed	50	18,330	624,282	34.1
Aerated Lagoon Process and Drying Bed	50	18,330	601,034	32.8
Primary Sedimentation + Stabilization Pond Proces and Drying Bed	50	18,330	622,170	33.9
Conventional Activated Sludge Process and Drying	20	22,560	1,001,241	44.4
Conventional Activated Sludge Process and Belt Pr	20	22,560	902,332	40.0
Primary Sedimentation and Belt Press	125	7,755	496,941	64.1
Modified Activated Sludge Process and Belt Press	50	18,330	691,761	37.7

1) In the point of investment efficiency towards BOD_5 removal, Primary sedimentation is the worst in the Phase I
Pond processes such as Stabilization pond and aerated lagoon process are superior to conventional activated sludge, but expansion of the facilities to the final stage is difficult due to the limitation of available land.
2) Investment efficiency of conventional activated sludge process with belt press is higher than that with drying bed.
3) Cost efficiency to BOD_5 removal of the modified activated sludge process with effluent quality of 50 mg/L in terms of BOD_5 is not so much different from that of pond processes.

Recommended wastewater process for the Phase I
Based on the following aspects, modified activated sludge process and belt press filter with design effluent quality of 50 mg/L in terms of BOD_5 is recommended for the Phase I

(1) From the economical view, the process of primary sedimentation and pond processes are superior to conventional activated sludge process.
However, the process of only primary sedimentation is the worst in cost efficiency to BOD_5 removal and the pond processes can't expand the capacity both in quantity and quality. That means the pond processes need dual investment in the final stage.
Adding to this, the pond processes have the smell problem in common.
Furthermore, the pond processes, if once the bacteria to purify organic matters are killed, more than two or three months will be necessary to recover the performance. As for activated sludge process, maximum two weeks are necessary.
(2) Therefore, activated sludge process should be recommended from the points of environmental aspects and the flexibility in expanding the facilities in the final stage without dual investment, even though construction and maintenance cost are higher than the pond processes.
(3) Conventional activated sludge process with drying bed is more economical in maintenance cost but higher in construction cost than that with belt press filter. However, the process with drying bed may cause smell problem from drying bed. Therefore, the conventional process with belt press filter is recommended in environmental aspects.
(4) Cost efficiency to BOD_5 removal of modified activated sludge process is close to that of pond processes and had flexibility of expanding the capacity both in quantity and quality.

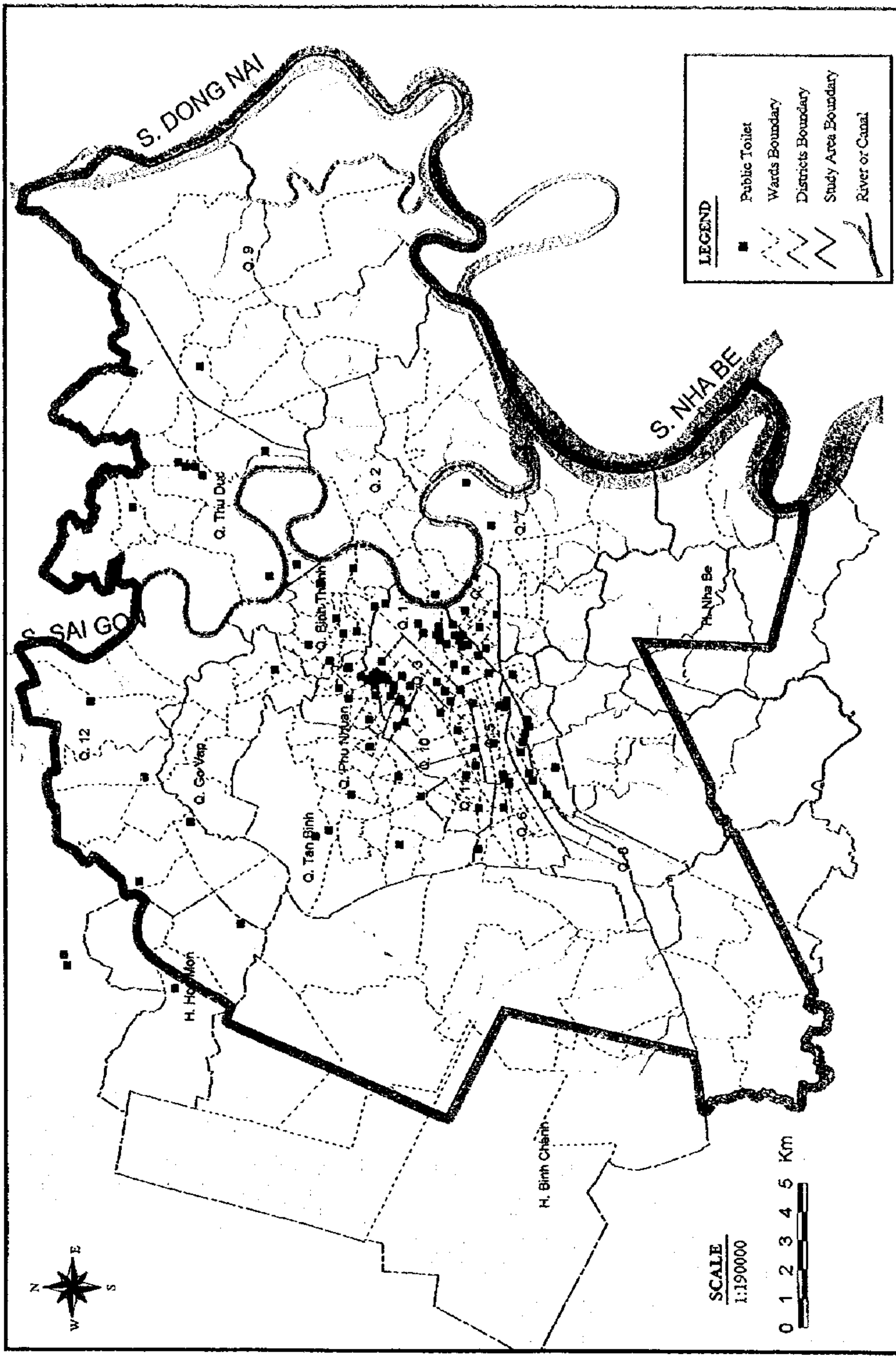


FIG. F.2.1 DISTRIBUTIONN OF PUBLIC TOILET

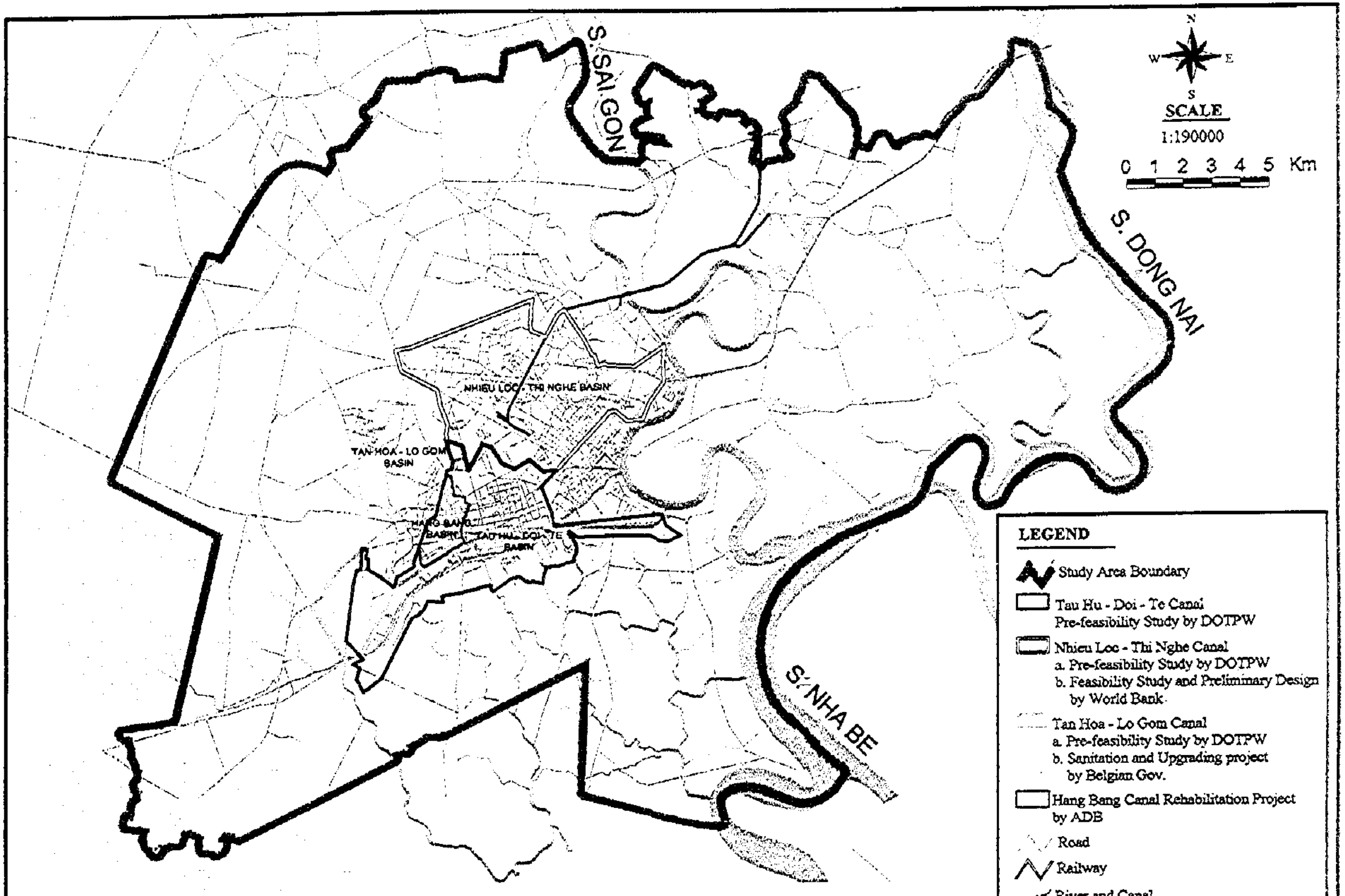


FIG. F.2.2 RELEVANT STUDY ON SEWERAGE DEVELOPMENT

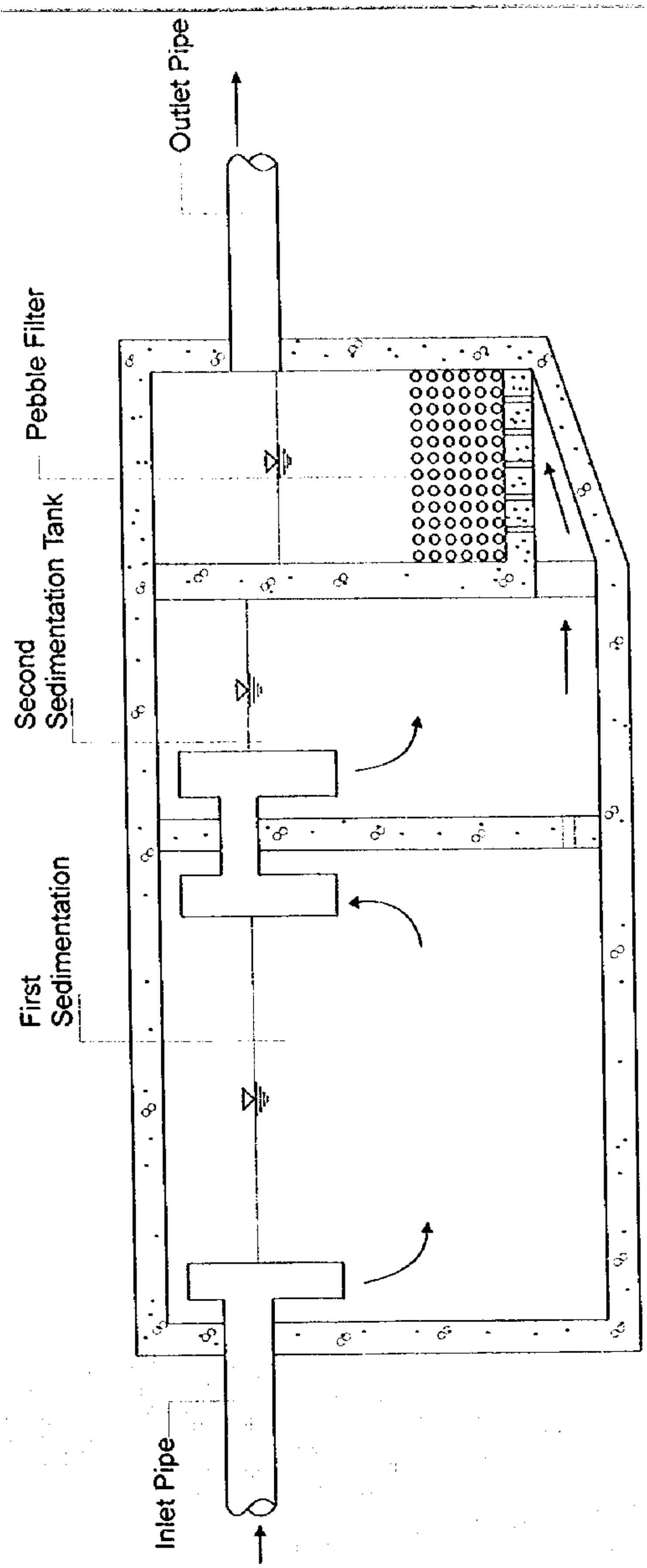


Fig. F.3.1 SEPTIC TANK WITH ANAEROBIC UP-FLOW FILTER

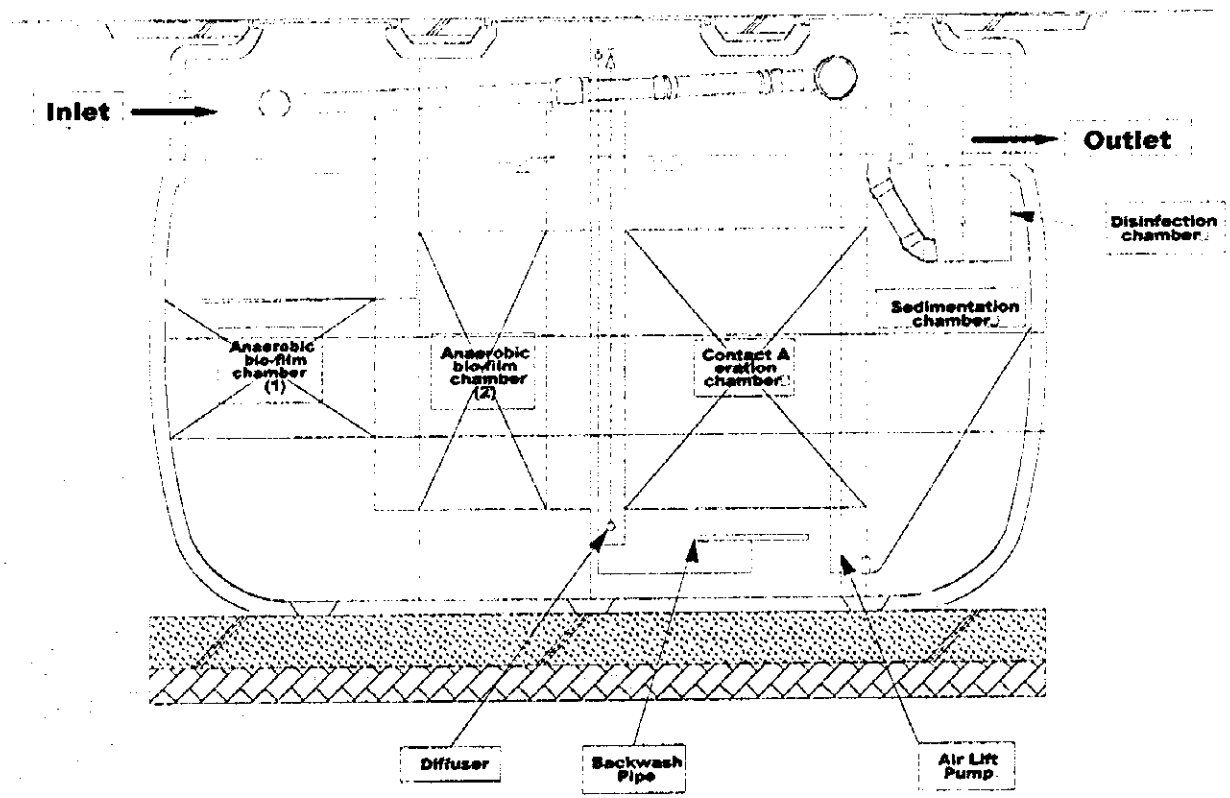
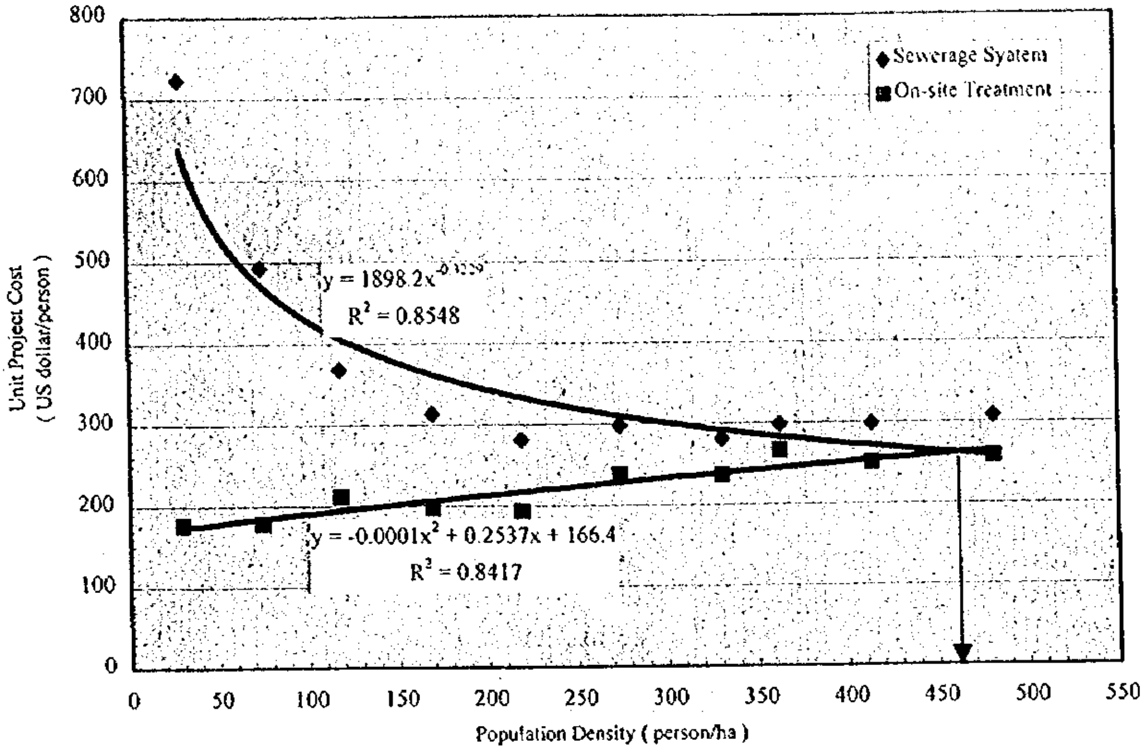
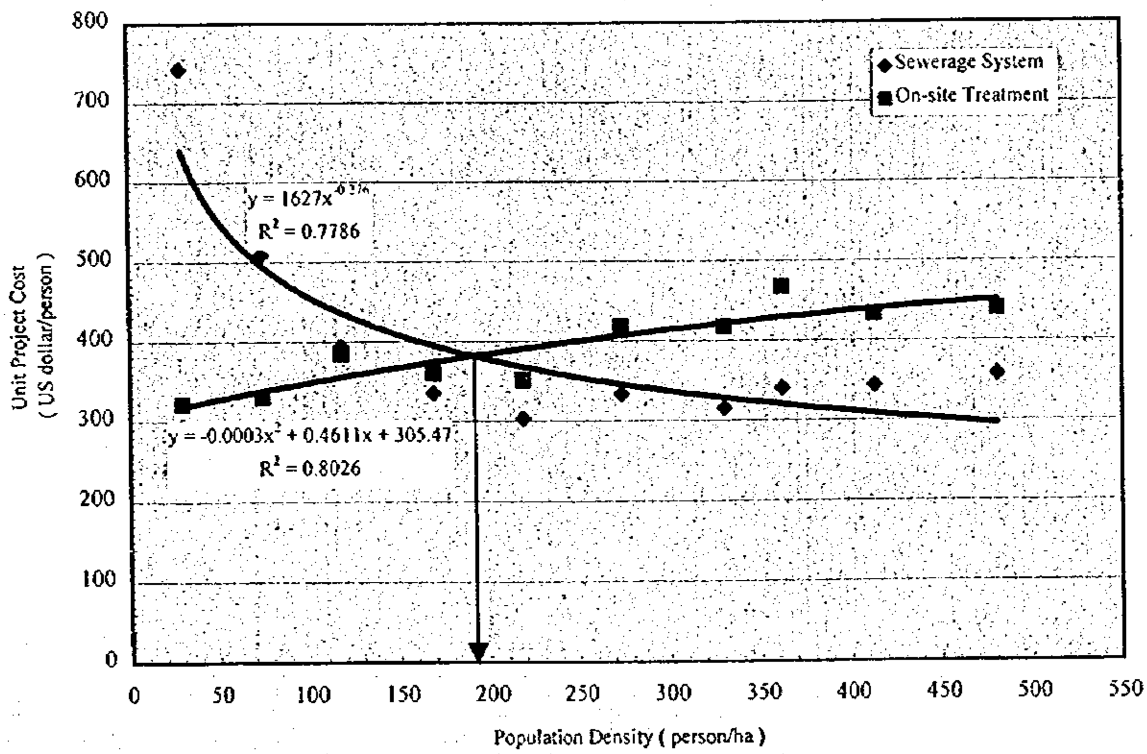


Fig. F.3.2 Cross-section of Johkaso



Relation of Population Density and Unit Project Cost
(Eff.BOD : 50 mg/L)



Relation of Population density and Unit Project Cost
(Eff.BOD 20 mg/L)

FIG. F.3.3 Relation of Population Density and Unit Project Cost

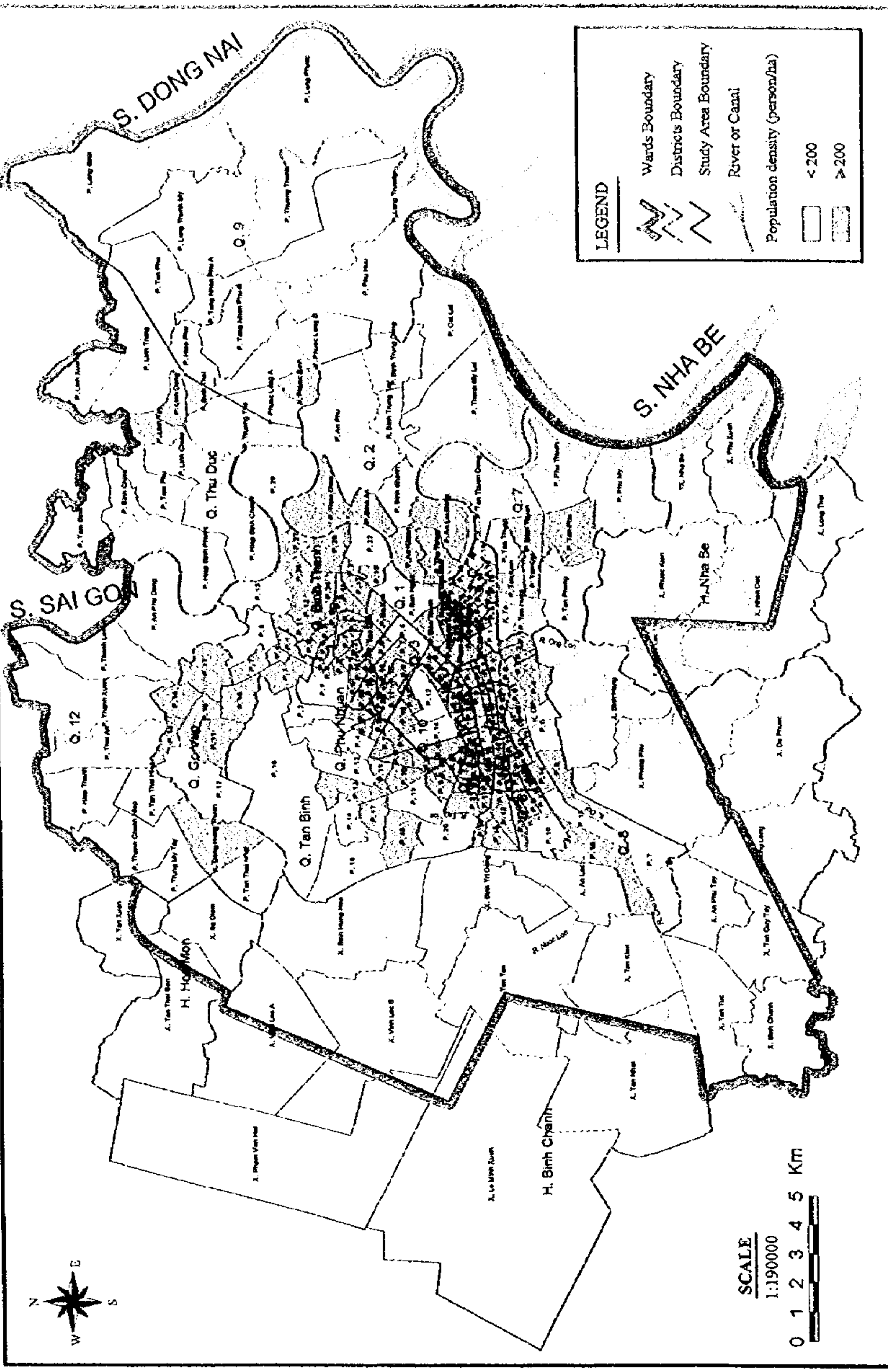


FIG. F.3.4 DIVISION OF PROJECT AREA BY POPULATION DENSITY (FUTURE - 2020)

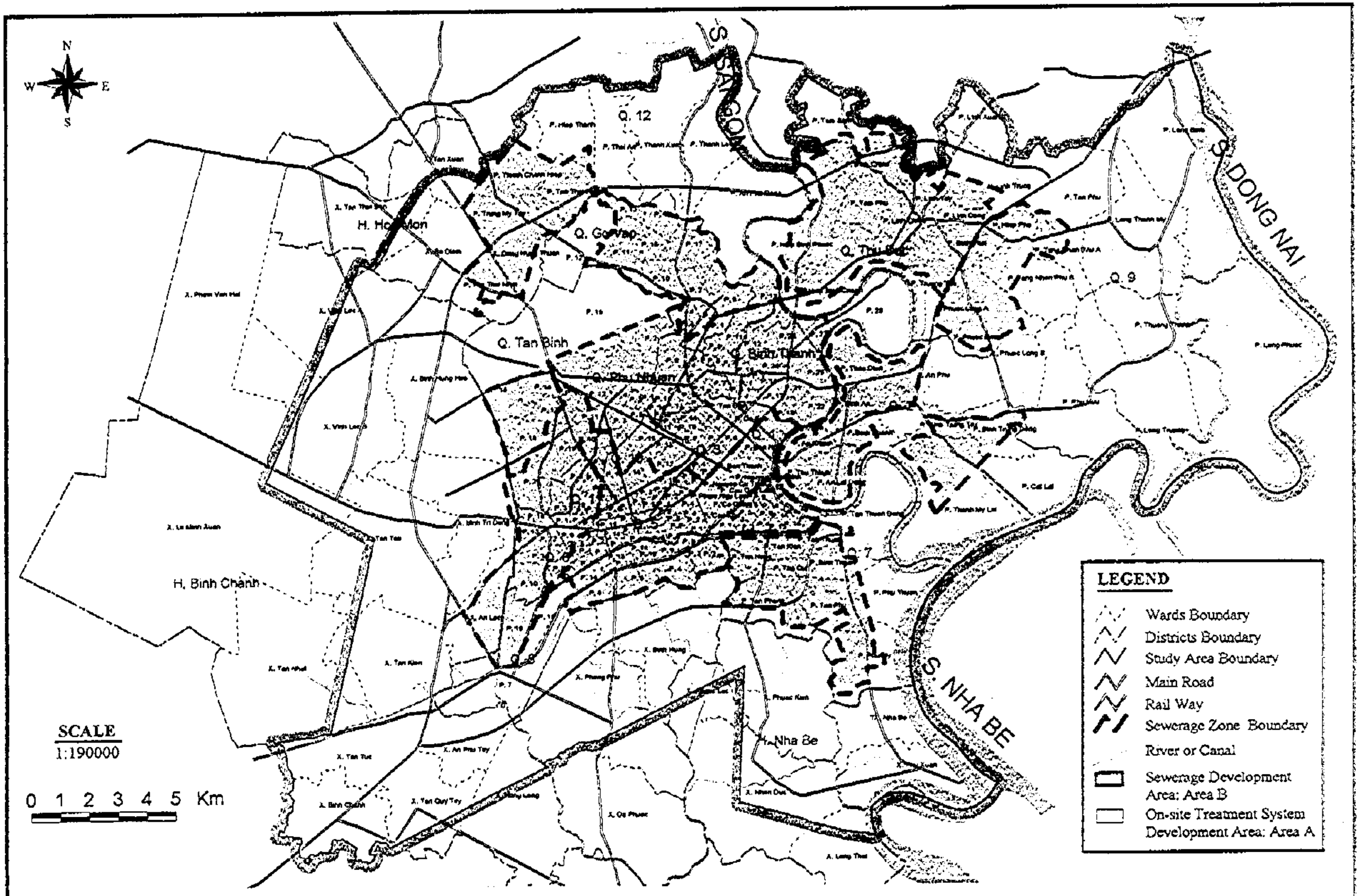


FIG. F.3.5 DIVISION OF PROJECT AREA BY SANITATION SYSTEM

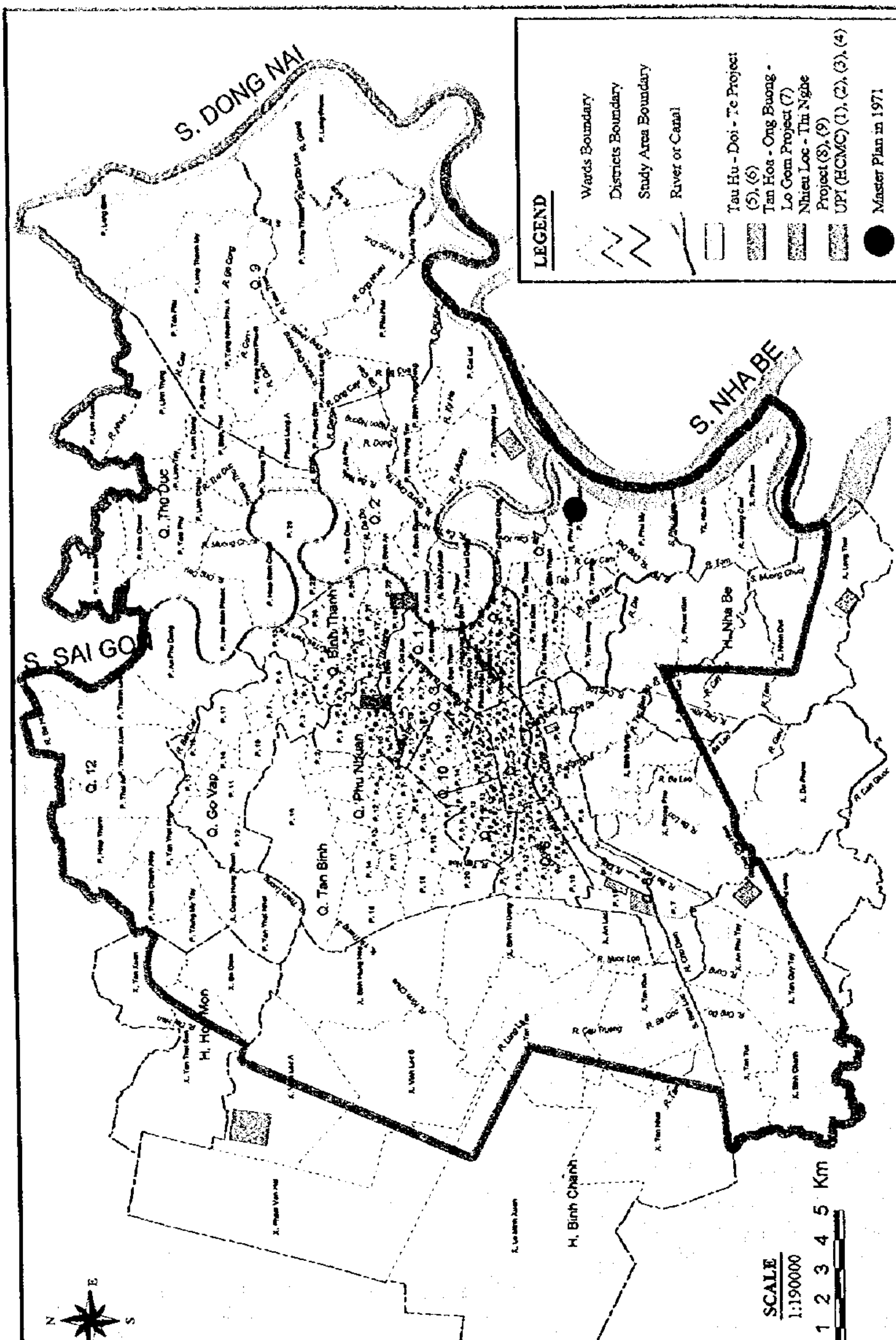


FIG. F.4.1 POTENTIAL WASTEWATER TREATMENT PLANT SITES BY OTHER PROJECTS

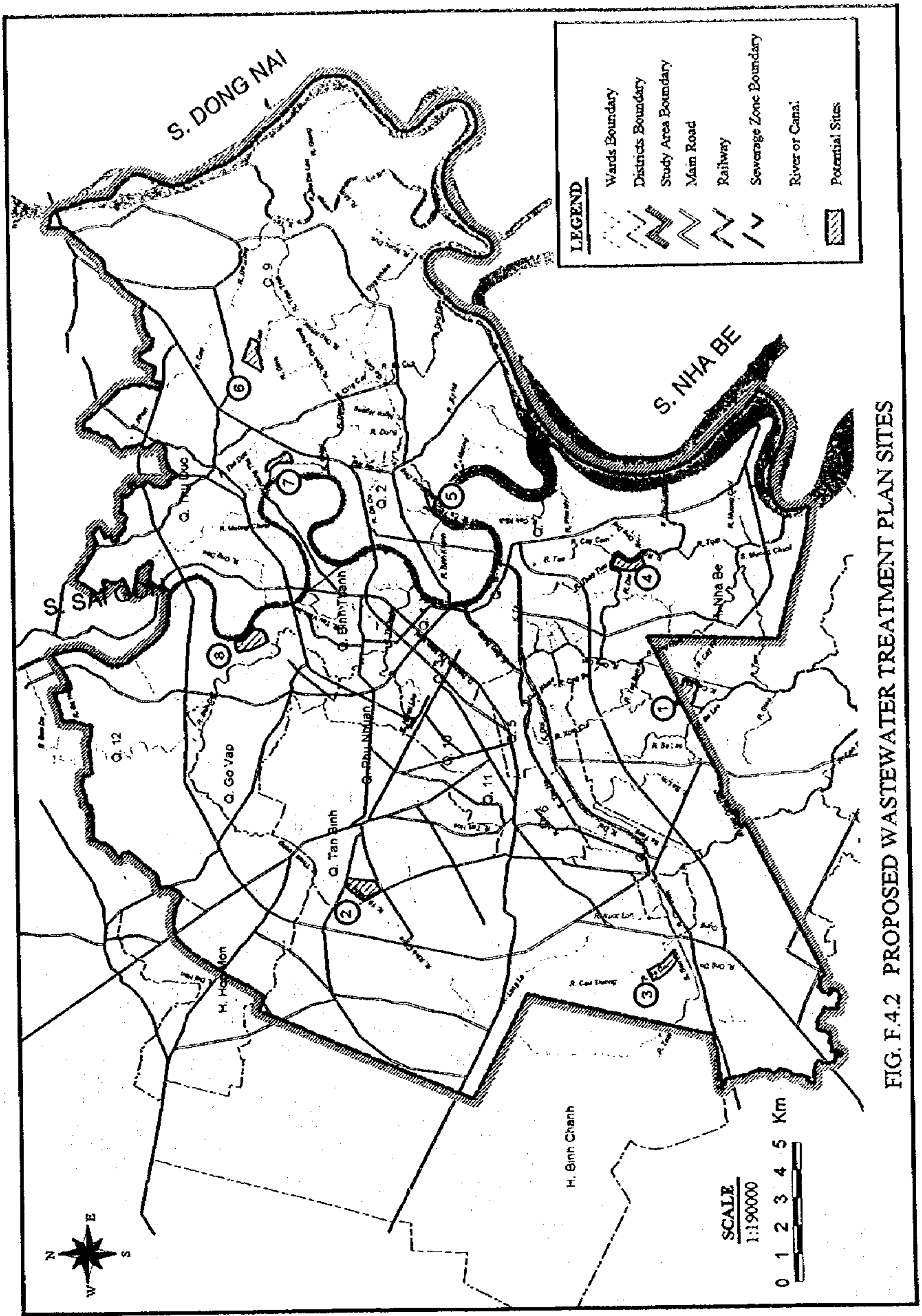


FIG. F.4.2 PROPOSED WASTEWATER TREATMENT PLAN SITES

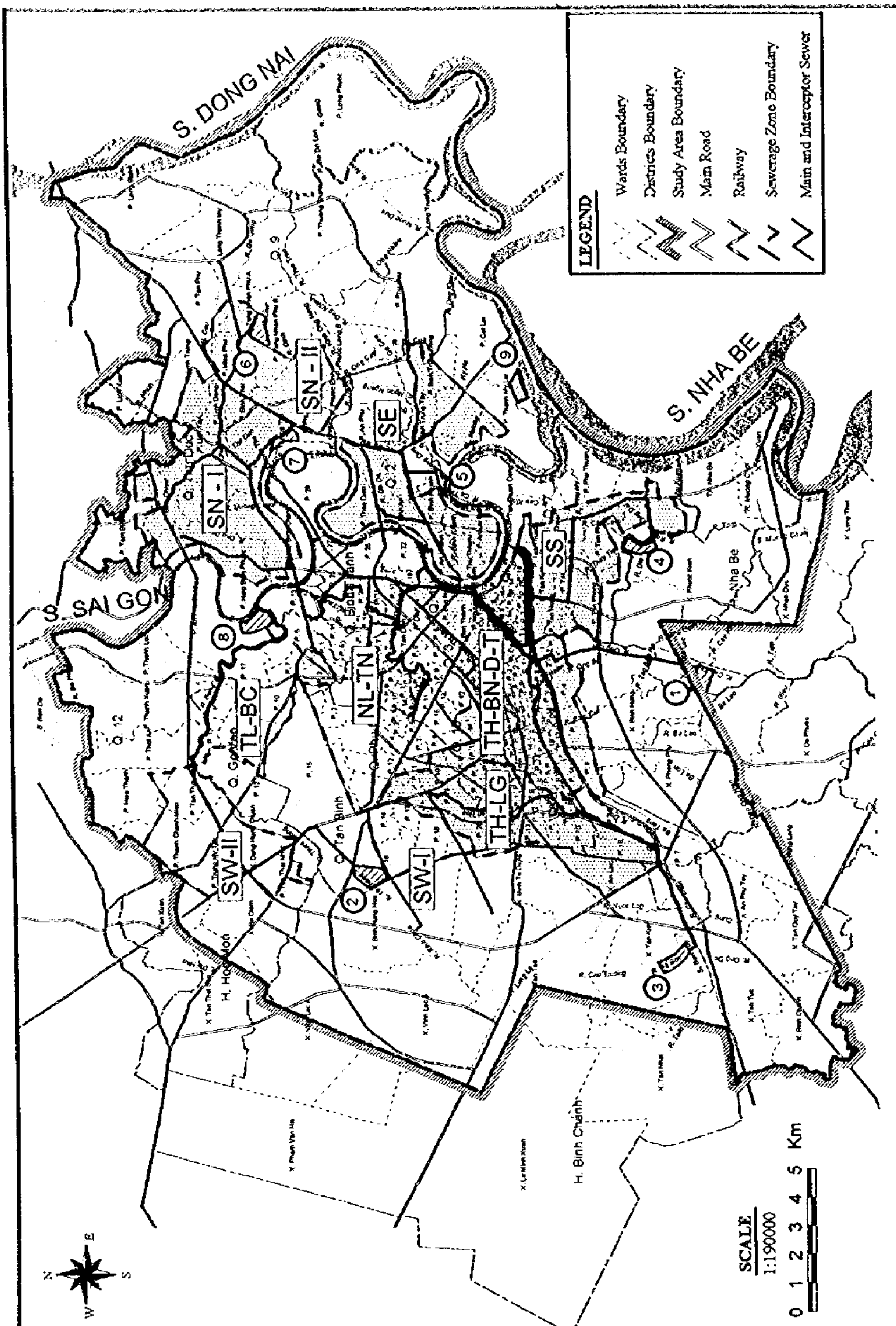


FIG. F.5.1 ALTERNATIVE I INDIVIDUAL SMALL SCALE TREATMENT SYSTEM

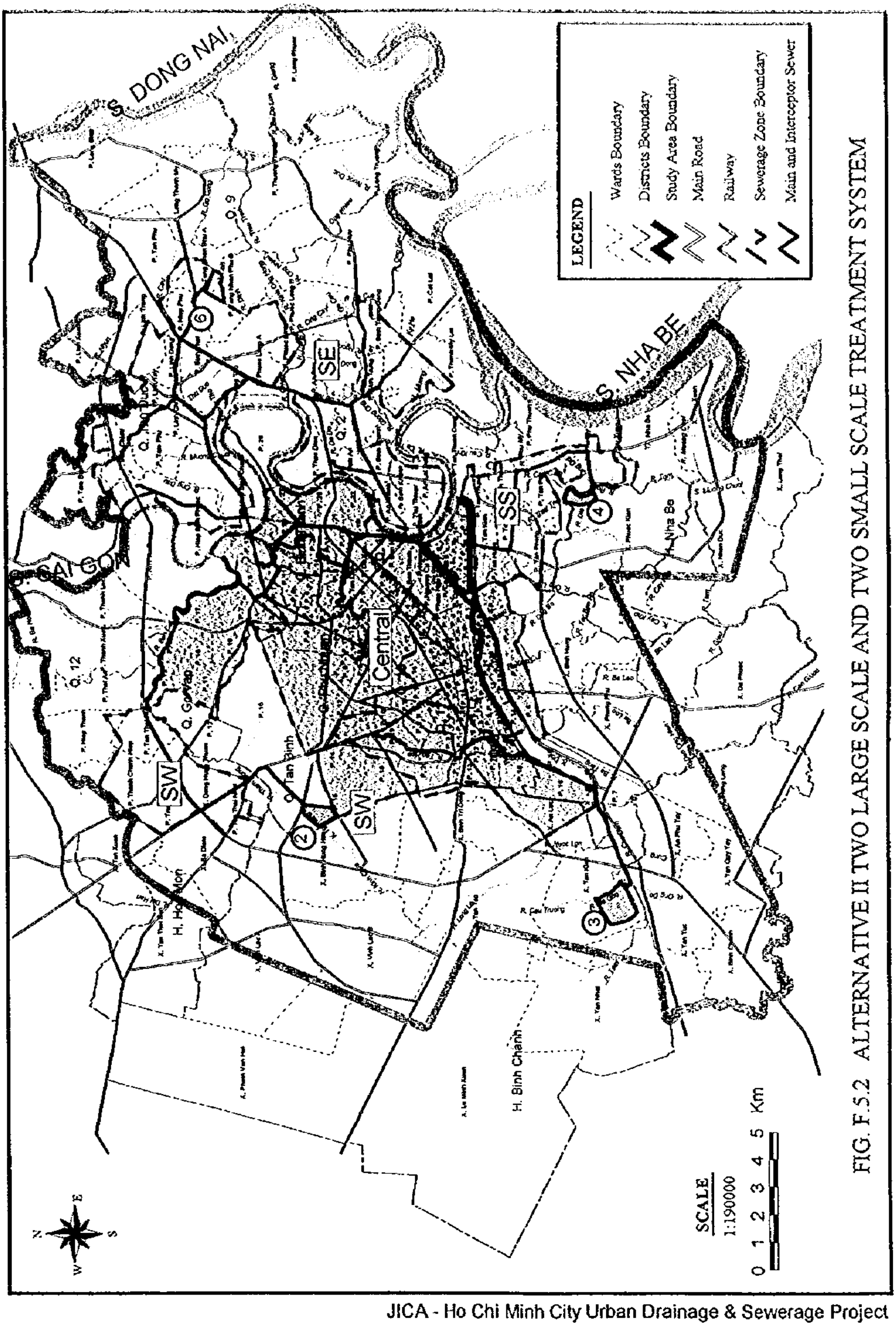


FIG. F.5.2 ALTERNATIVE II TWO LARGE SCALE AND TWO SMALL SCALE TREATMENT SYSTEM

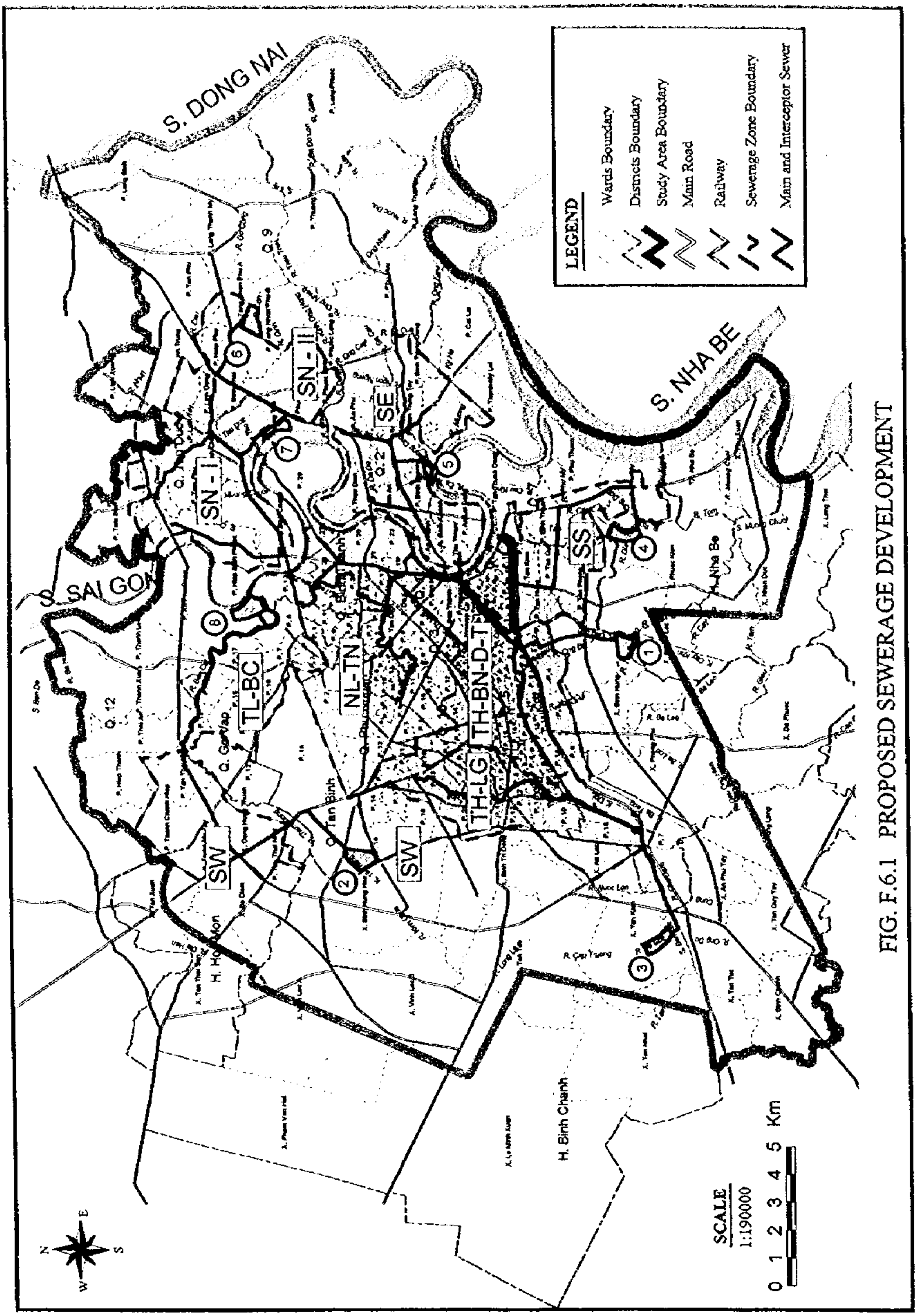


FIG. F.6.1 PROPOSED SEWERAGE DEVELOPMENT

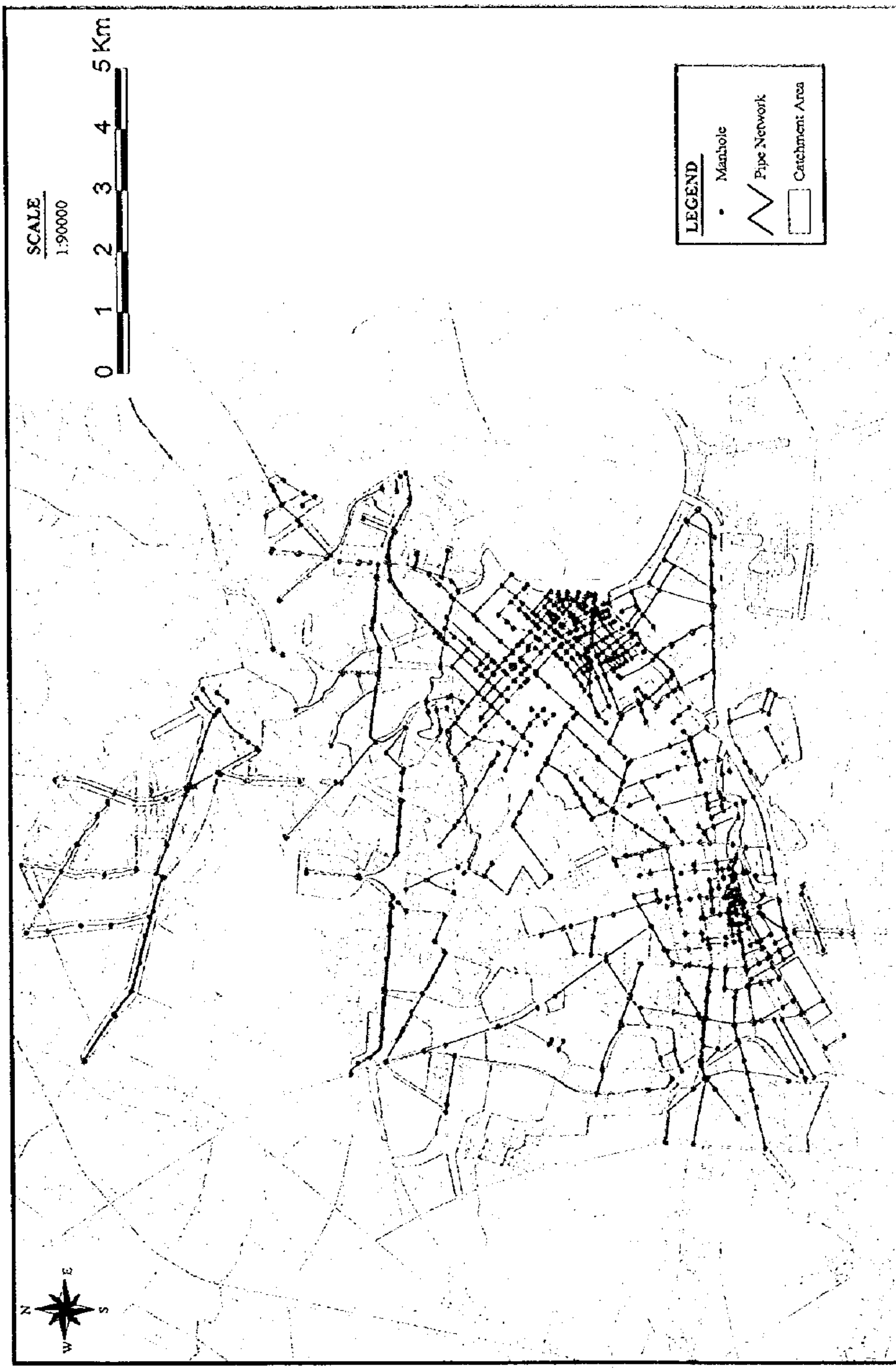


FIG. F.6.2 EXISTING MAIN DRAINAGE PIPE NETWORK

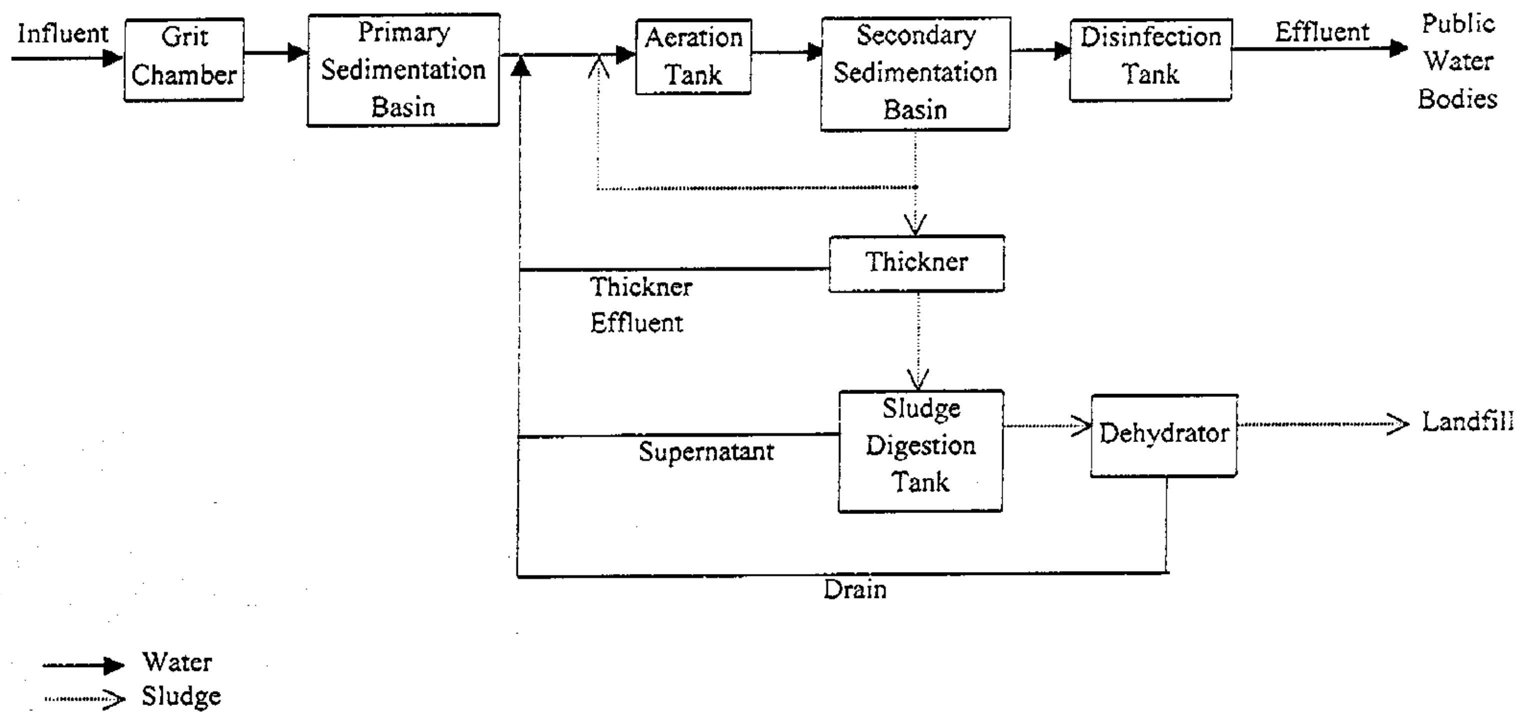


FIG. F.6.3 FLOW CHART OF ACTIVATED SLUDGE PROCESS

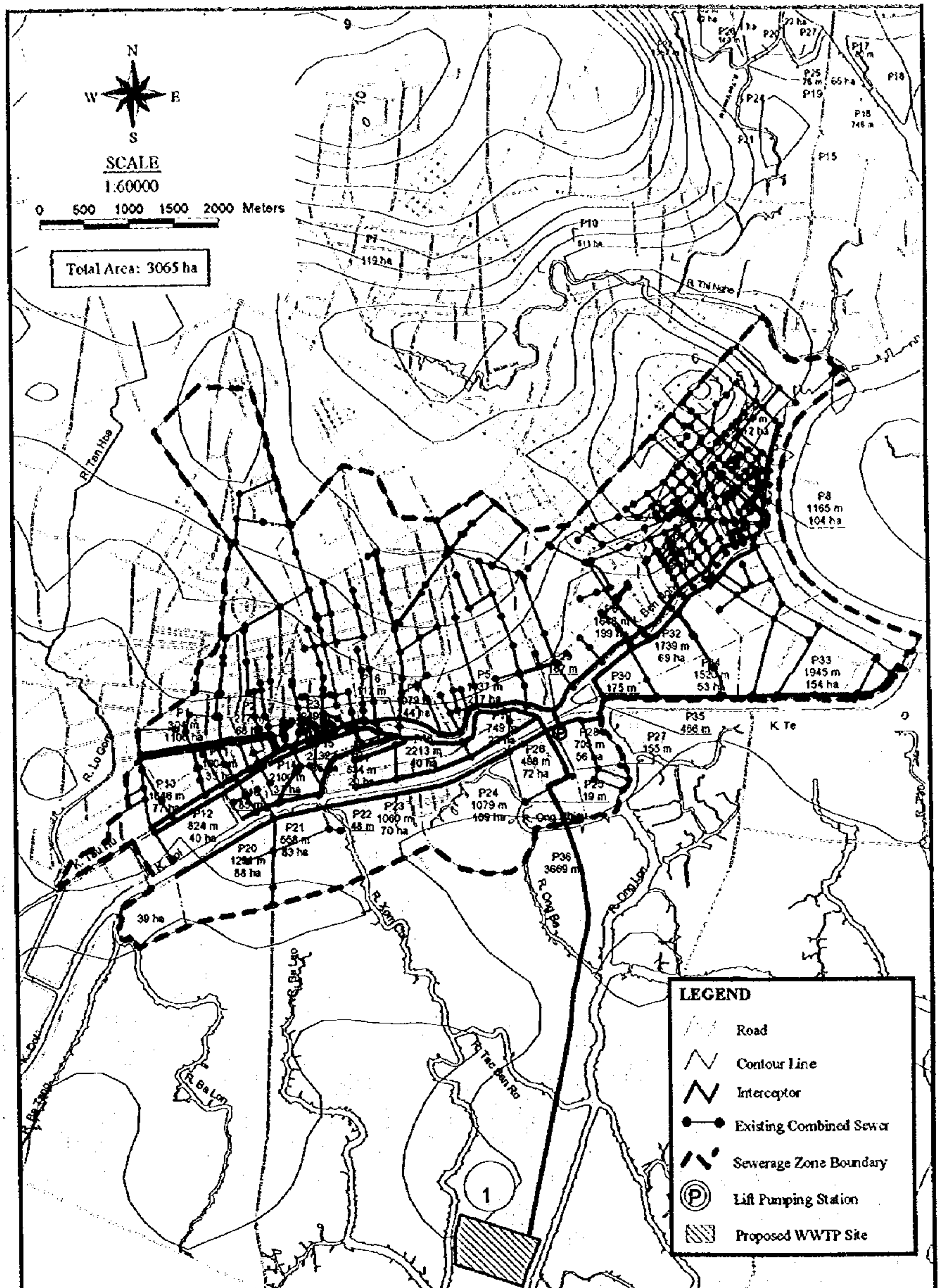


FIG. F.6.4 TH - BN - D - T SEWERAGE DEVELOPMENT ZONE

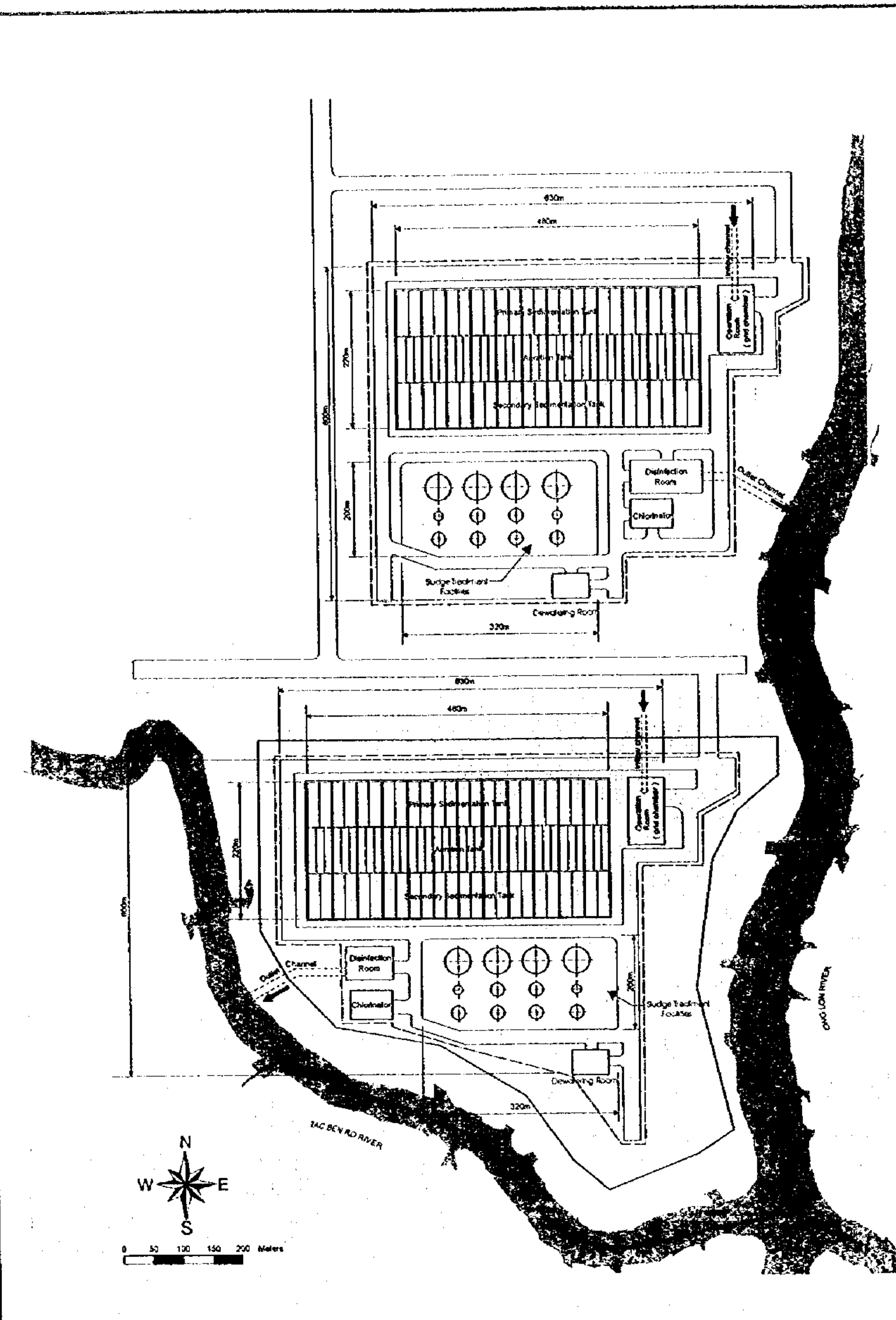


FIG. F.6.5 LAYOUT OF THBNDT AND NLTN WASTEWATER TREATMENT PLANTS

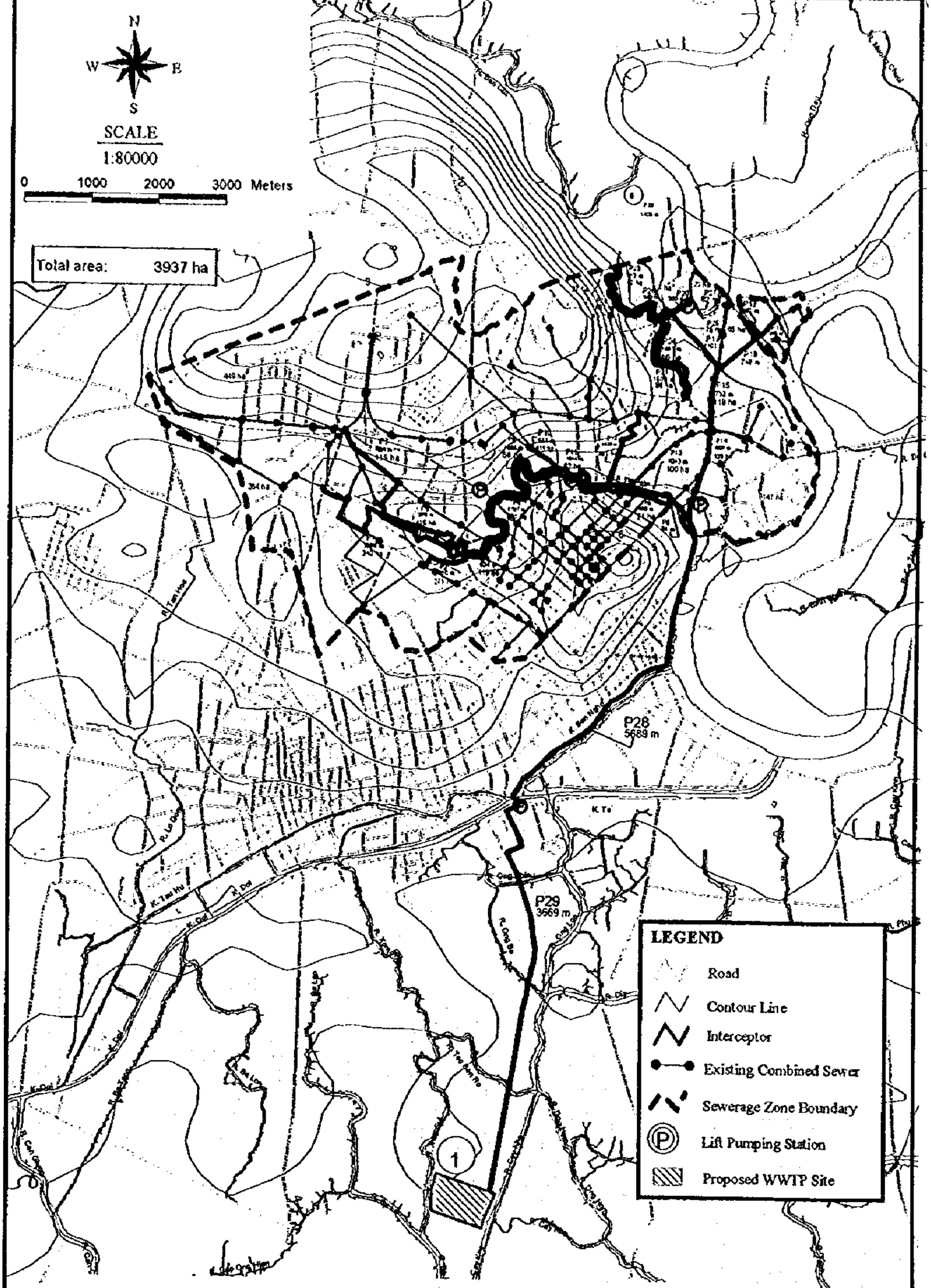


FIG. F.6.6 NL-TN SEWERAGE DEVELOPMENT ZONE

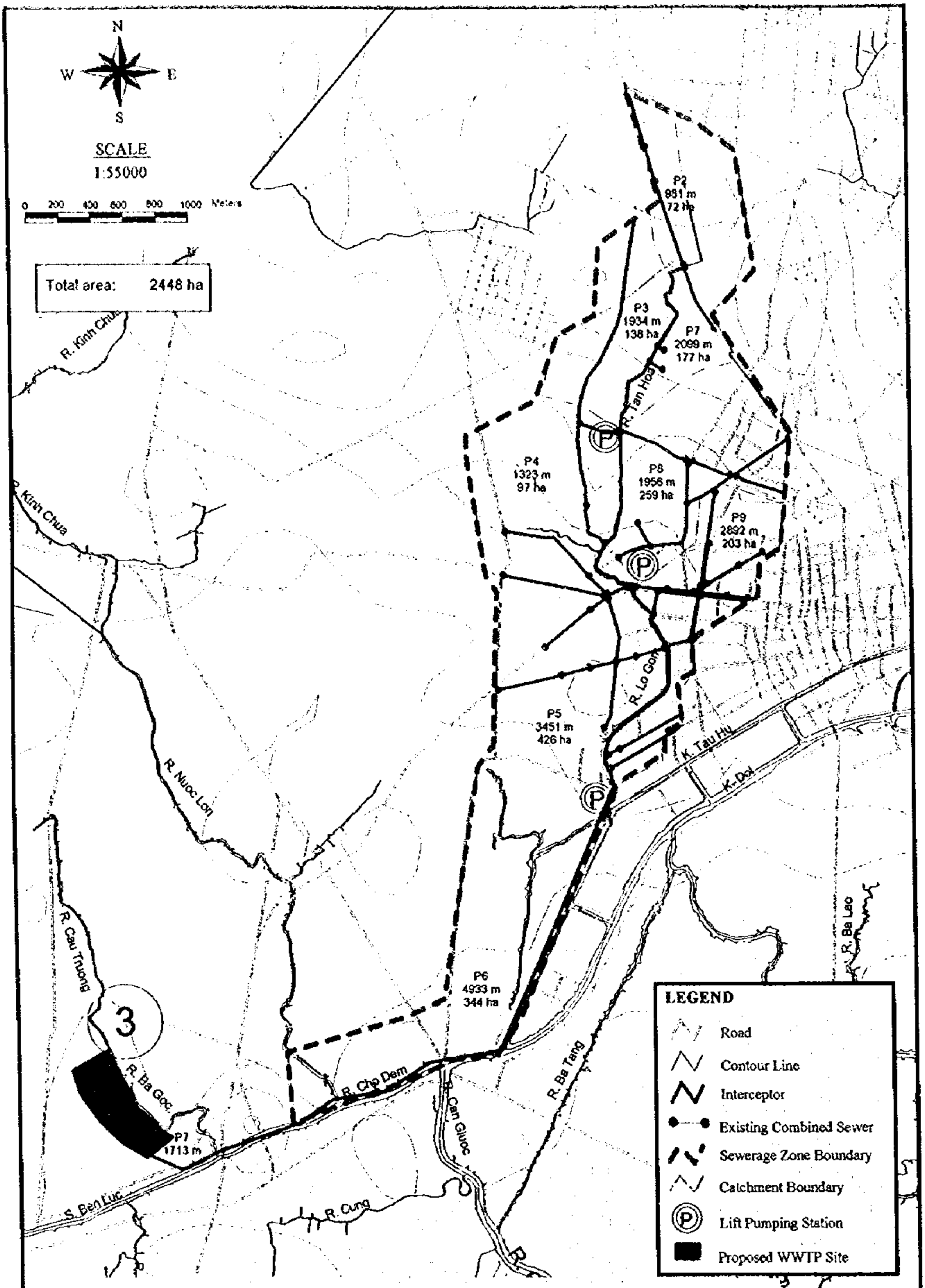


FIG. F.6.7 TH - LG SEWERAGE DEVELOPMENT ZONE

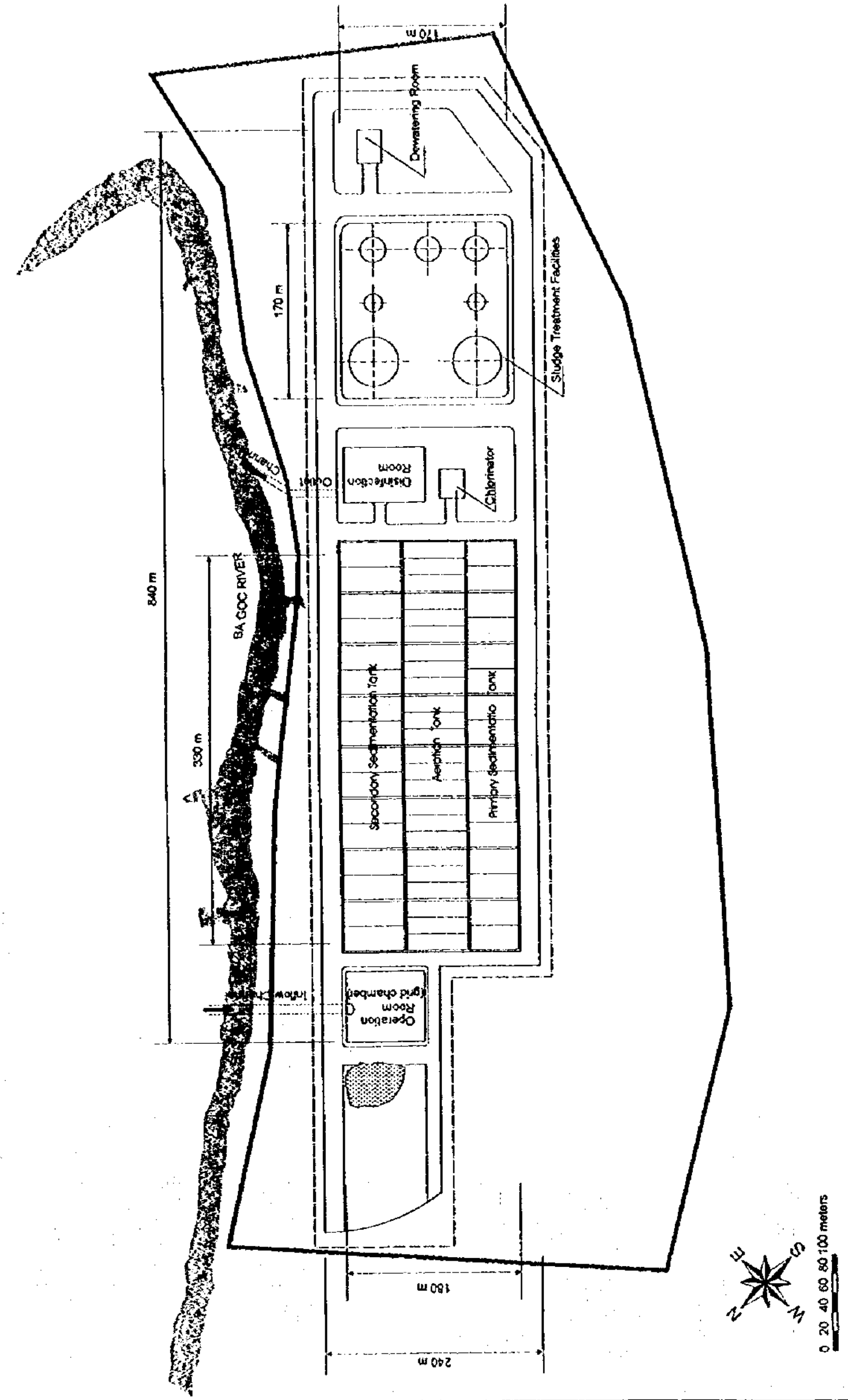


FIG. F.6.8 LAYOUT OF THLG WASTEWATER TREATMENT PLANT

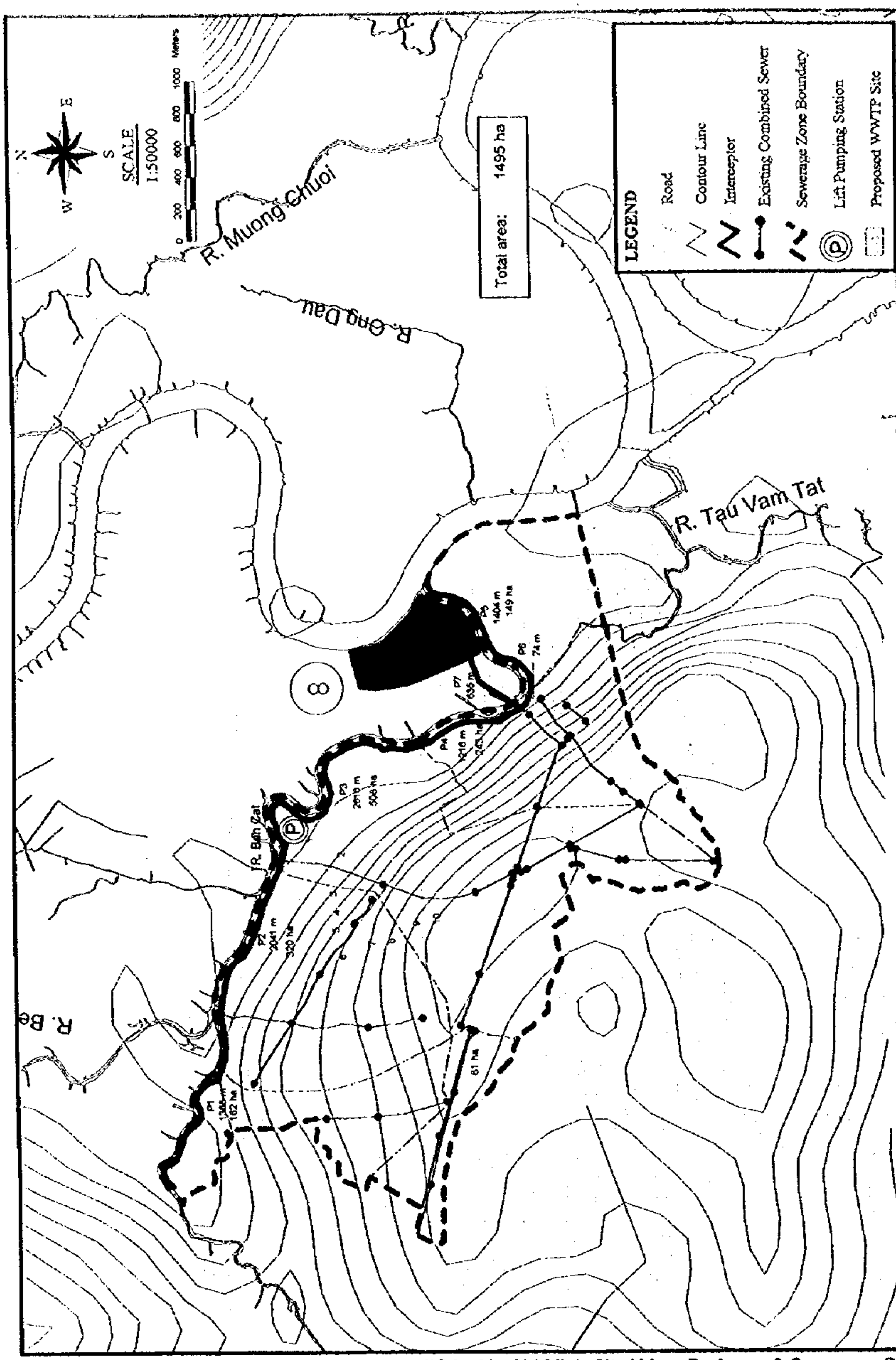


FIG. F.6.9 TL-BC SEWERAGE DEVELOPMENT ZONE

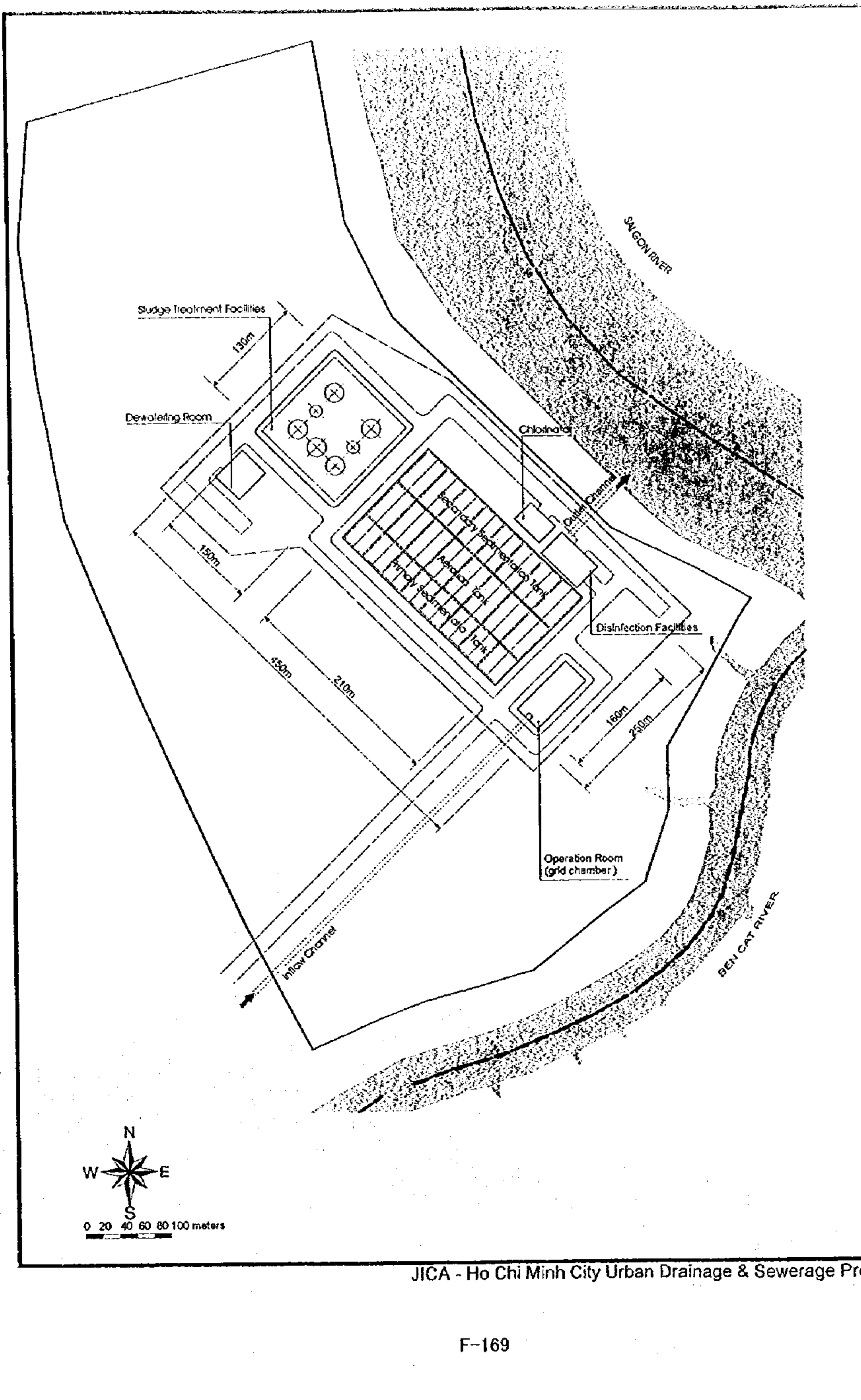


FIG. F.6.10 LAYOUT OF THLBC WASTEWATER TREATMENT PLANT

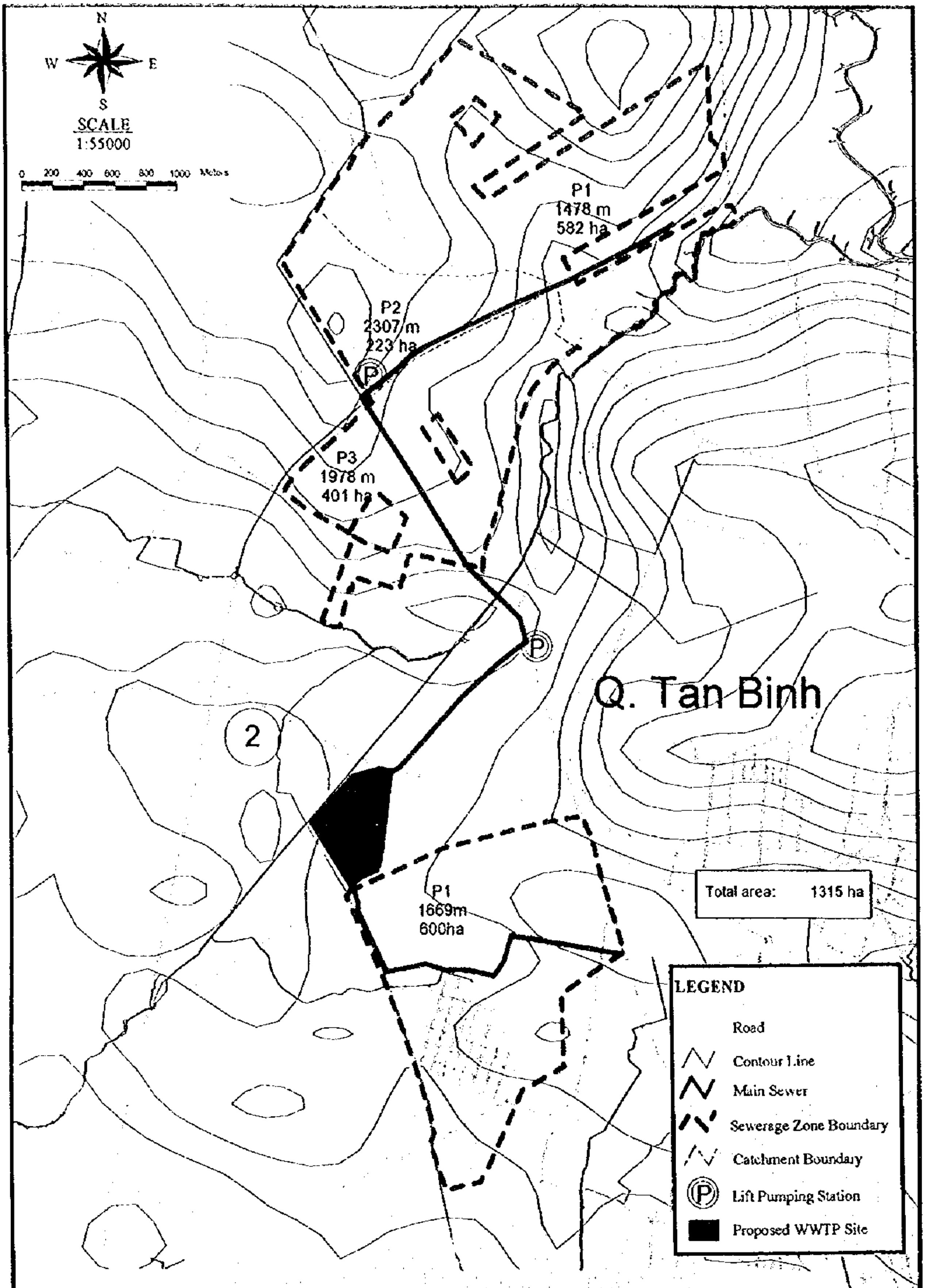


FIG. F.6.11 SW SEWERAGE DEVELOPMENT ZONE

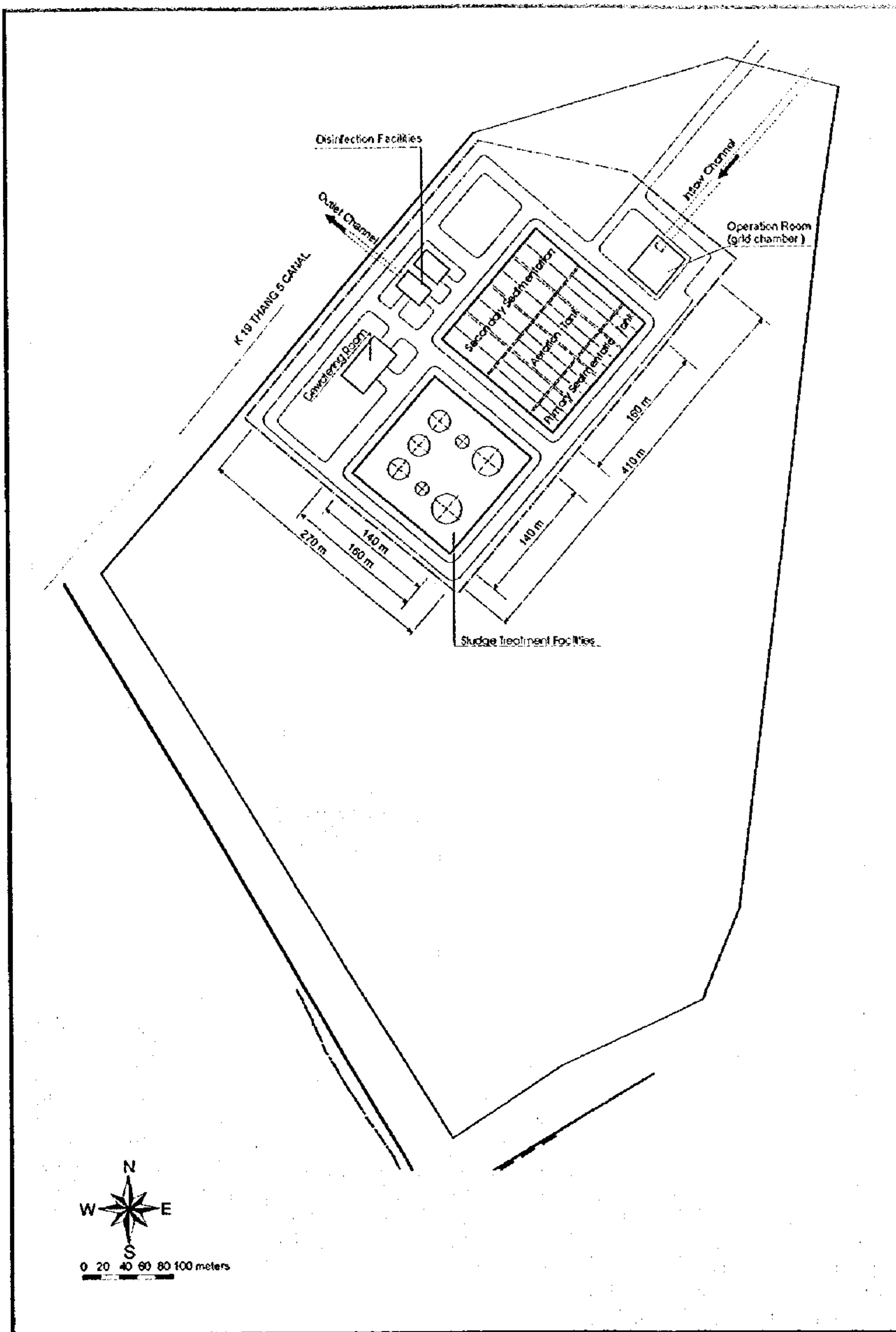


FIG. F.6.12 LAYOUT OF SW WASTEWATER TREATMENT PLANT

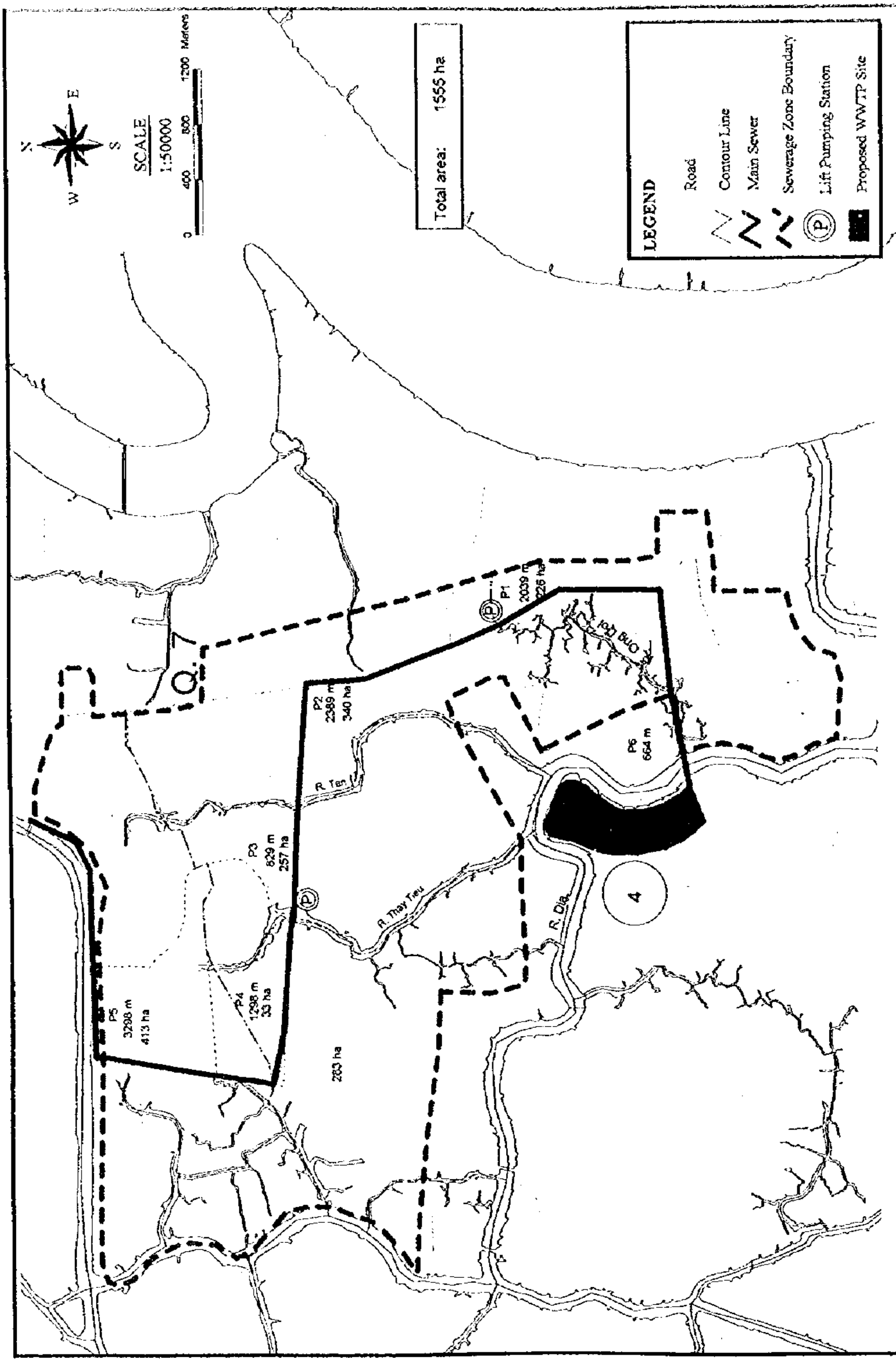


FIG. F.6.13 SS SEWERAGE DEVELOPMENT ZONE

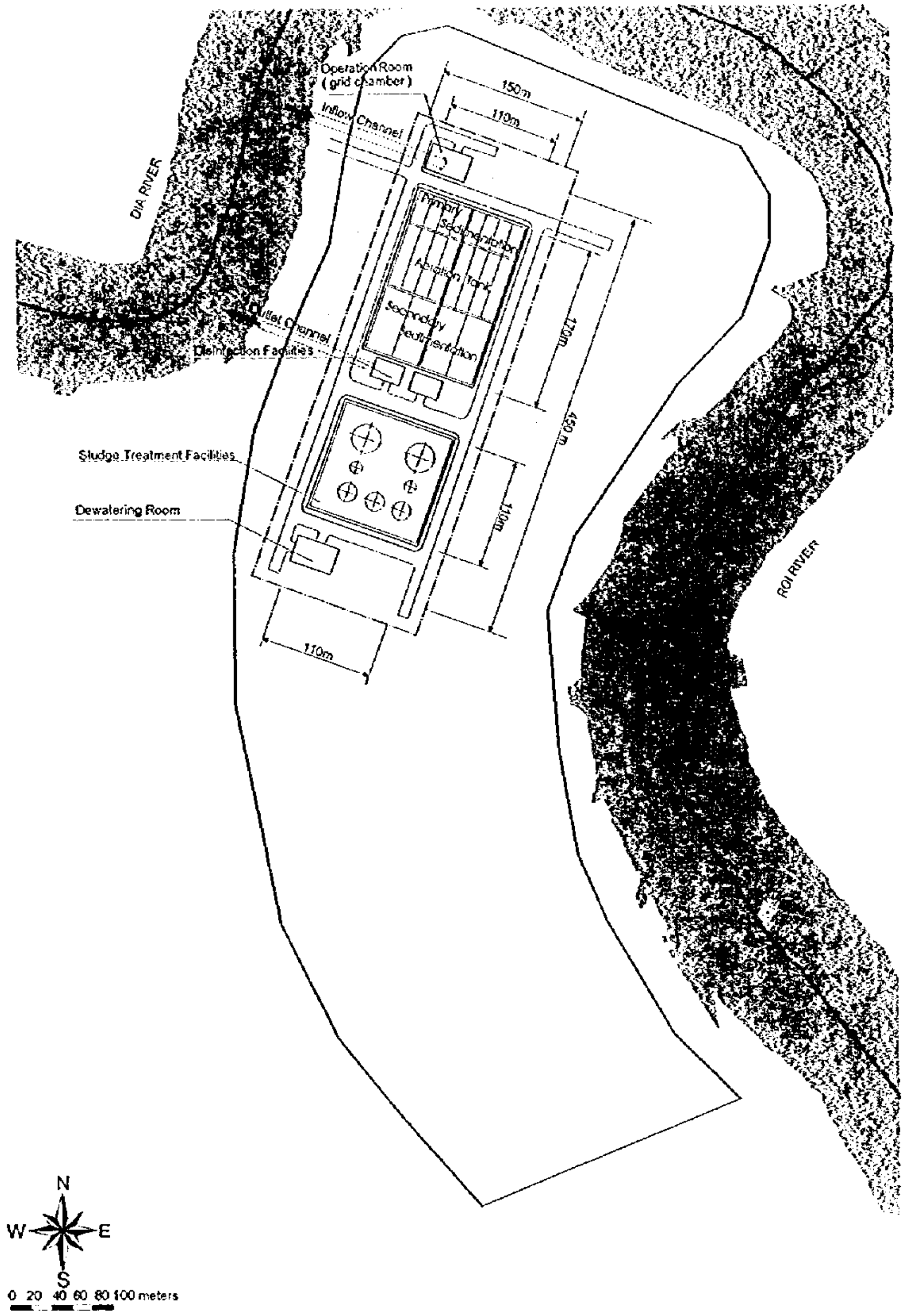


FIG. F.6.14 LAYOUT OF SS WASTEWATER TREATMENT PLANT

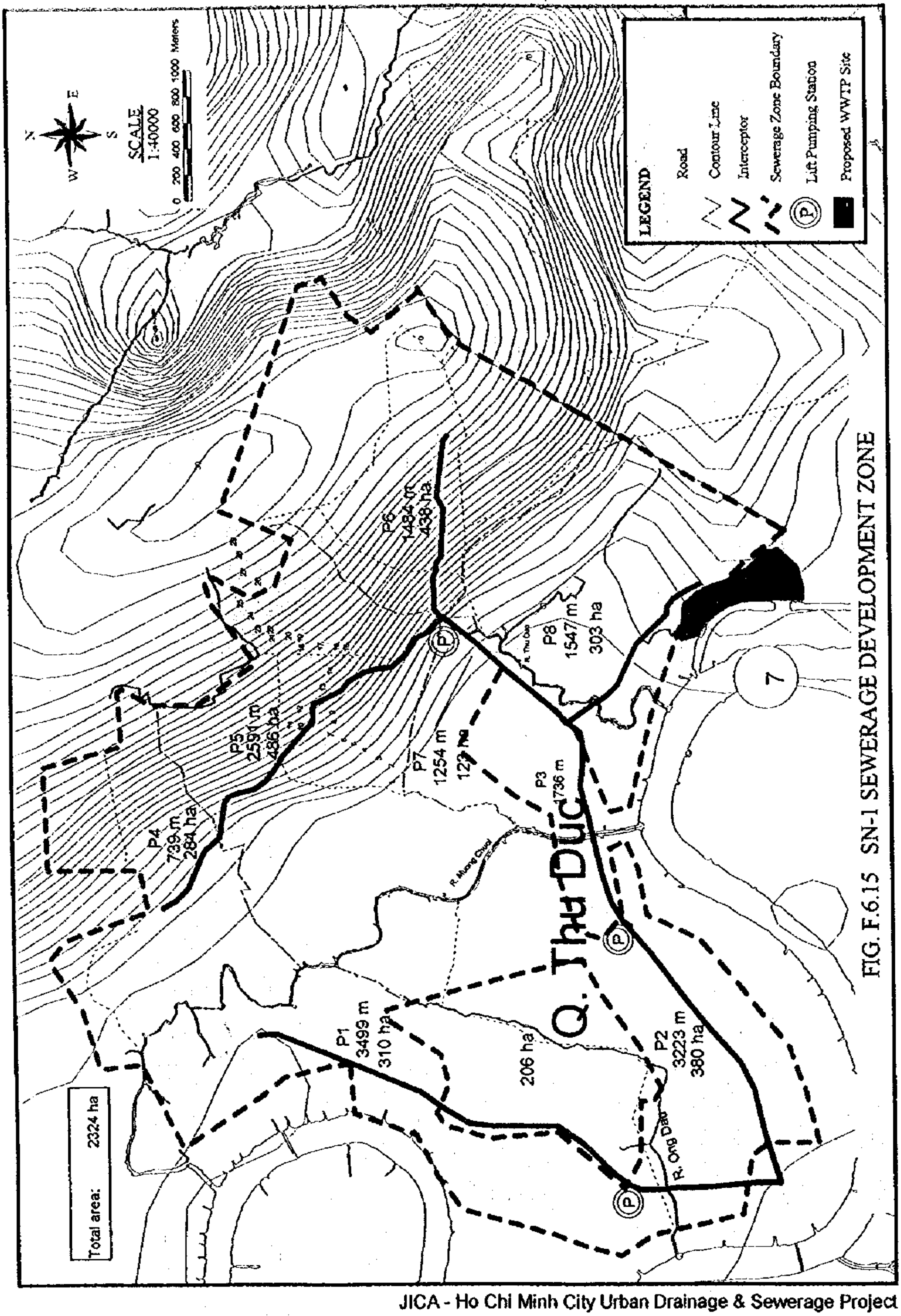
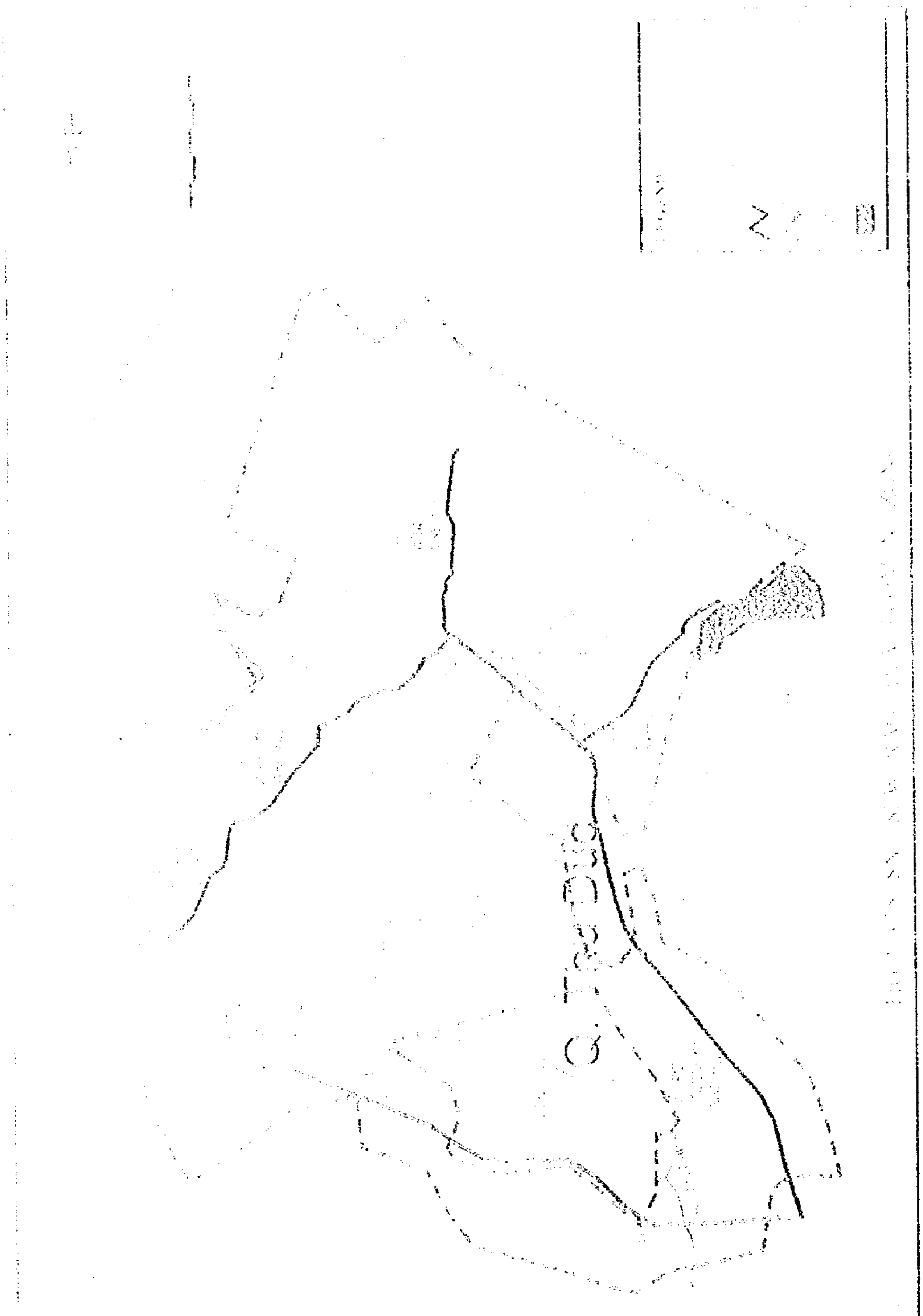


FIG. F.6.15 SN-1 SEWERAGE DEVELOPMENT ZONE



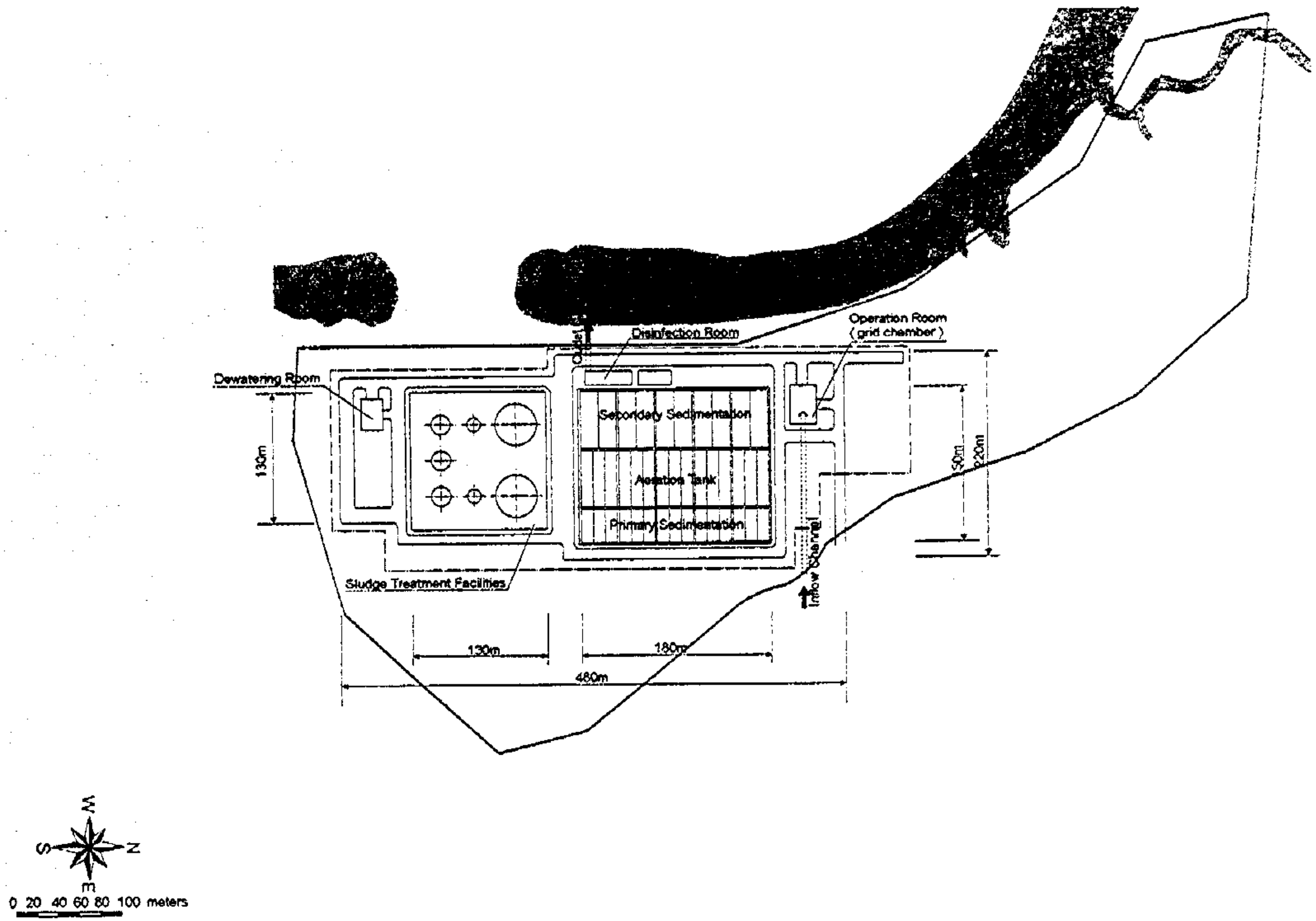
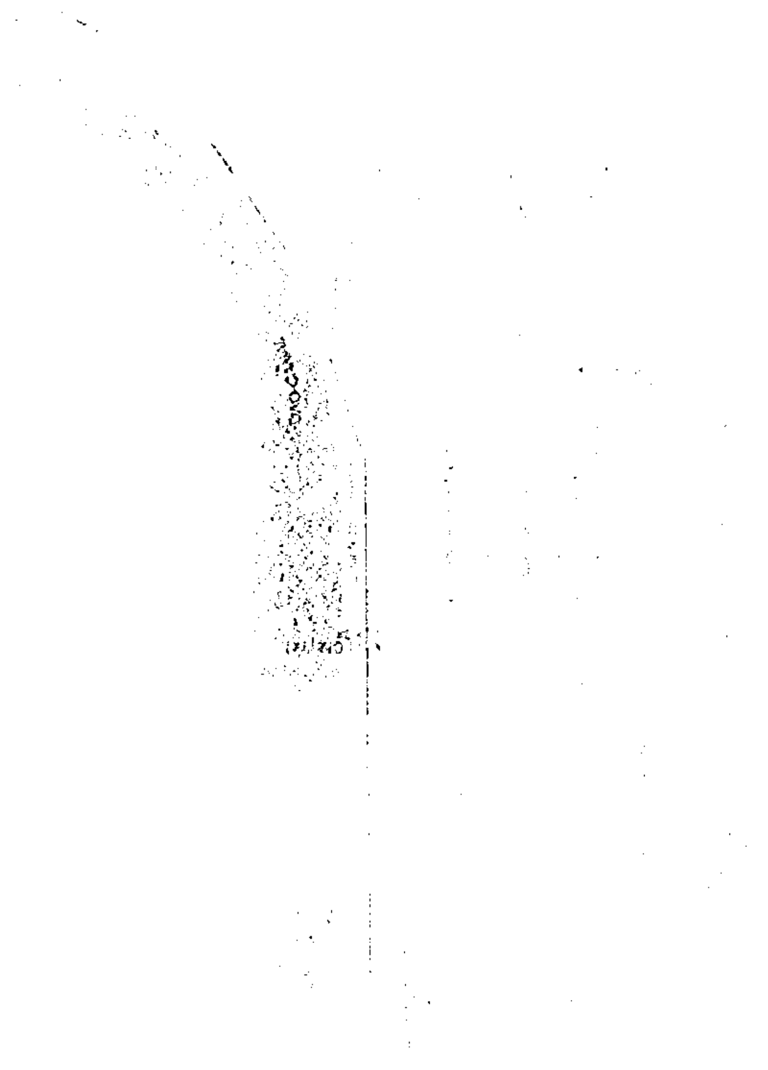


FIG. F.6.16 LAYOUT OF SN-I WASTEWATER TREATMENT PLANT



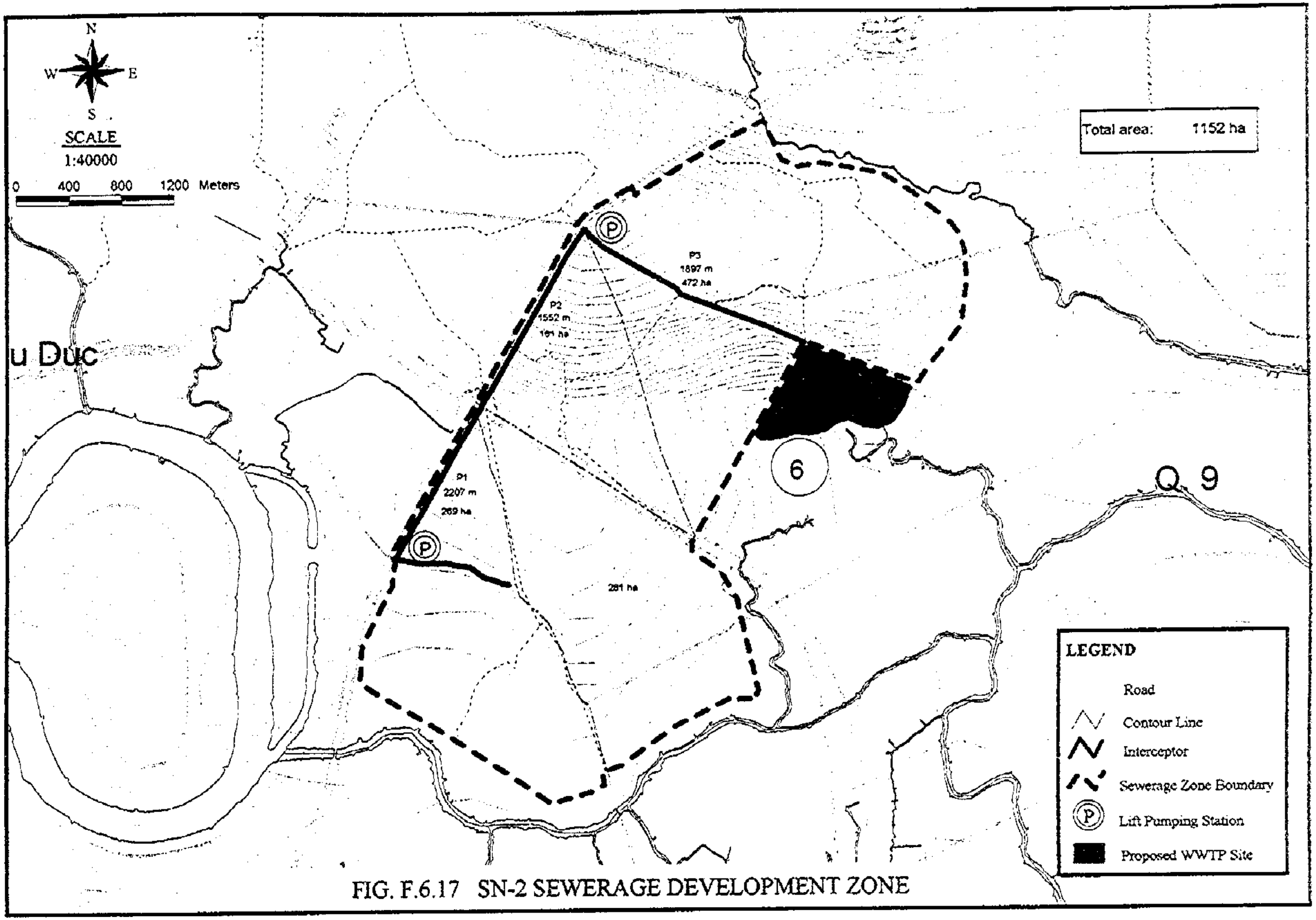


FIG. F.6.17 SN-2 SEWERAGE DEVELOPMENT ZONE

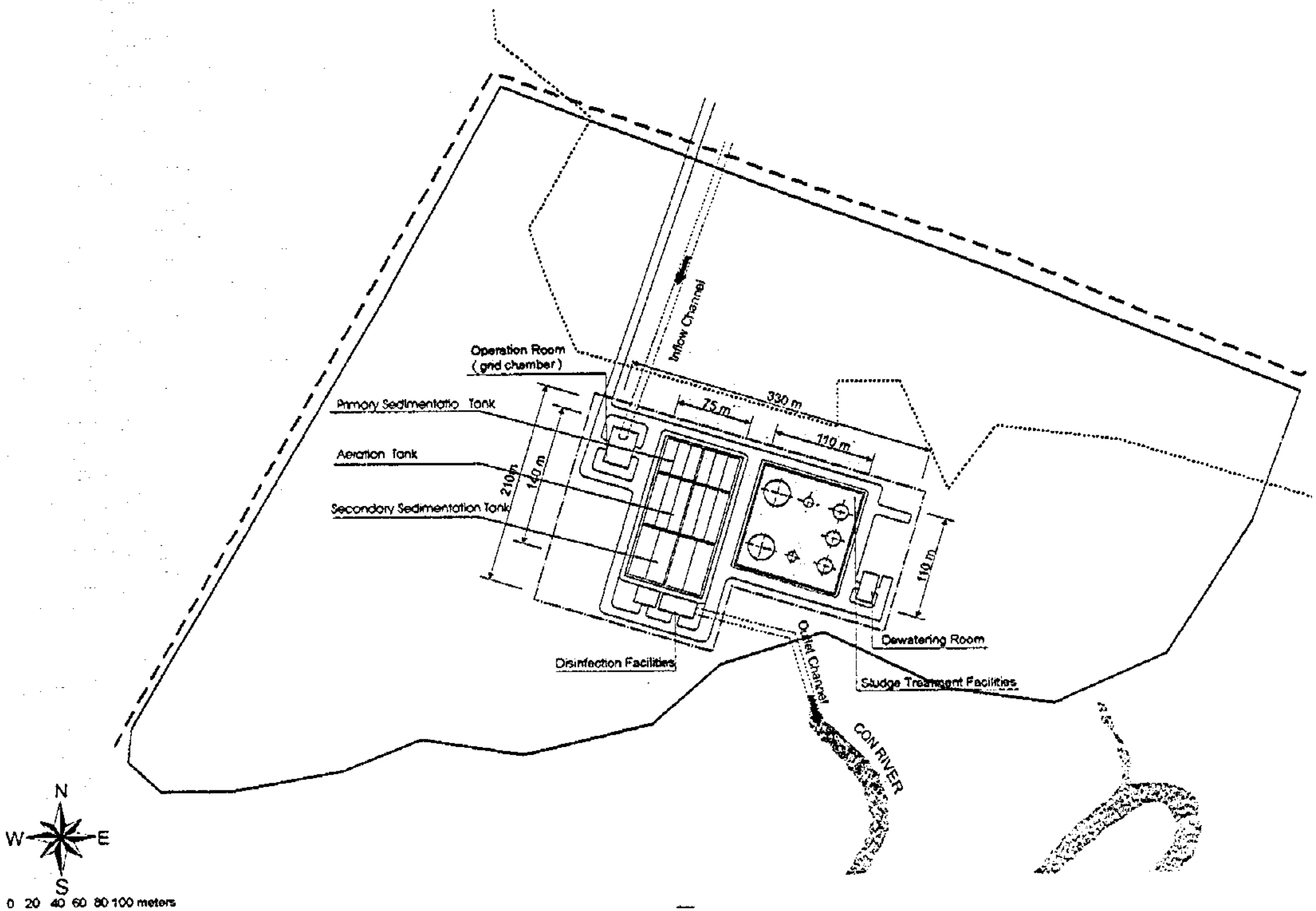


FIG. F.6.18 SN-II WASTEWATER TREATMENT PLANT

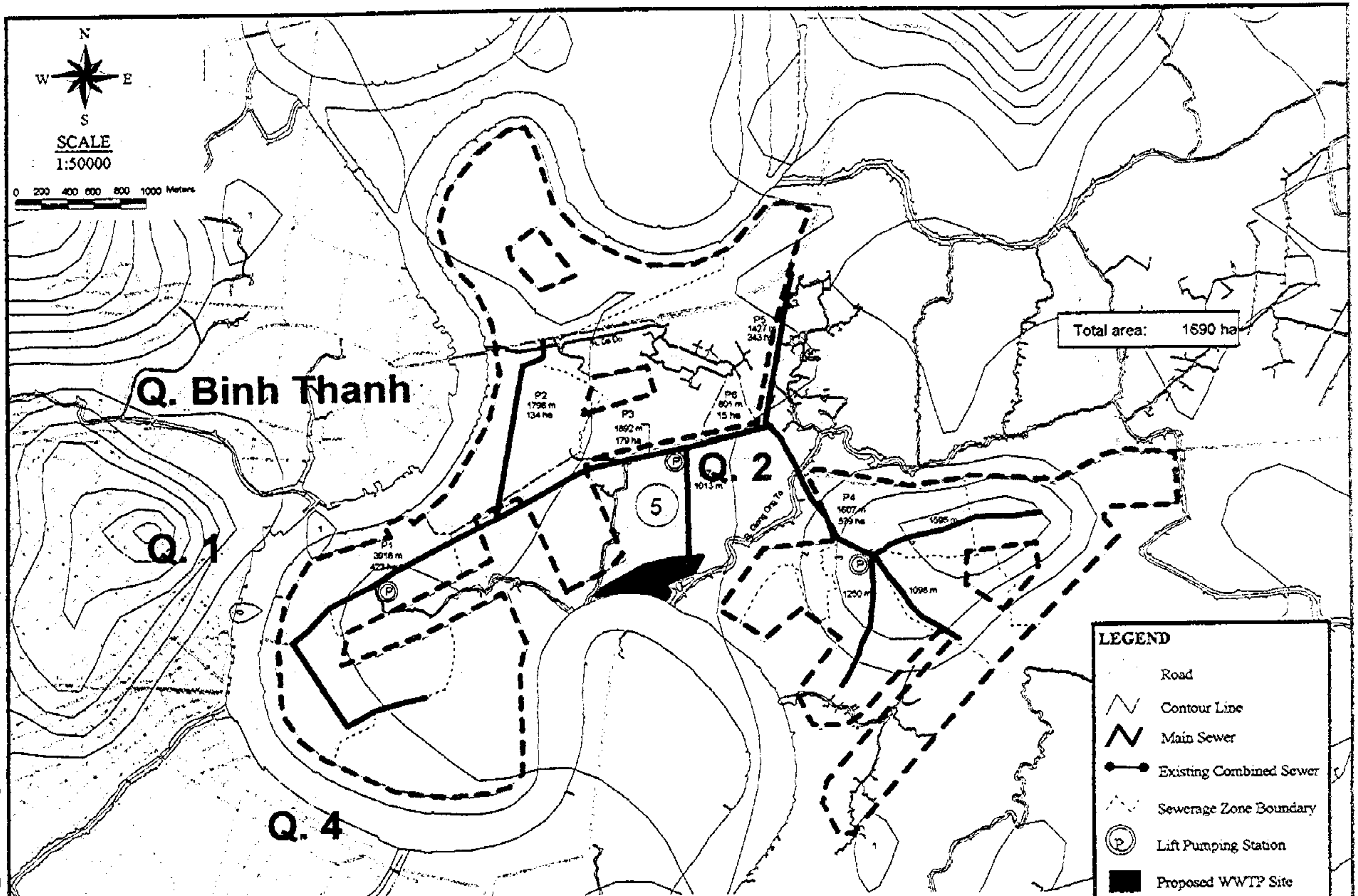
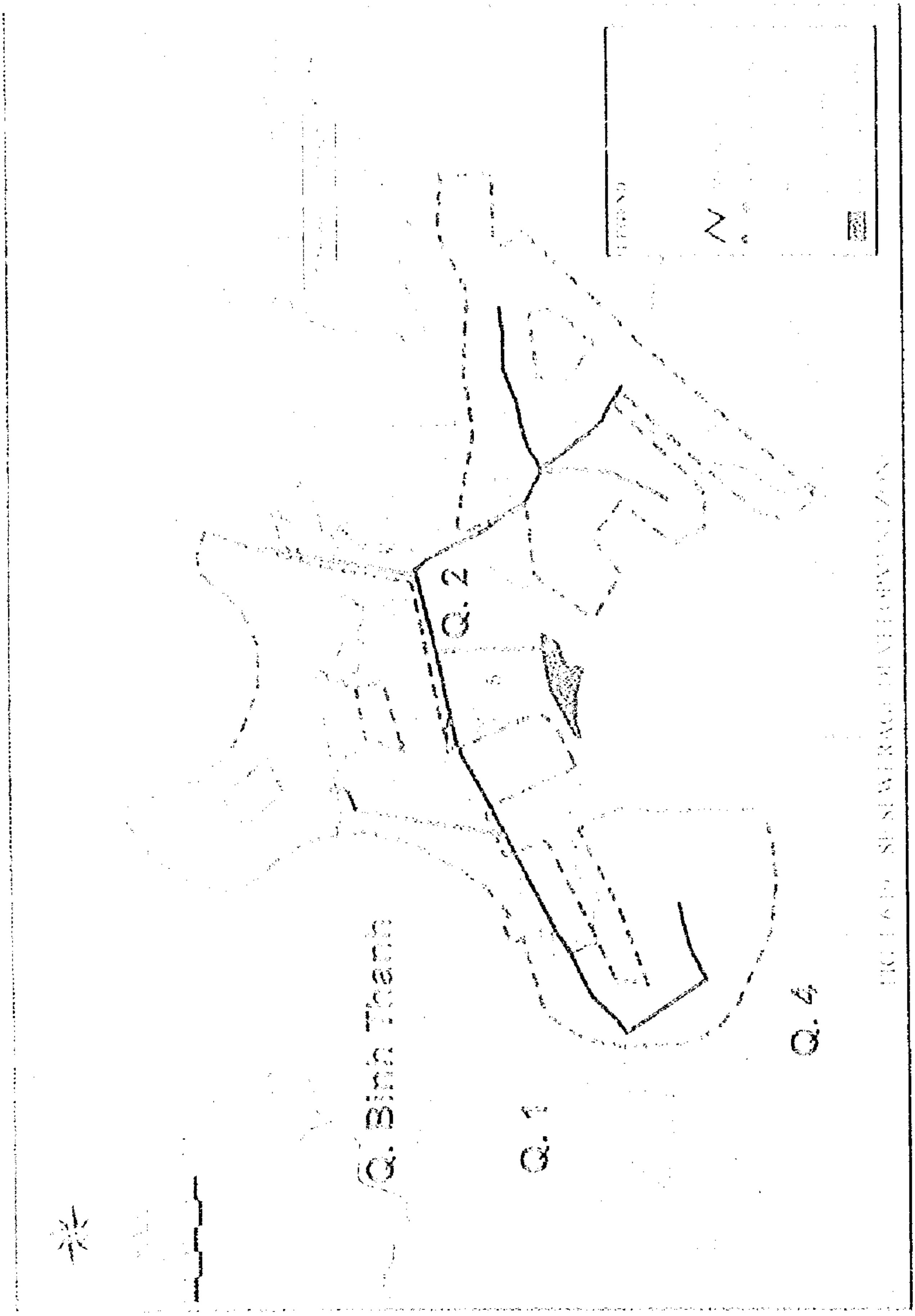


FIG. F.6.19 SE SEWERAGE DEVELOPMENT ZONE


Q. Binh Thanh
Q. 1
Q. 2
Q. 4

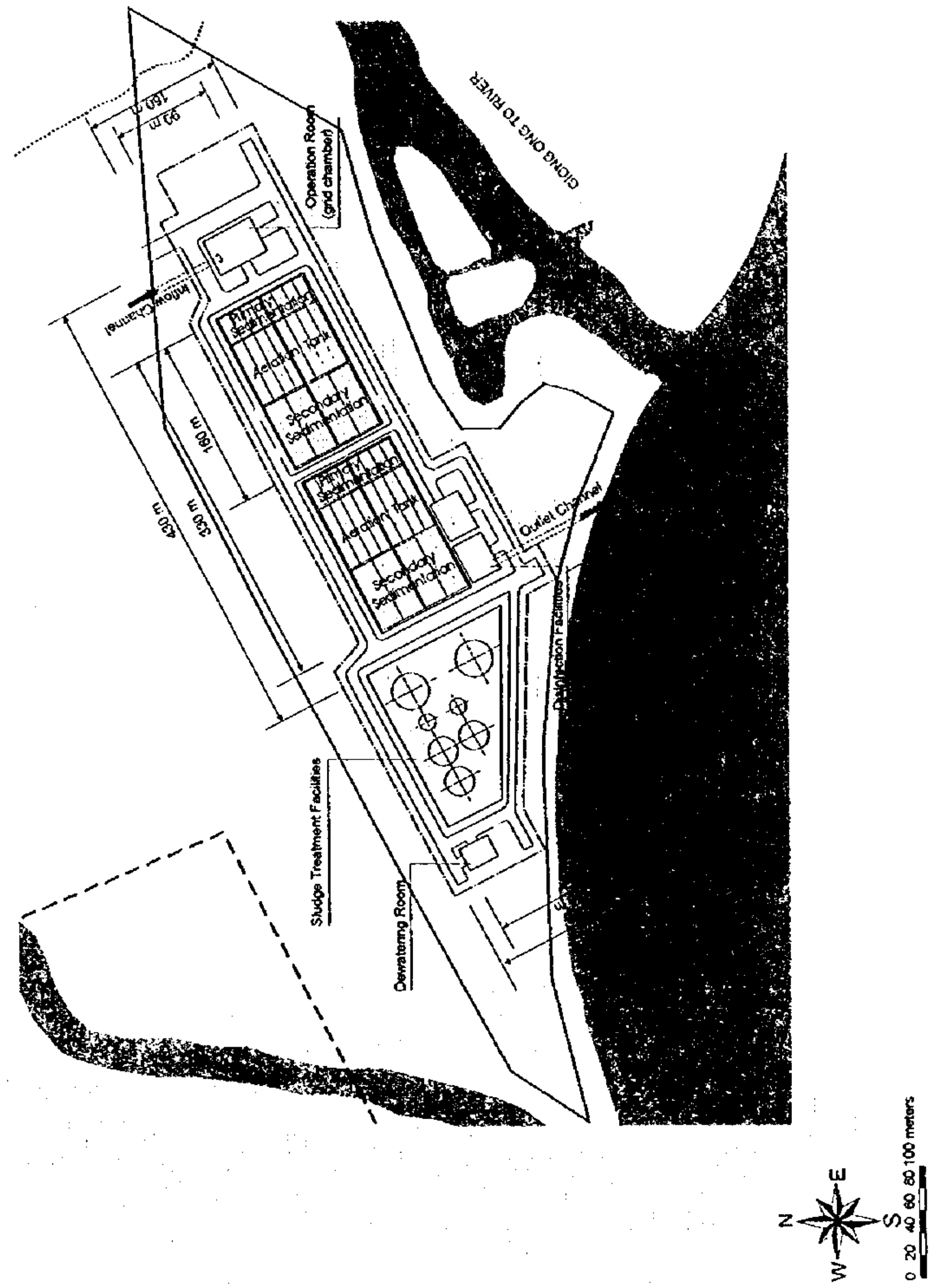


FIG. F.6.20 LAYOUT OF SE WASTEWATER TREATMENT PLANT


SAIGON RIVER
140
130 m

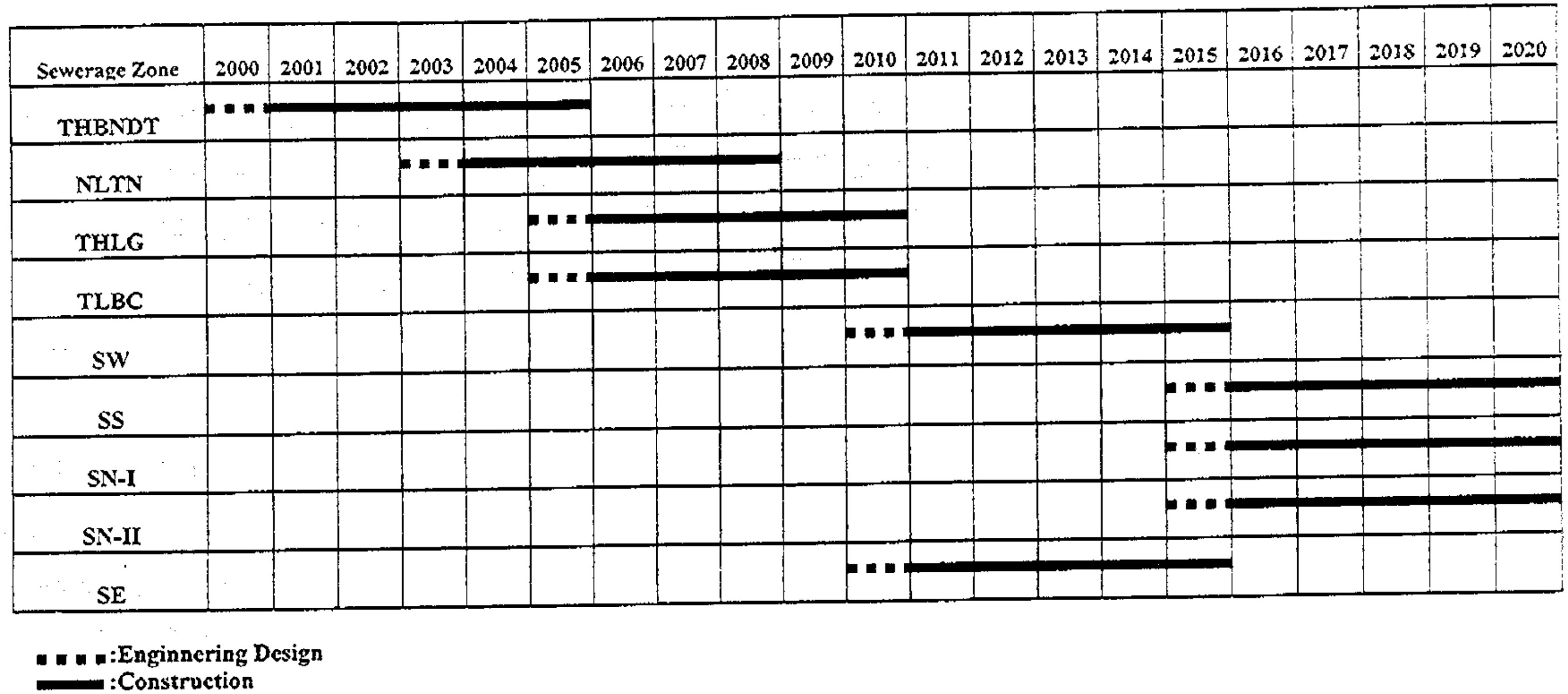


Fig. F.8.1 IMPLEMENTATION PROGRAM FOE SEWERAGE DEVELOPMENT

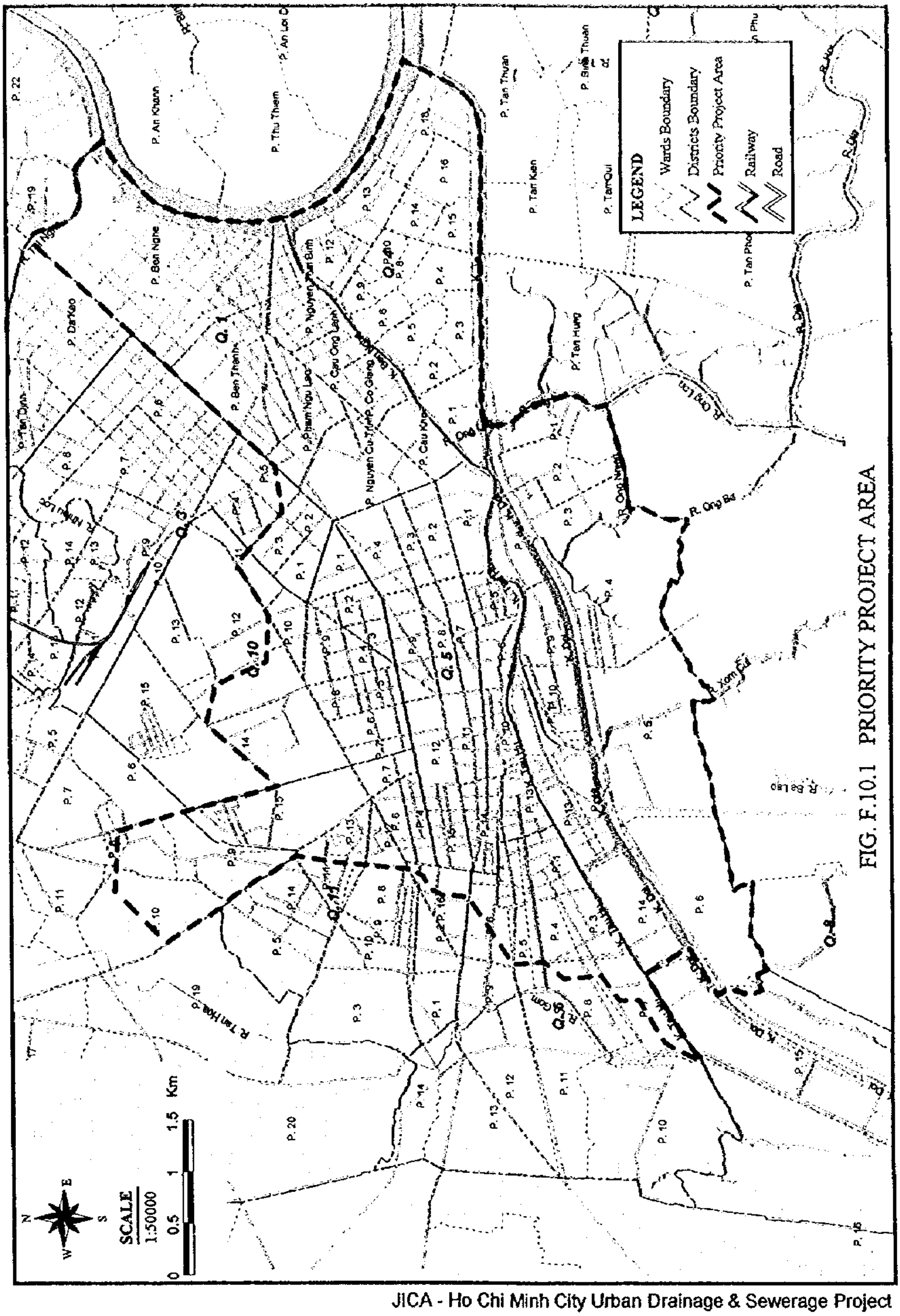


FIG. F.10.1 PRIORITY PROJECT AREA

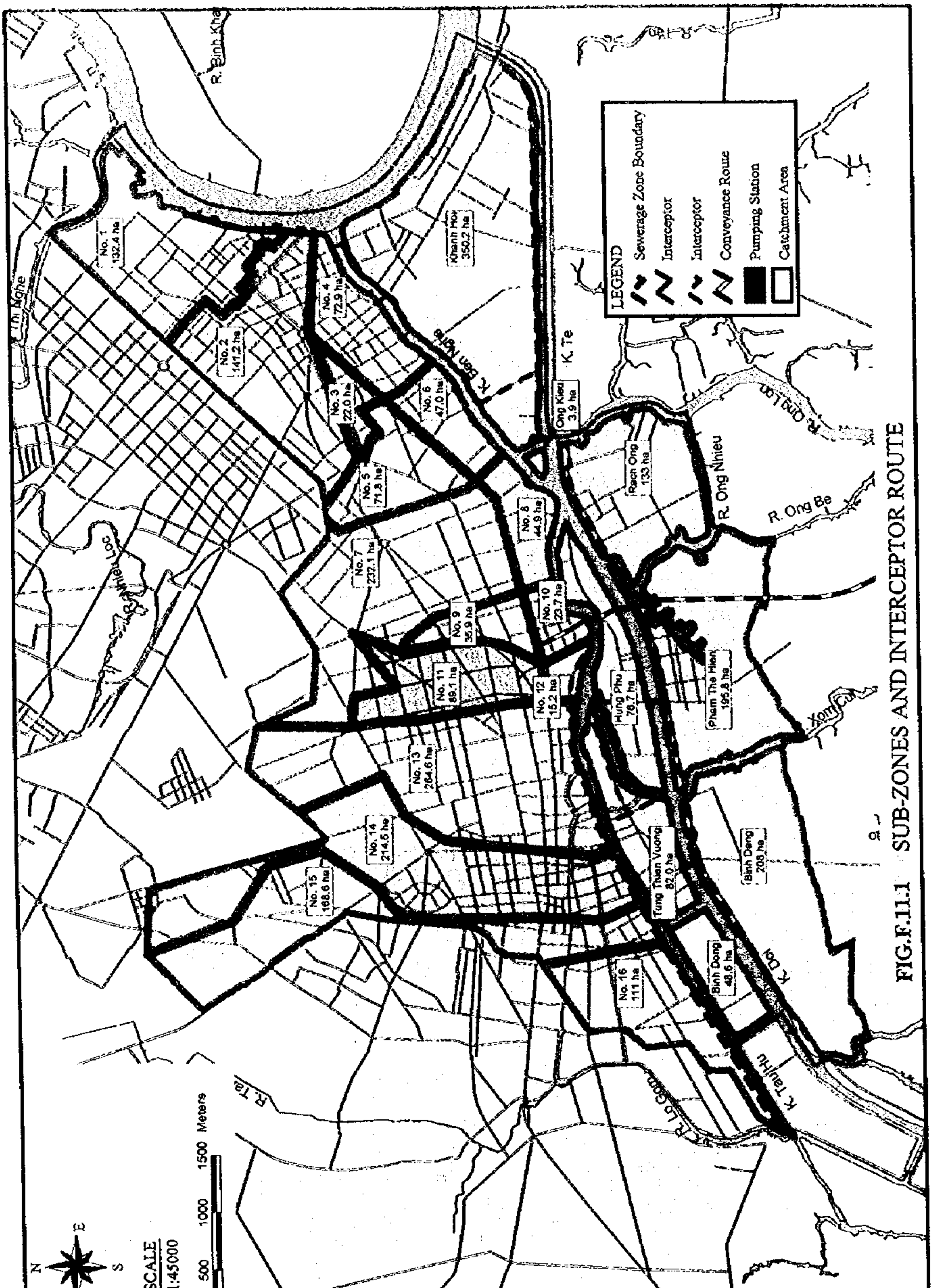


FIG.F.11.1 SUB-ZONES AND INTERCEPTOR ROUTE

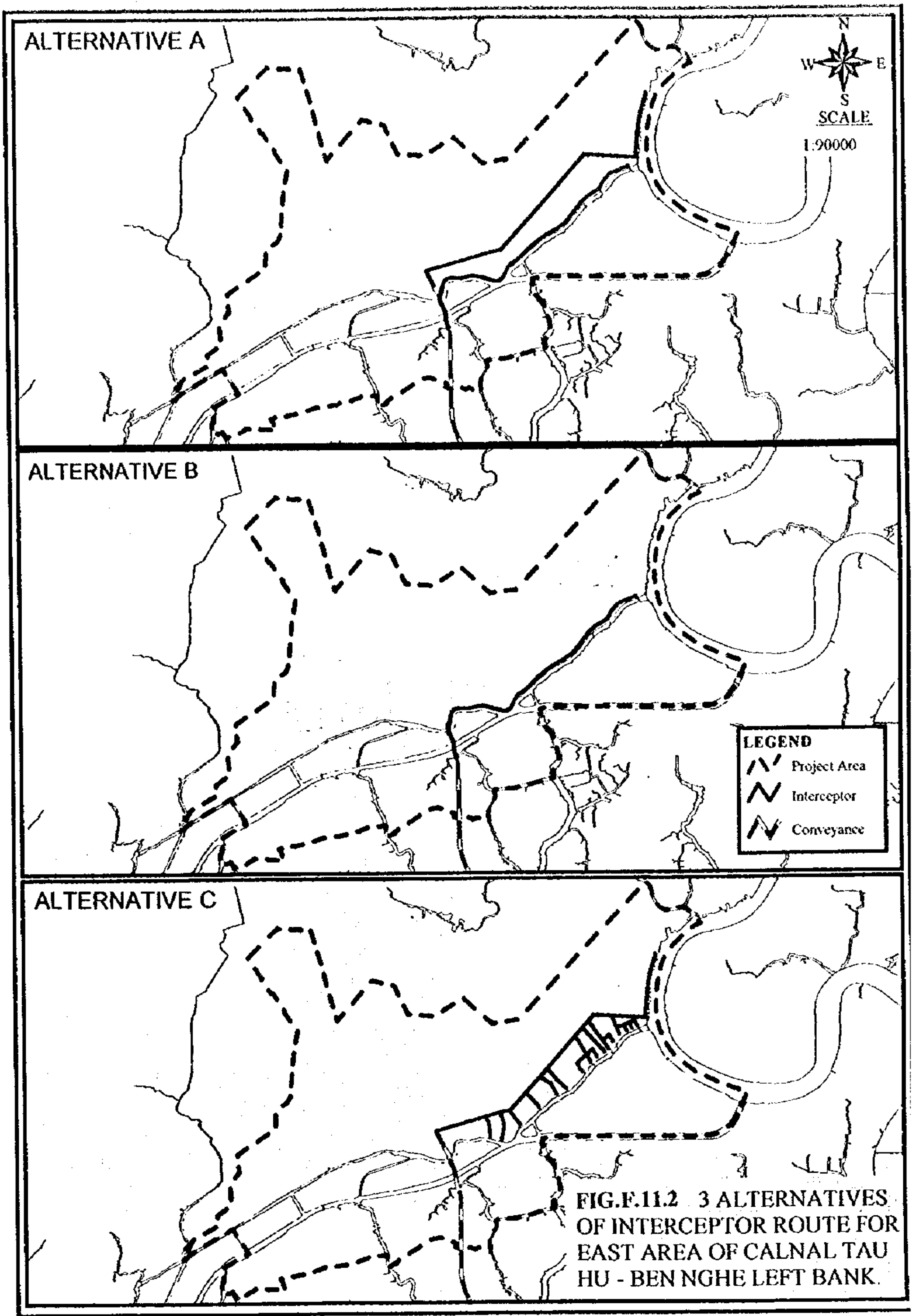


FIG.F.11.2 3 ALTERNATIVES OF INTERCEPTOR ROUTE FOR EAST AREA OF CALNAL TAU HU - BEN NGHE LEFT BANK.

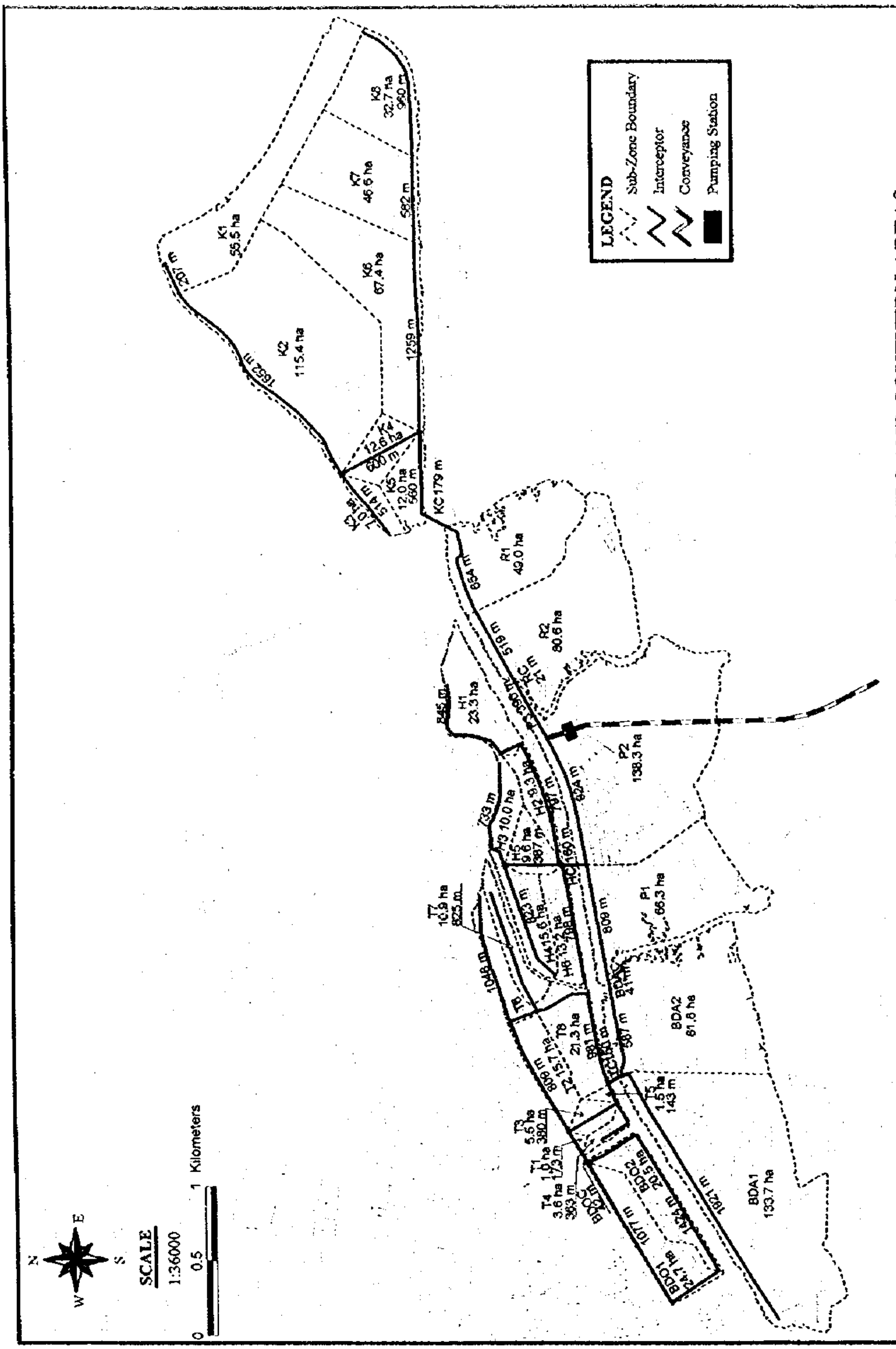
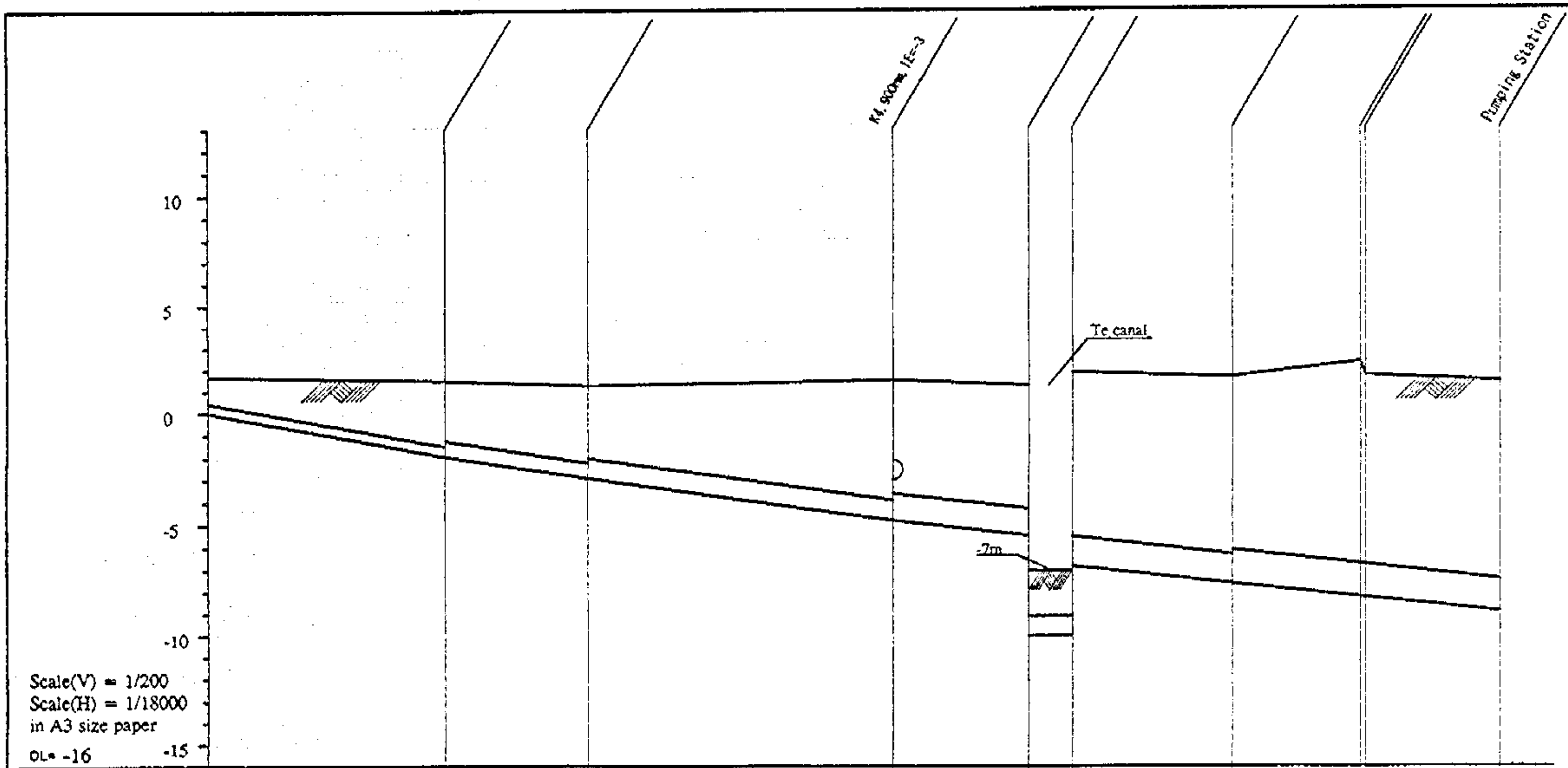


FIG.F.11.3 SUB-ZONE AND INTERCEPTOR ROUTE FOR ISLANDS AND SOUTHERN AREAS



Line Number	K8	K7	K6	K5	KC	R1	R2	RC	P3
Diameter (mm)	450	700	900	1200	900	1300	1500	1500	1500
Gradient (o/oo)	2	1.7	1.5	1.2	-	1.2	1.2	1.2	1.2
Length (m)	960	582	1259	560	179	654	519	21	540

Total Length (m)	Ground Elevation (m)	Earth Covering (m)	Invert Elevation (m)
0	1.7	1.2	0
960	1.54	2.96 / 2.69	-1.92 / -1.92
1542	1.3	3.44 / 3.22	-2.91 / -2.91
2801	1.52	5.33 / 5	-4.8 / -4.8
3361	1.3	5.45 / 2	-5.47 / -9.99
3540	-7	2 / 7.27	-9.99 / -6.8
4194	1.69	7.55 / 7.65	-7.58 / -7.58
4713 / 4734	2.37 / 1.75	8.96 / 8.36 / 8.96 / 8.36	-8.23 / -8.23 / -8.23 / -8.23
5274	1.48	8.74	-8.88

FIG.F.11.4 LONGITUDINAL PROILE OF INTERCEPTOR FOR KHANH HOI AND RACH ONG SUB-ZONES

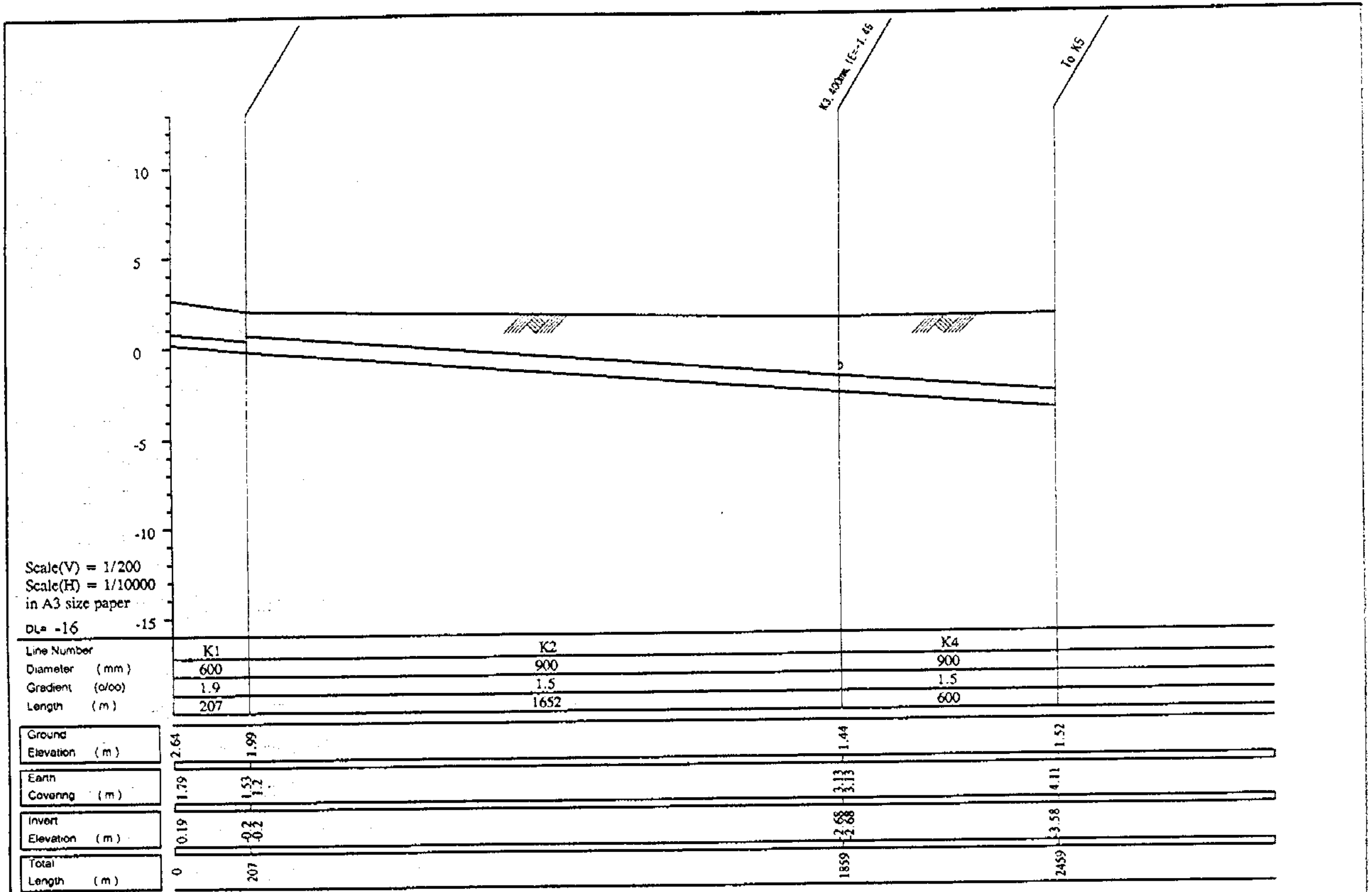
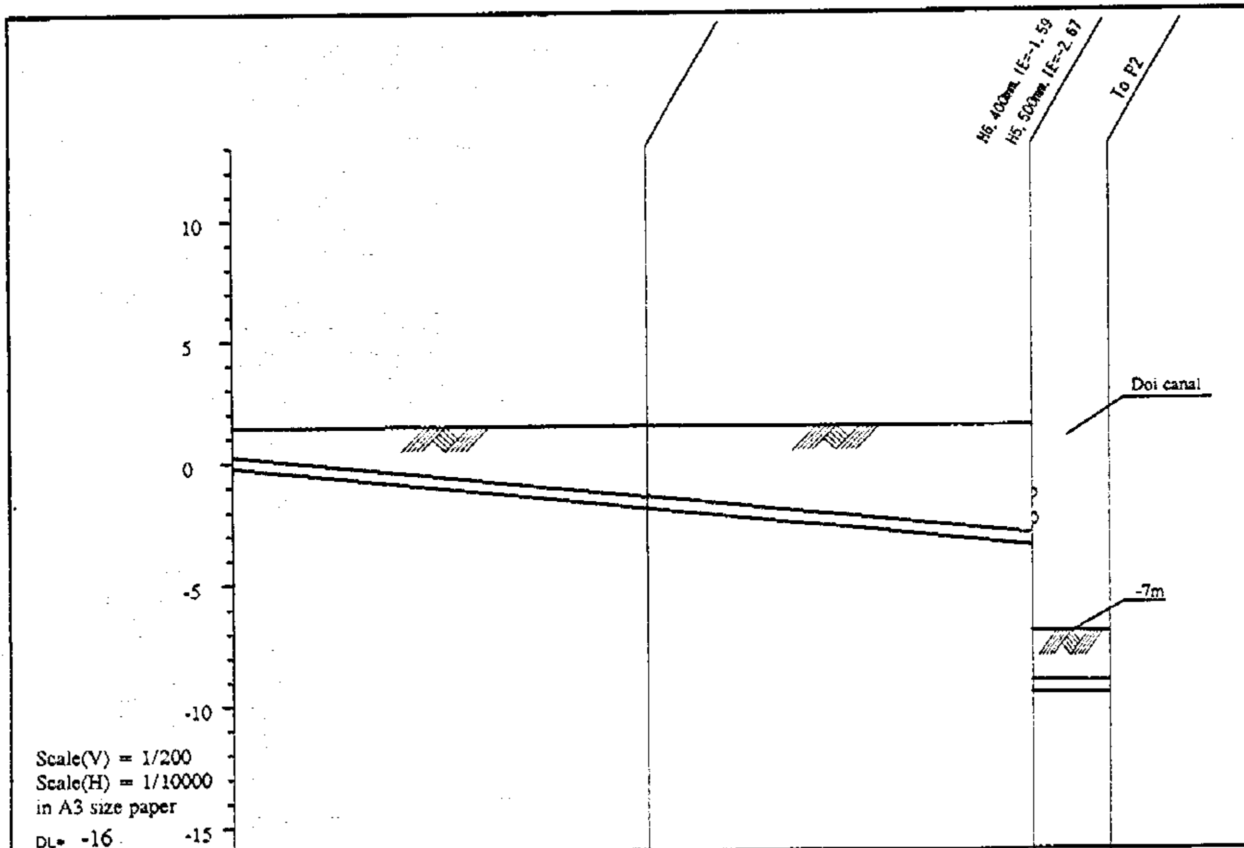
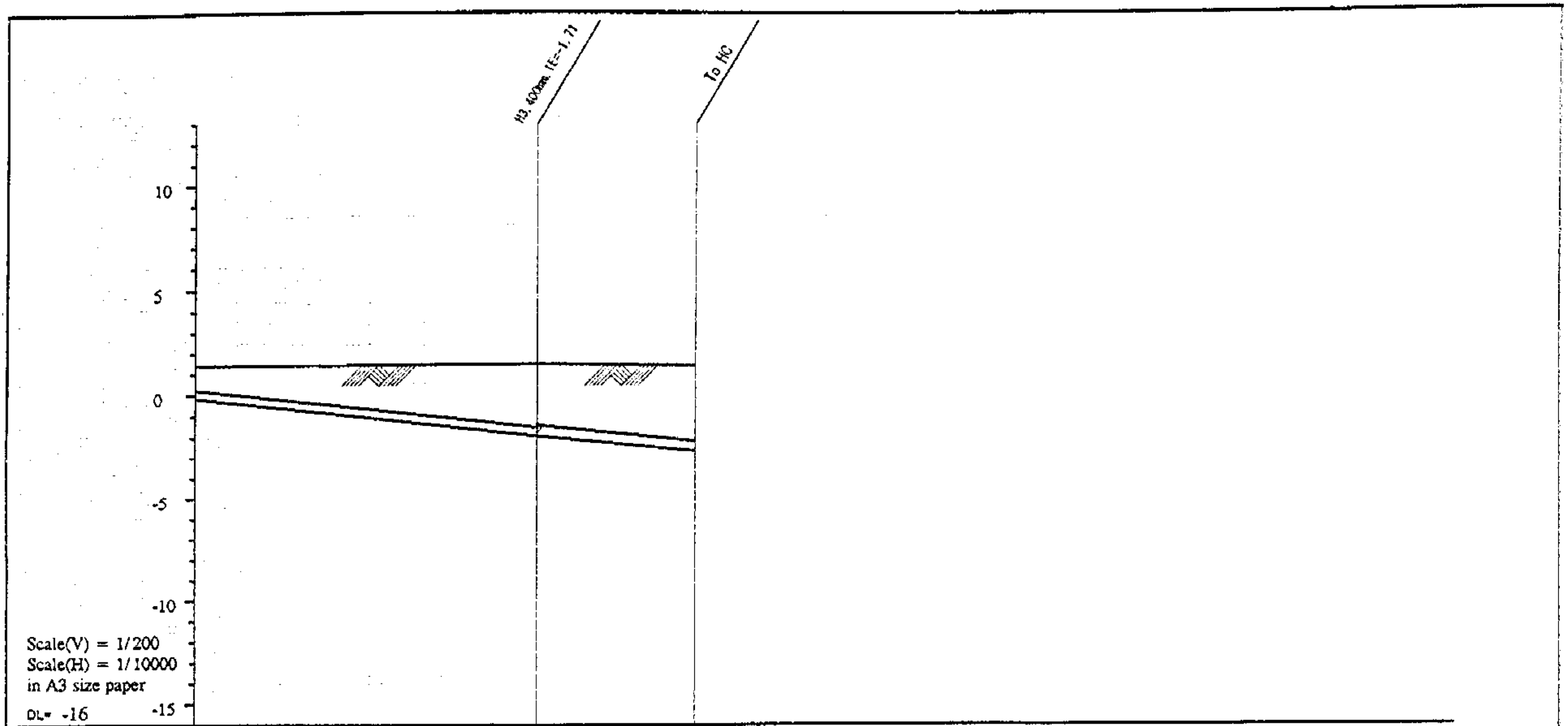


FIG.F.11.5 LONGITUDINAL PROILE OF INTERCEPTOR FOR KHANH HOI SUB-ZONES



Line Number	H1		H2		HC
Diameter (mm)	450		500		500
Gradient (o/oo)	2		2		-
Length (m)	845		797		160
Ground Elevation (m)	1.45	1.48		1.42	-7
Earth Covering (m)	1.2	2.87 / 2.82		4.35 / 2	2
Invert Elevation (m)	-0.2	-1.89 / -1.89		-3.48 / -9.55	-9.55
Total Length (m)	0	845		1642	1802

FIG.F.11.6 LONGITUDINAL PROILE OF INTERCEPTOR FOR HUNG PHU SUB-ZONES



Line Number	H4	H5	
Diameter (mm)	400	500	
Gradient (o/oo)	2.1	2	
Length (m)	823	387	
Ground Elevation (m)	1.43	1.51	1.42
Earth Covering (m)	1.2	2.96 / 2.86	3.54
Invert Elevation (m)	0.17	-1.9 / -1.9	-2.67
Total Length (m)	0	823	1210

FIG.F.11.7 LONGITUDINAL PROILE OF INTERCEPTOR FOR HUNG PHU SUB-ZONES

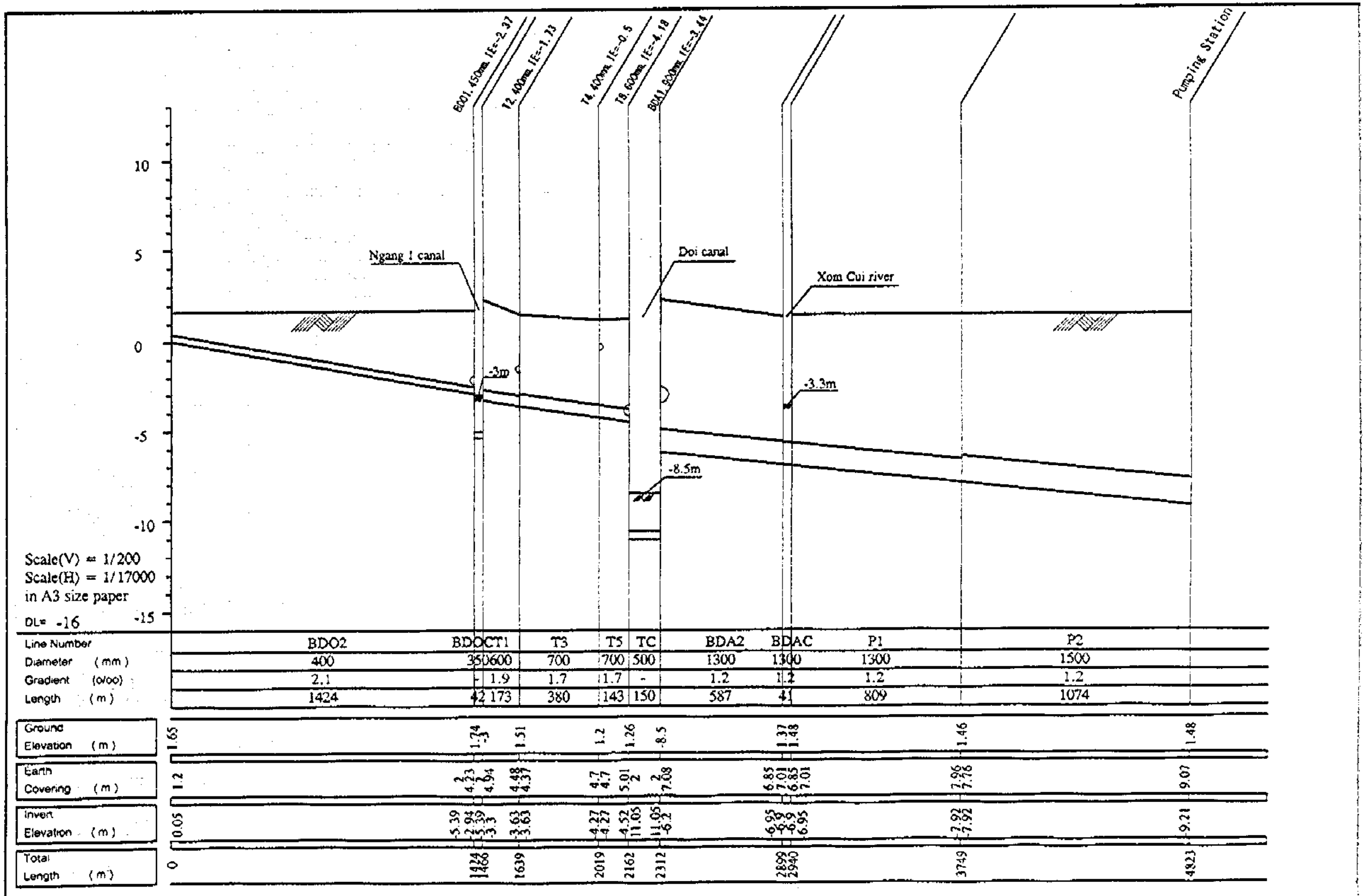


FIG.F.11.8 LONGITUDINAL PROILE OF INTERCEPTOR FOR BINH DONG, TUNG THIEN VUONG, BINH DANG AND PHAM THE HIEN SUB-ZONES

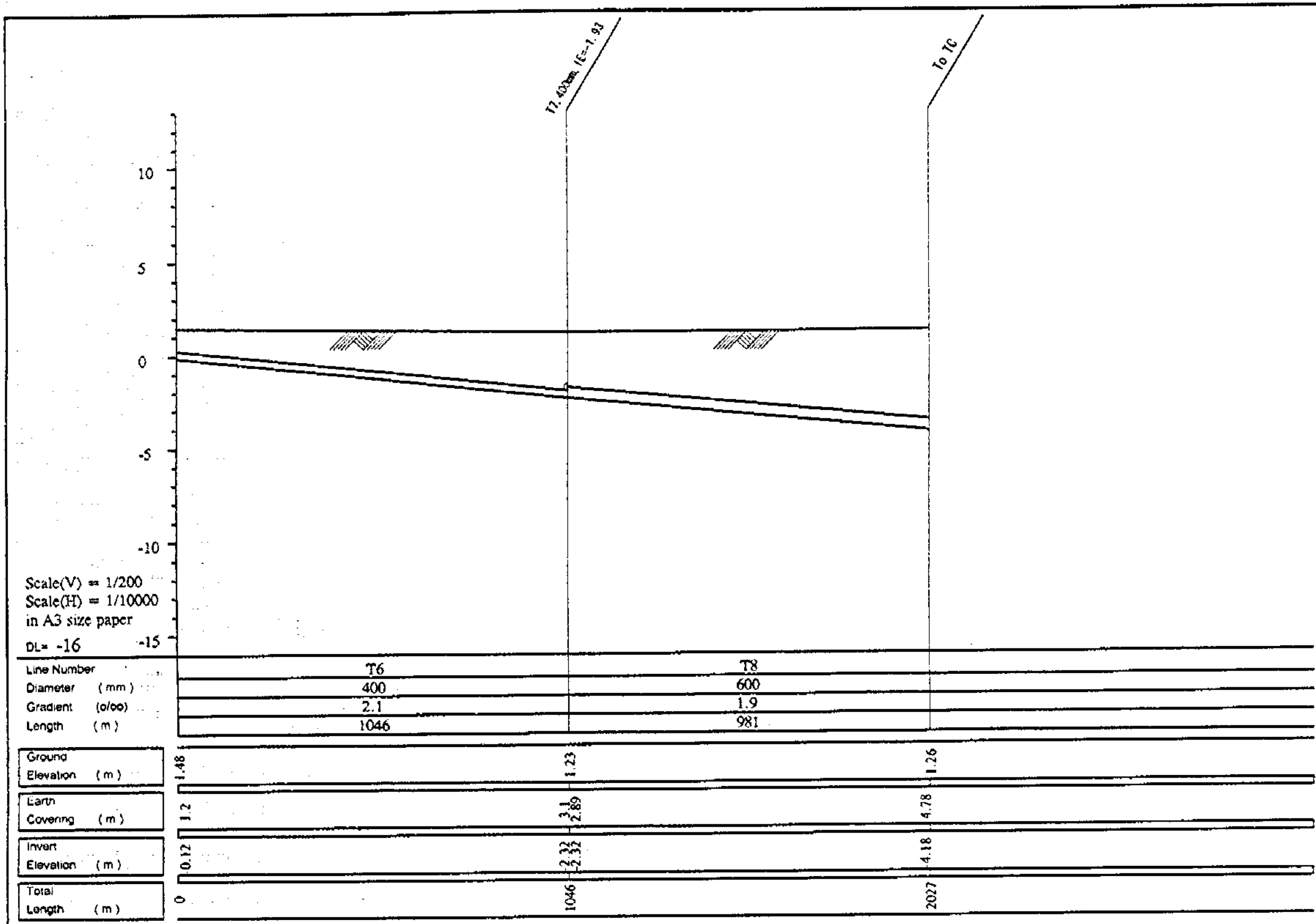


FIG.F.11.9 LONGITUDINAL PROILE OF INTERCEPTOR FOR TUNG THIEN VUONG SUB-ZONES