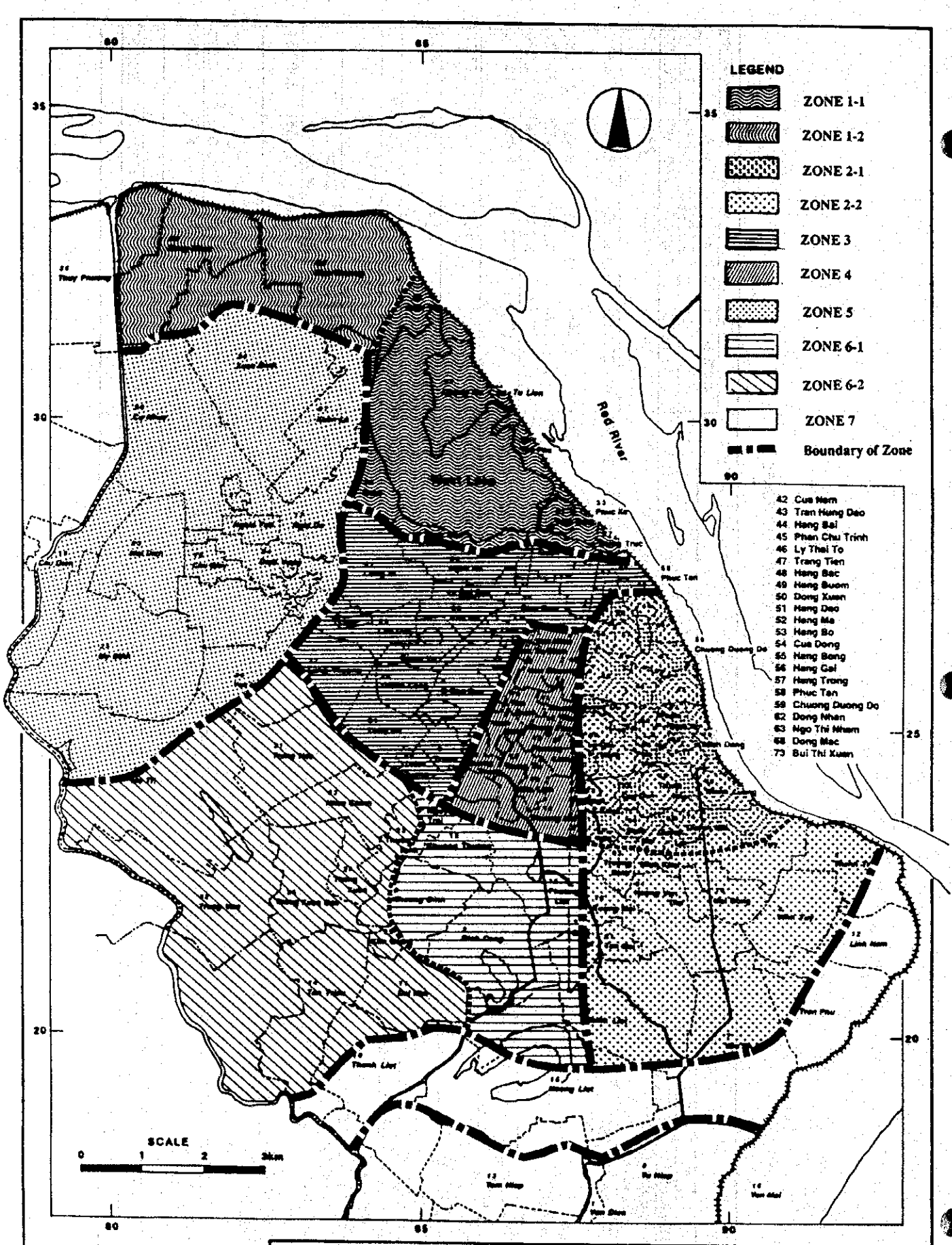

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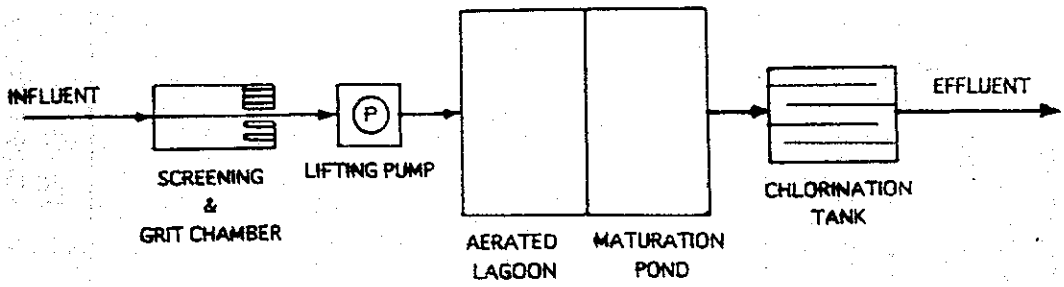
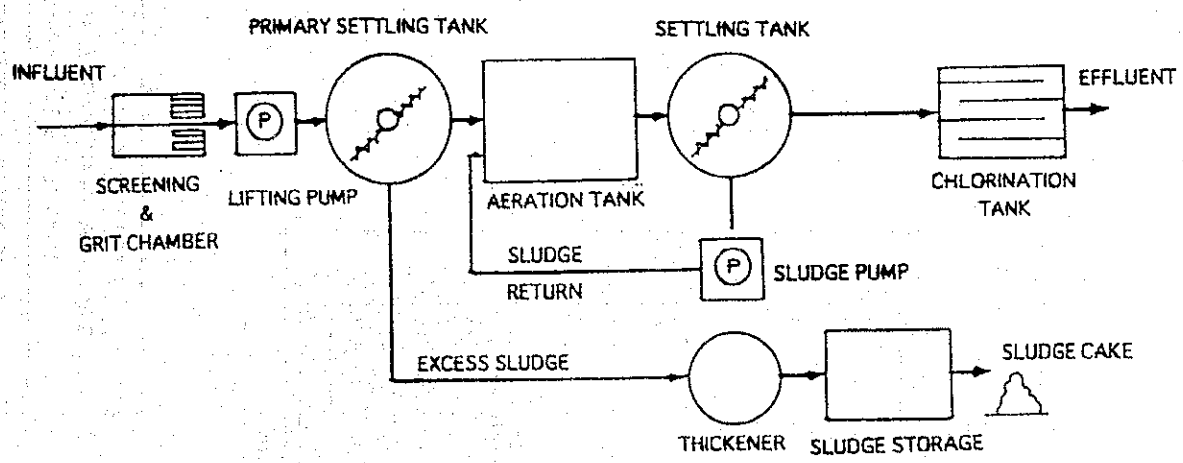
Fig. 4.1

ZONING PLAN

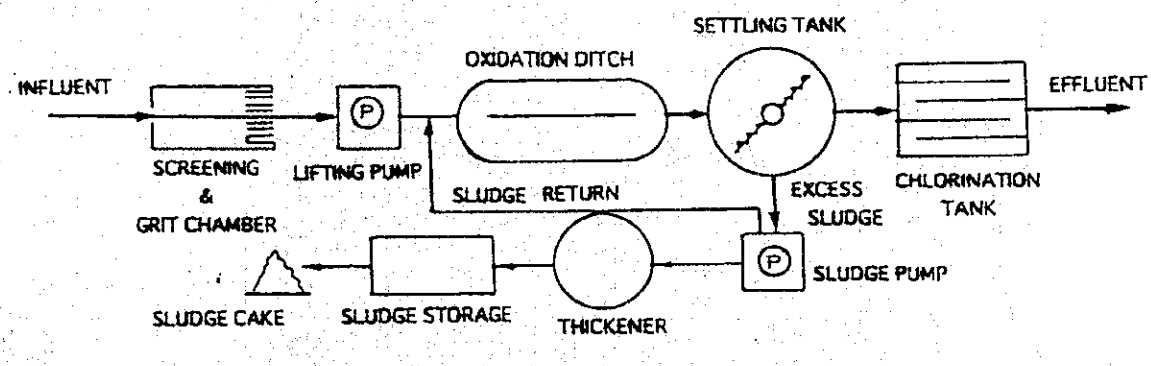
AERATED LAGOON



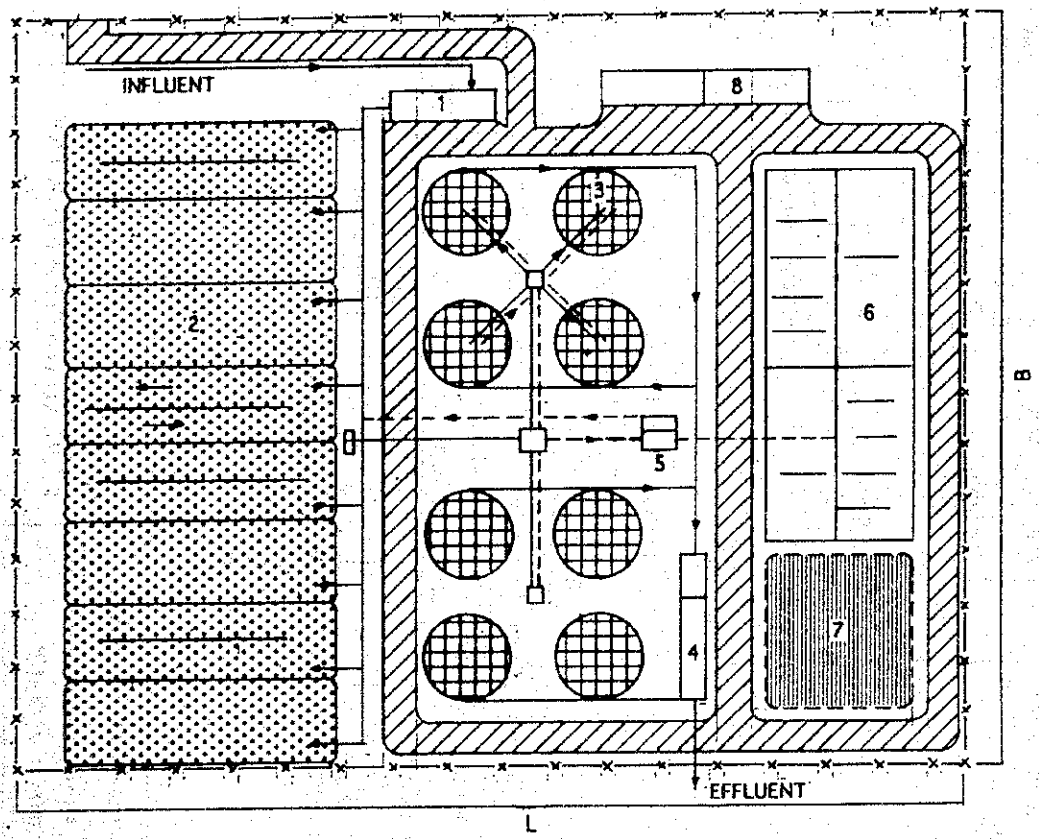
CONVENTIONAL ACTIVATED SLUDGE



OXIDATION DITCH



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. 4.2** **TYPICAL WASTEWATER TREATMENT METHODS**



1. INLET FACILITIES AND FLOW MEASUREMENT
2. OXIDATION DITCHES
3. SETTLING TANKS
4. CHLORINATION CONTACT TANK
   DOSING PUMPS AND STORAGE
5. SLUDGE PUMPING STATION
6. SLUDGE DRYING BEDS
7. SLUDGE STORAGE
8. ADMINISTRATIVE OFFICE AND LABORATORY

LEGEND

- ROAD
- FENCE
- FLOW PATH
- SLUDGE PIPES

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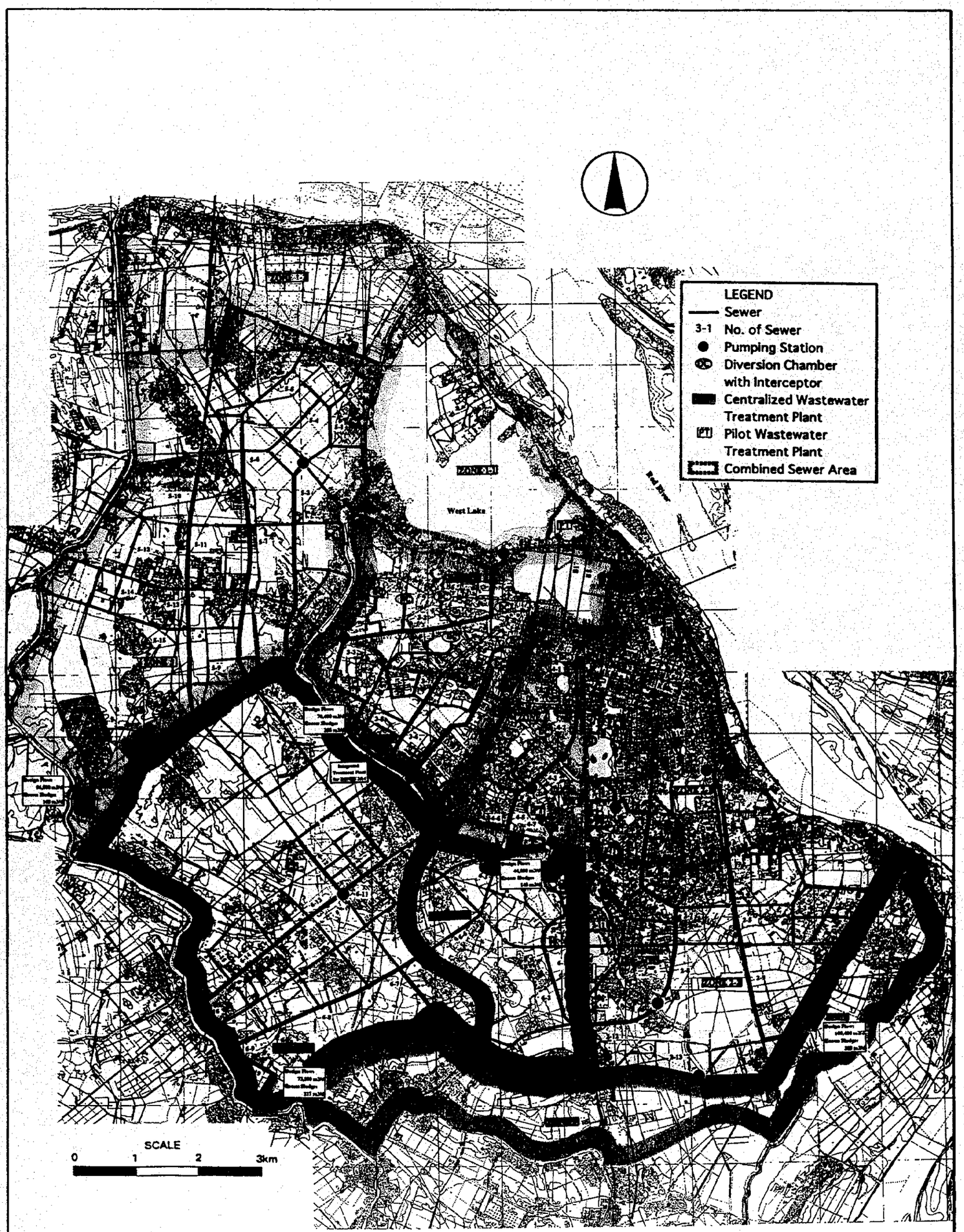
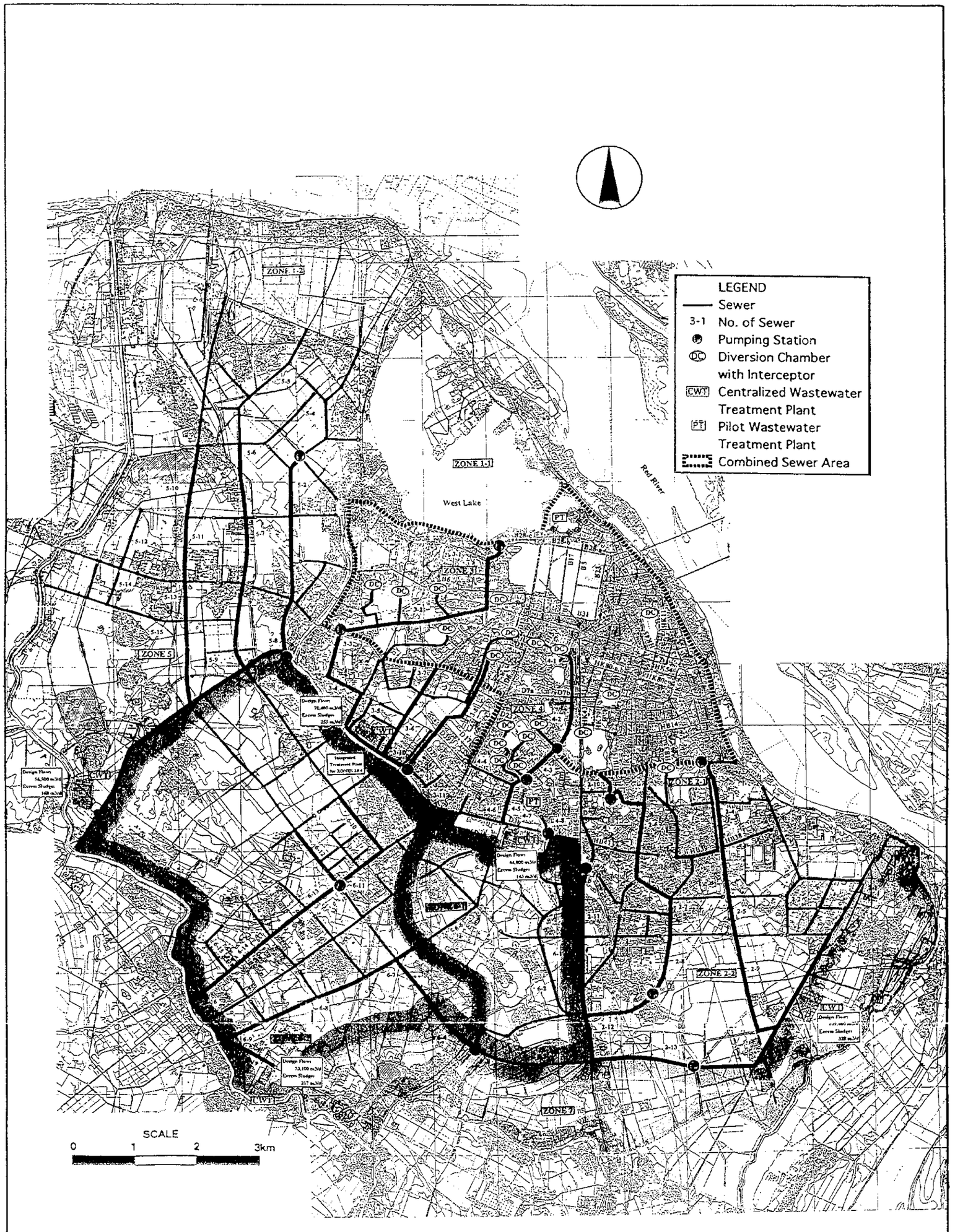
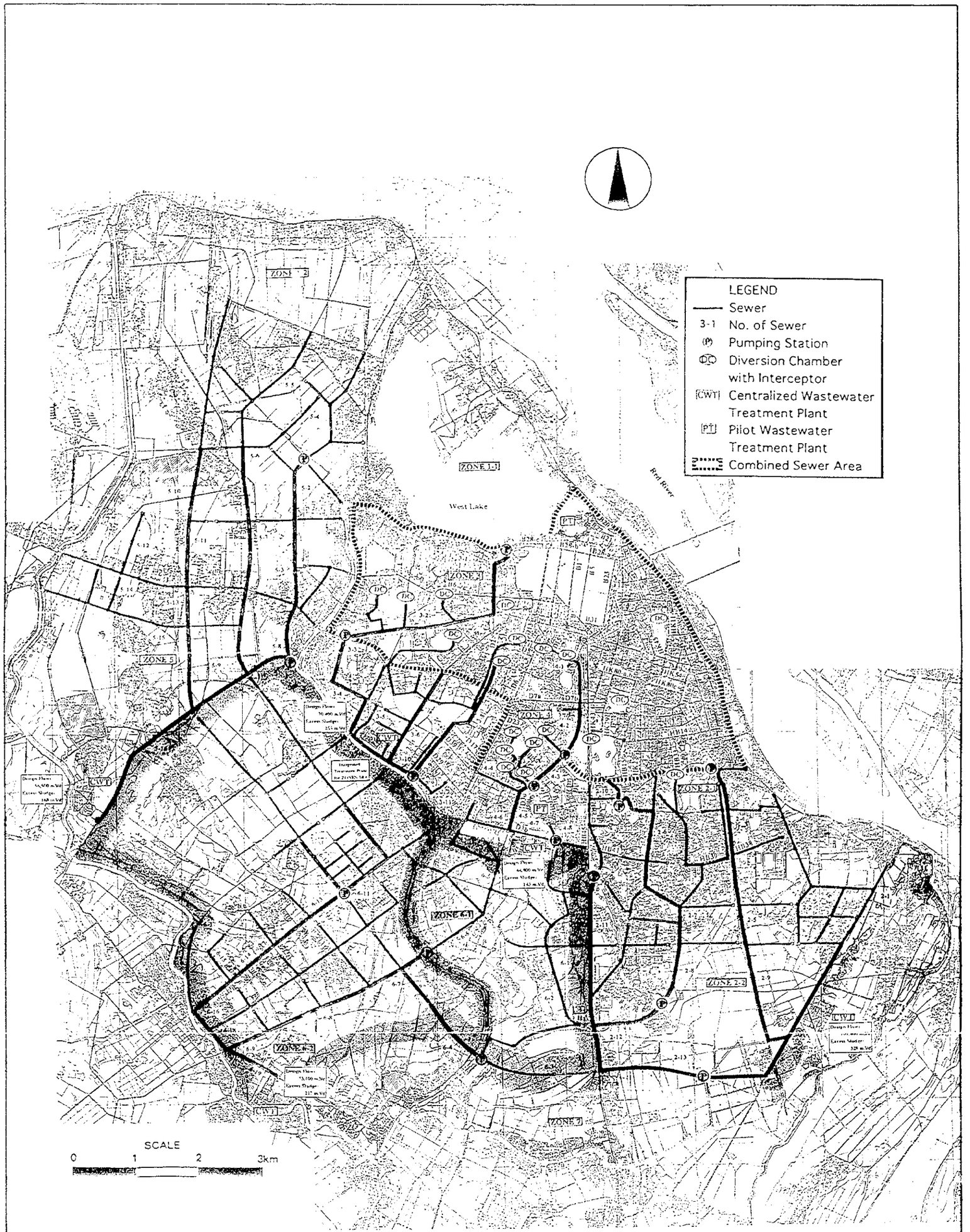
Fig. 4.3
SCHEMATIC LAYOUT OF THE OXIDATION DITCH



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 4.4 OVERALL DEVELOPMENT PLAN FOR THE WASTEWATER DISPOSAL SYSTEM



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 4.4 OVERALL DEVELOPMENT PLAN FOR THE WASTEWATER DISPOSAL SYSTEM



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 4.4 OVERALL DEVELOPMENT PLAN FOR THE WASTEWATER DISPOSAL SYSTEM

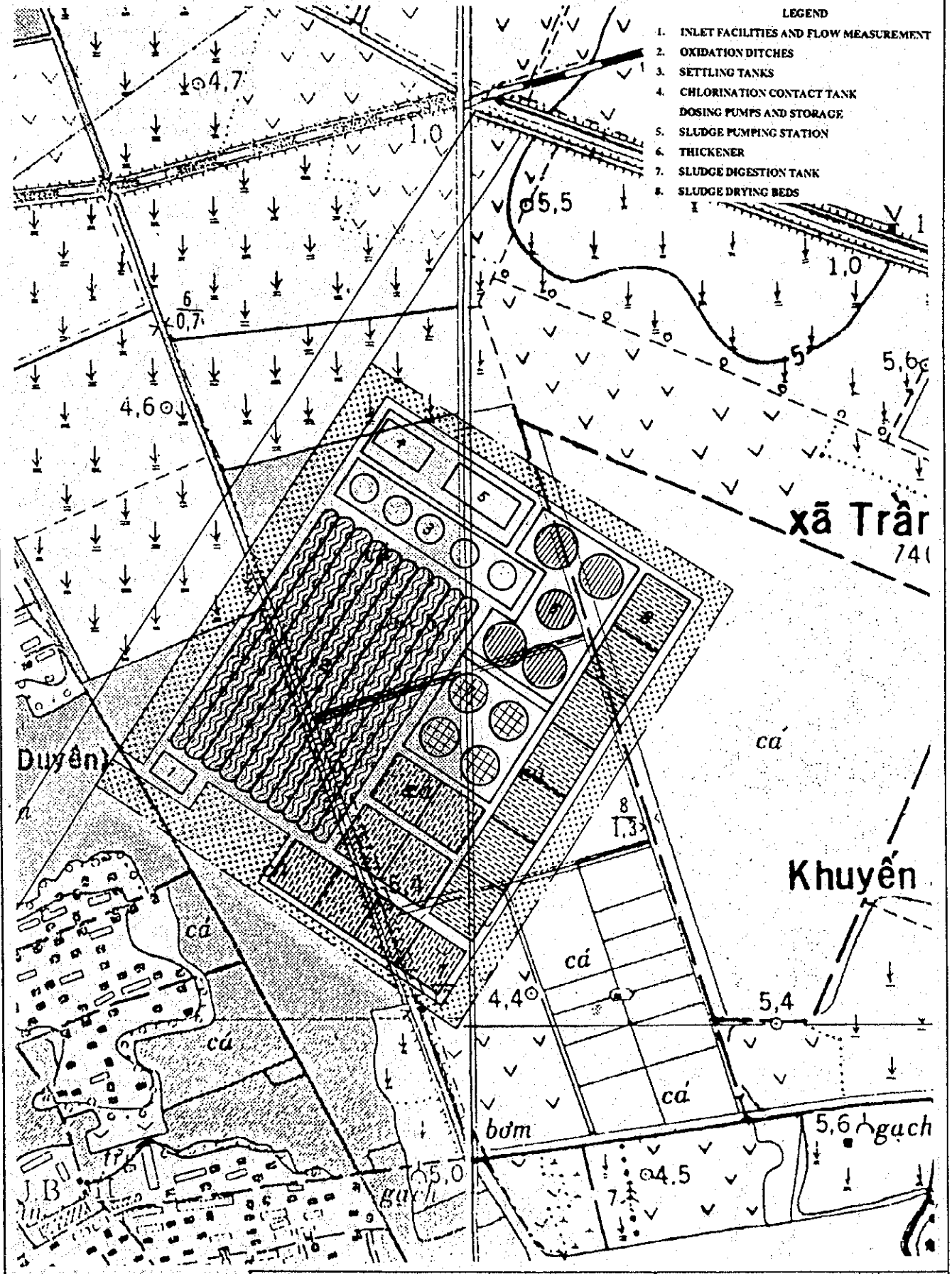


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Fig. 4.5
LAYOUT OF PLANT (OD) FOR ZONE 2

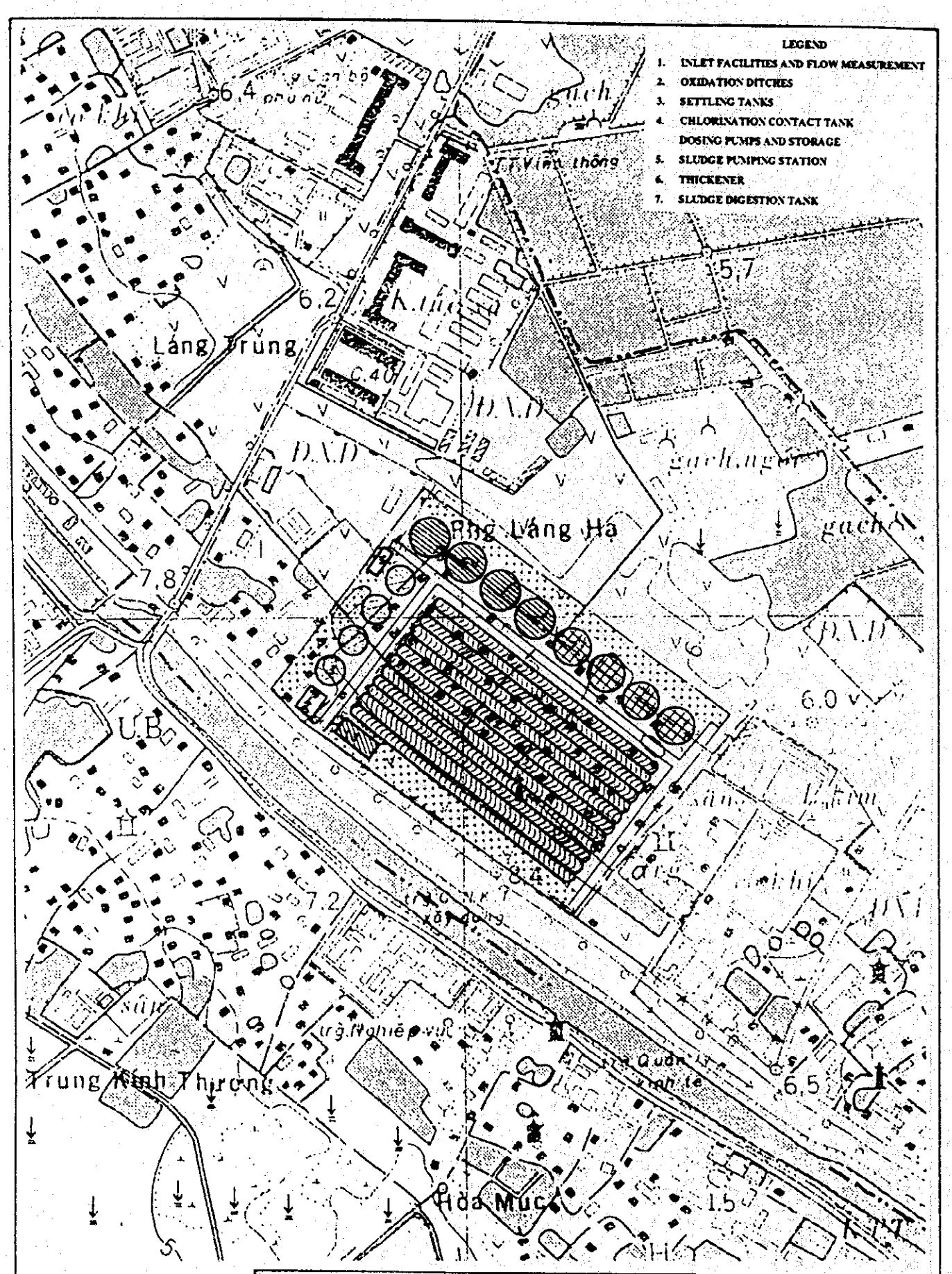

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Fig. 4.6
LAYOUT OF PLANT (OD) FOR ZONE 3

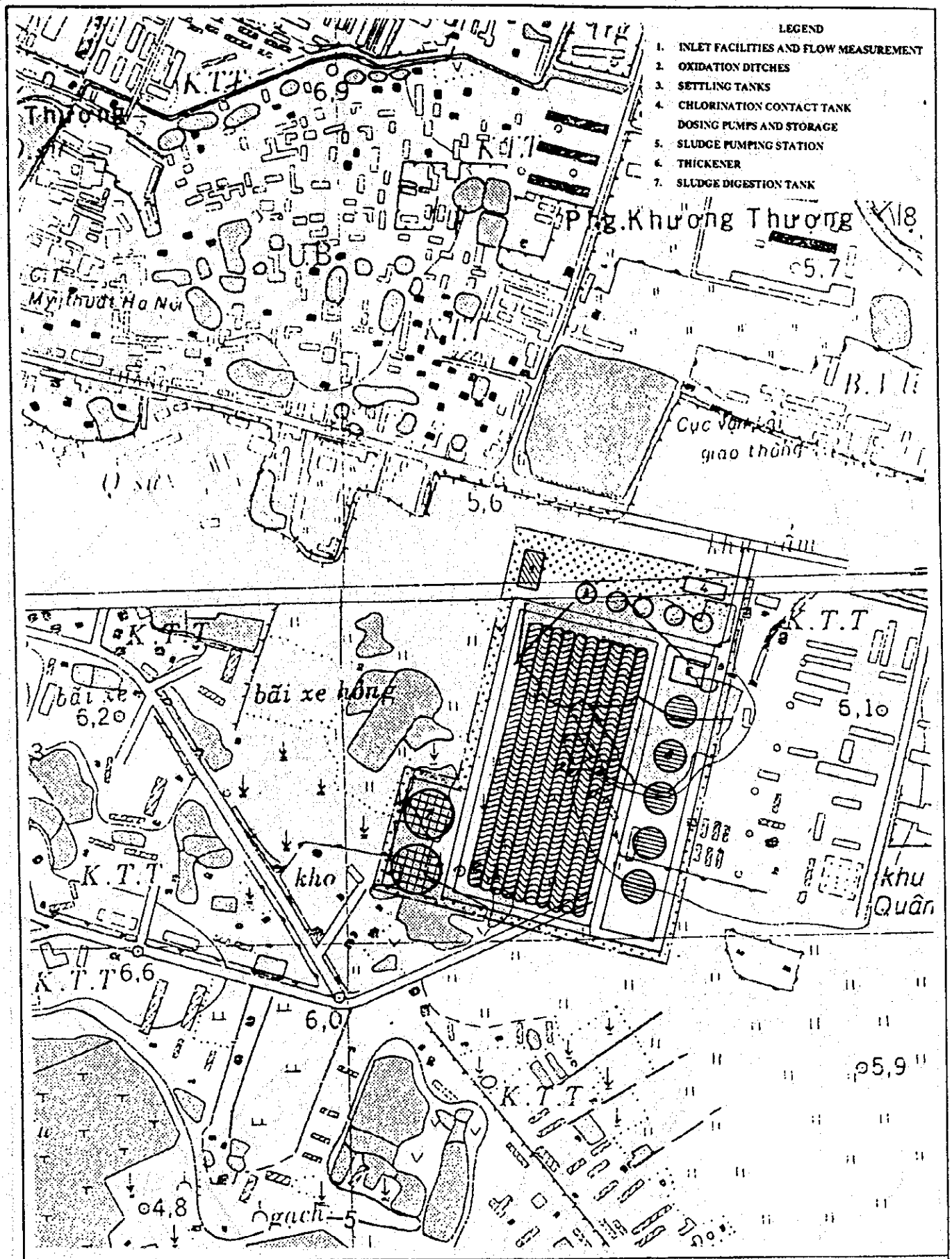

Fig. 4.7
LAYOUT OF PLANT (OD) FOR ZONE 4

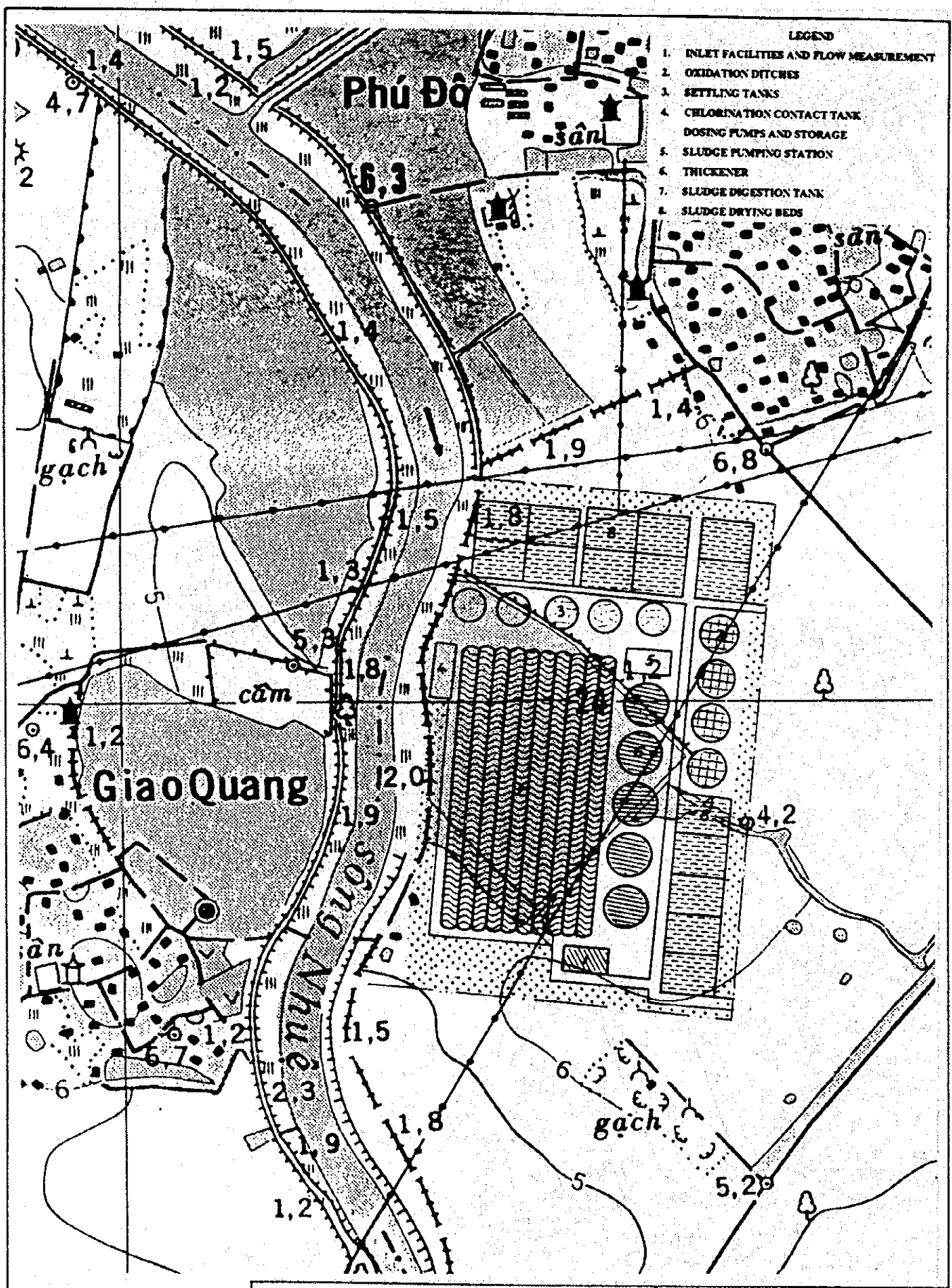

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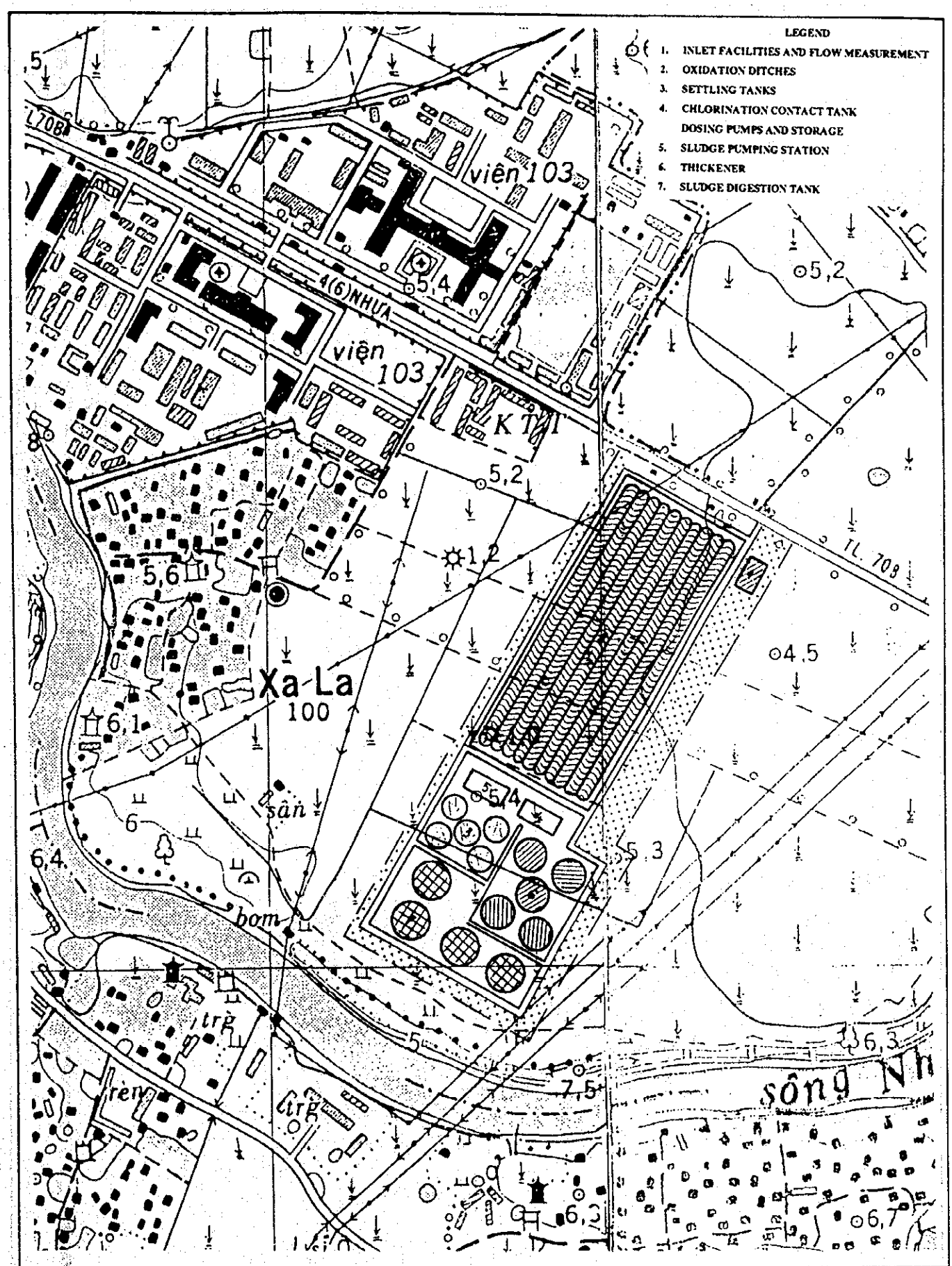
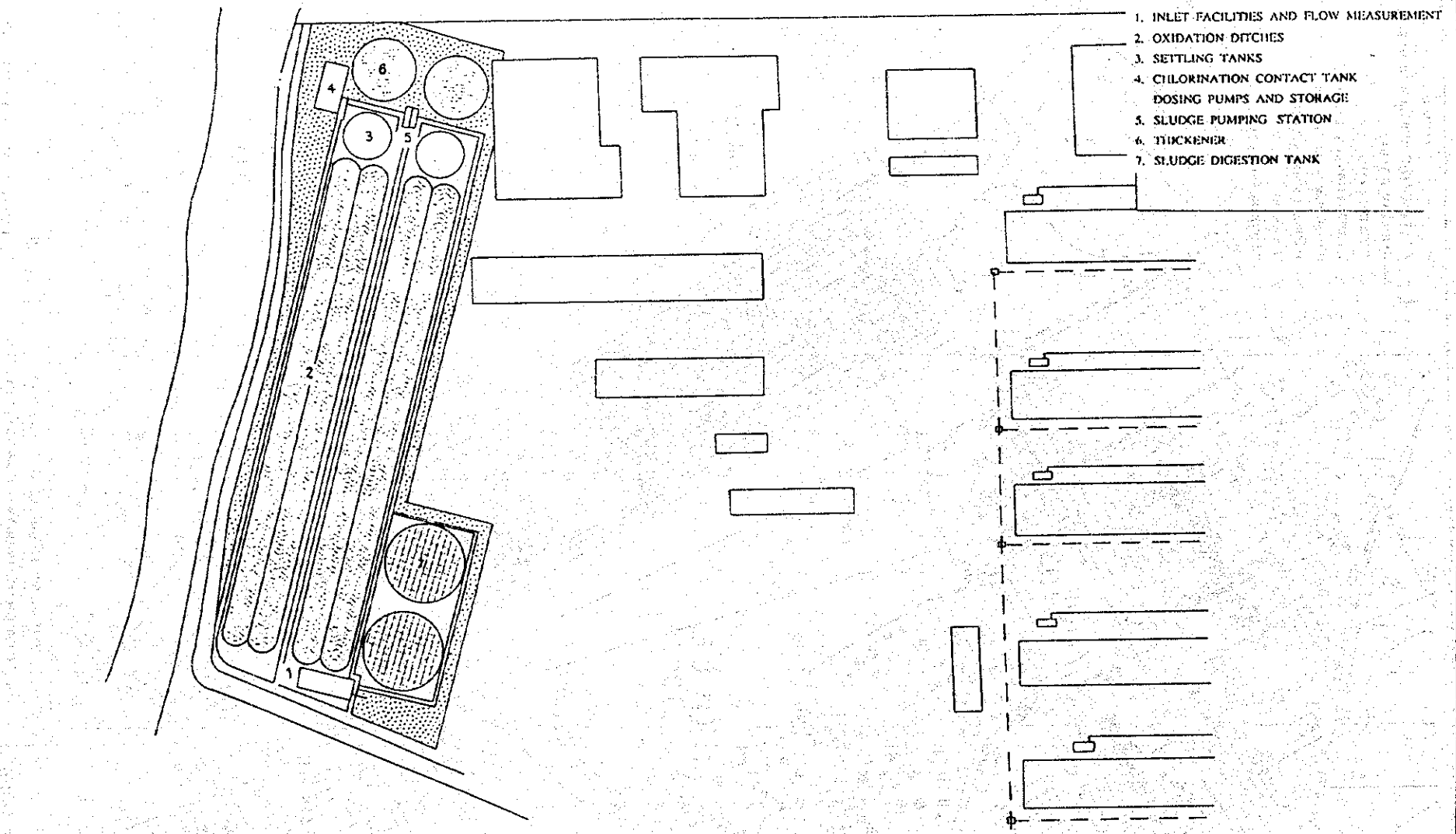
Fig. 4.8
LAYOUT PLANT (OD) FOR ZONE 5



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 4.9 LAYOUT OF PLAN (OD) FOR ZONE 6



SOCIALIST REPUBLIC OF VIET NAM
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Fig. 4.10
LAYOUT OF PLANT (OD) FOR KIM LIEN

Fig. 4.11 IMPLEMENTATION SCHEDULE OF THE WASTEWATER DISPOSAL PLAN

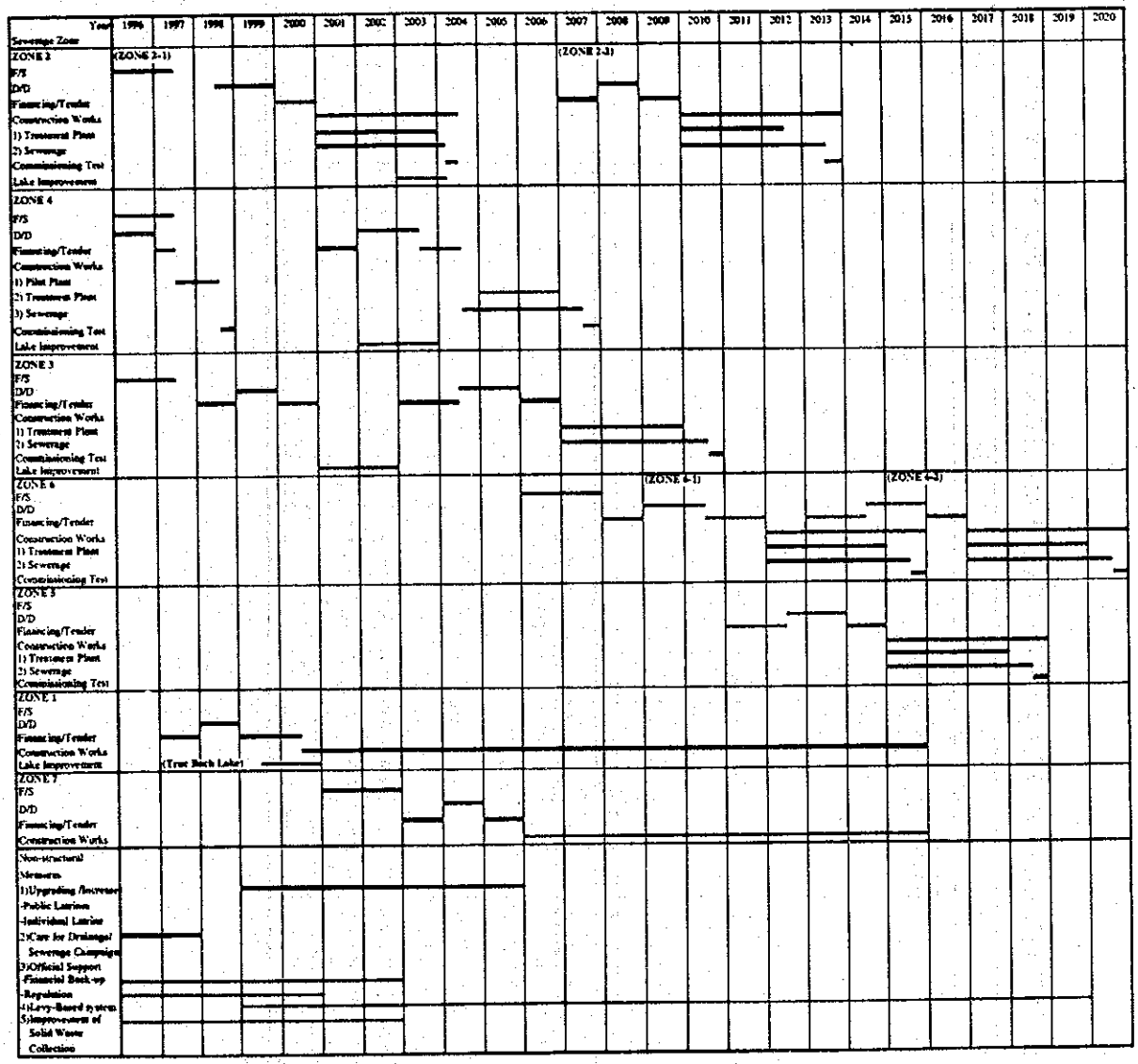

Fig. 4.12 DISBURSEMENT SCHEDULE OF THE WASTEWATER DISPOSAL SYSTEM (1/4)

(Unit:Million US$)

Sewerage Zone / Item	Total	Year 1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ZONE 2-1																										
A.Construction Cost	57.198						16.288	16.288	18.228	6.395																
1.Treatment Plant	35.499						11.833	11.833	11.833																	
2.Sewerage	17.820						4.455	4.455	4.455	4.455																
3.Lake Water Quality Improvement Work	3.879								1.940	1.940																
B.Land Acquisition Cost	2.505				1.253	1.253																				
C.Engineering Service Cost	8.580	0.613	0.613	1.226	1.226	0.613	1.226	1.226	1.226	0.613																
D.Administration Cost	2.985	0.332	0.332	0.332	0.332	0.332	0.332	0.332	0.332	0.332																
E.Physical Contingency	14.254	0.189	0.189	0.312	0.562	0.440	3.569	3.569	3.957	1.468																
Sub-Total	85.522	1.134	1.134	1.870	3.373	2.638	21.415	21.415	23.743	8.808																
ZONE 4																										
A.Construction Cost	38.275		2.724	2.724				1.178	1.178	1.702	13.534	13.534	1.702													
1.Pilot Treatment Plant	5.448		2.724	2.724																						
2.Treatment Plant	23.663										11.832	11.832														
3.Sewerage	6.808									1.702	1.702	1.702	1.702													
4.Lake Water Quality Improvement Work	2.356							1.178	1.178																	
B.Land Acquisition Cost	11.419	1.900						4.760	4.760																	
C.Engineering Service Cost	5.741	0.273	0.273	0.273	0.410			0.8201	0.8201	0.8201	0.8201	0.8201	0.410													
D.Administration Cost	2.485	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207													
E.Physical Contingency	11.584	0.476	0.641	0.641	0.123	0.041	0.041	1.393	1.393	0.546	2.912	2.912	0.464													
Sub-Total	69.504	2.857	3.845	3.845	0.741	0.249	0.249	8.358	8.358	3.275	17.473	17.473	2.783													

Fig. 4.12 DISBURSEMENT SCHEDULE OF THE WASTEWATER DISPOSAL SYSTEM (2/4)

(Unit:Million US$)

Sewerage Zone / Item	Total	Year 1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ZONE 3																										
A.Construction Cost	62.904						0.918	0.918					18.383	18.383	18.383	5.922										
1.Treatment Plant	37.383												12.461	12.461	12.461											
2.Sewerage	23.686												5.922	5.922	5.922	5.922										
3.Lake Water Quality Improvement Work	1.835						0.918	0.918																		
B.Land Acquisition Cost	15.200										7.600	7.600														
C.Engineering Service Cost	9.436				1.048		1.048	1.048		1.048	1.048		1.048	1.048	1.048	1.048										
D.Administration Cost	3.905			0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300										
E.Physical Contingency	18.289			0.060	0.270	0.060	0.453	0.453	0.060	0.270	1.790	1.580	3.946	3.946	3.946	1.454										
Sub-Total	109.734			0.360	1.619	0.360	2.720	2.720	0.360	1.619	10.739	9.480	23.678	23.678	23.678	8.724										
ZONE 2-2																										
A.Construction Cost	35.375															10.295	10.295	10.295	4.489							
1.Treatment Plant	17.418															5.806	5.806	5.806								
2.Sewerage	17.957															4.489	4.489	4.489	4.489							
3.Lake Water Quality Improvement Work	0.000																									
B.Land Acquisition Cost	1.253													0.627	0.627											
C.Engineering Service Cost	5.306													1.061		1.061	1.061	1.061	1.061							
D.Administration Cost	1.831												0.262	0.262	0.262	0.262	0.262	0.262	0.262							
E.Physical Contingency	8.753												0.052	0.390	0.178	2.324	2.324	2.324	1.162							
Sub-Total	52.518												0.314	2.339	1.066	13.942	13.942	13.942	6.974							

Fig. 4.12 DISBURSEMENT SCHEDULE OF THE WASTEWATER DISPOSAL SYSTEM (3/4)

(Unit:Million US$)

Sewerage Zone / Item	Total	Year 1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ZONE 6-1																										
A.Construction Cost	30.705																	8.986	8.986	8.986	3.746					
1.Treatment Plant	15.721																	5.240	5.240	5.240						
2.Sewerage	14.984																	3.746	3.746	3.746	3.746					
3.Lake Water Quality Improvement Works																										
B.Land Acquisition Cost	0.718															0.359	0.359									
C.Engineering Service Cost	4.606														0.768	0.768		0.768	0.768	0.768	0.768					
D.Administration Cost	1.571											0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157					
E.Physical Contingency	7.520											0.031	0.031	0.031	0.183	0.257	0.103	1.982	1.982	1.982	0.934					
Sub-Total	45.120											0.189	0.189	0.189	1.110	1.541	0.619	11.893	11.893	11.893	5.605					
ZONE 5																										
A.Construction Cost	77.397																				21.971	21.971	21.971	11.483		
1.Treatment Plant	31.466																				10.489	10.489	10.489			
2.Sewerage	45.931																				11.483	11.483	11.483	11.483		
3.Lake Water Quality Improvement Works																										
B.Land Acquisition Cost	2.755																		1.378	1.378						
C.Engineering Service Cost	11.610																	1.935	1.935		1.935	1.935	1.935	1.935		
D.Administration Cost	4.008																0.501	0.501	0.501	0.501	0.501	0.501	0.501	0.501		
E.Physical Contingency	19.154																0.100	0.487	0.763	0.376	4.881	4.881	4.881	2.784		
Sub-Total	114.924																0.601	2.923	4.576	2.254	29.289	29.289	29.289	16.703		
ZONE 6-2																										
A.Construction Cost	61.433																						17.256	17.256	17.256	9.664
1.Treatment Plant	22.778																						7.593	7.593	7.593	
2.Sewerage	38.655																						9.664	9.664	9.664	9.664
3.Lake Water Quality Improvement Works																										
B.Land Acquisition Cost	1.040																				0.520	0.520				
C.Engineering Service Cost	9.215																			1.536	1.536		1.536	1.536	1.536	1.536
D.Administration Cost	3.124																		0.391	0.391	0.391	0.391	0.391	0.391	0.391	0.391
E.Physical Contingency	14.962																0.000		0.078	0.385	0.489	0.182	3.837	3.837	3.837	2.318
Sub-Total	89.774																0.000		0.469	2.312	2.936	1.093	23.019	23.019	23.019	13.908

Fig. 4.12 DISBURSEMENT SCHEDULE OF THE WASTEWATER DISPOSAL SYSTEM (4/4)

(Unit:Million US$)

Sewerage Zone / Item	Total	Year 1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ZONE I-1																										
A.Construction Cost	15.608				0.880	1.791	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863					
1.Treatment Plant	13.800					0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863					
2.Sewerage	0.048					0.048																				
3.Lake Water Quality Improvement Work	1.760				0.880	0.880																				
B.Land Acquisition Cost	2.982				0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186						
C.Engineering Service Cost	2.341			0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130					
D.Administration Cost	0.930		0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049					
E.Physical Contingency	4.372		0.010	0.036	0.249	0.431	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.208					
Sub-Total	26.233		0.059	0.215	1.494	2.587	1.474	1.474	1.474	1.474	1.474	1.474	1.474	1.474	1.474	1.474	1.474	1.474	1.474	1.474	1.250					
ZONE I-2																										
A.Construction Cost	17.038													2.482	2.482	2.482	1.074	2.482	2.482	2.482	1.074					
1.Treatment Plant	8.444													1.407	1.407	1.407		1.407	1.407	1.407						
2.Sewerage	8.594													1.074	1.074	1.074	1.074	1.074	1.074	1.074	1.074					
3.Lake Water Quality Improvement Work	0.000												0.000	0.000												
B.Land Acquisition Cost	0.361												0.181				0.181									
C.Engineering Service Cost	2.556												0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284	0.284					
D.Administration Cost	0.870											0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087					
E.Physical Contingency	4.165											0.017	0.110	0.571	0.571	0.571	0.325	0.571	0.571	0.571	0.289					
Sub-Total	24.990											0.104	0.662	3.423	3.423	3.423	1.951	3.423	3.423	3.423	1.734					
ZONE 7																										
A.Construction Cost	13.253											1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325					
1.Treatment Plant	13.253											1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325					
2.Sewerage																										
3.Lake Water Quality Improvement Works																										
B.Land Acquisition Cost	0.415										0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042						
C.Engineering Service Cost	1.988									0.181		0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181					
D.Administration Cost	0.683						0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046					
E.Physical Contingency	3.268						0.009	0.009	0.009	0.045	0.017	0.319	0.319	0.319	0.319	0.319	0.319	0.319	0.319	0.319	0.310					
Sub-Total	19.607						0.055	0.055	0.055	0.272	0.104	1.912	1.912	1.912	1.912	1.912	1.912	1.912	1.912	1.912	1.862	19.611				

5. PROJECT EVALUATION AND DEVELOPMENT PROGRAM

5.1 Development Cost

5.1.1 General

The construction cost and operation and maintenance cost for the urban drainage plan and wastewater disposal plan are estimated on the following assumptions:

(1) Total construction cost consists of, direct construction cost, government administration cost, land acquisition cost, engineering service cost, and physical contingency (price contingency is excluded from this cost estimate).

(2) All the costs are estimated in US$. The basic exchange rates applied are:

US$ = Yen 100 = VN Dong 10,800

(3) The cost of imported machineries, equipments and materials excludes imported tax and duties since such taxes are not imposed for this government project.

(4) The labor cost applied is the prevailing wage rate in Hanoi city (no adjustments are made for estimating the shadow wage rate since the current rate barely covers subsistence income levels).

(5) All project costs are estimated at mid. 1994 price levels.

5.1.2 Drainage Plan

The construction and OM costs of the urban drainage plan for the To Lich River basin and Nhue River basin are estimated as follows:

(US$ 1,000)

Basin/Stage	Const. Cost	OM Cost (per year)
To Lich River Basin		
(1) 1st Stage	160,470	1,143
(2) 2nd Stage	156,939	579
(Sub-total)	(317,409)	(1,722)

Nhue River Basin			
(1)	Co Nhue	86,218	273
(2)	My Dinh	40,950	159
(3)	Me Tri	53,588	179
(4)	Ba Xa	25,942	118
	(Sub-total)	(206,698)	(729)
Total		524,107	2,451

The operation and maintenance cost includes costs for the dredging of channels, removal of garbage and other debris, repair of embankments and other structures, and the OM of pumping stations and related facilities.

5.1.3 Wastewater Disposal Plan

The construction and OM costs of all the wastewater disposal plans (Zone 1-1 to Zone 7) are estimated as follows:

		Const. Cost	OM Cost (per year)
(1)	Centralized Treatment		
	Zone 2-1	85,522	1,130
	Zone 2-2	52,518	577
	Zone 3	109,734	1,198
	Zone 4	69,504	900
	Zone 5	114,924	1,082
	Zone 6-1	45,120	517
	Zone 6-2	89,774	799
	(Sub - Total)	(567,096)	(6,203)
(2)	On-Site Treatment		
	Zone 1-1	26,233	419
	Zone 1-2	24,990	279
	Zone 7	19,607	1,136
	(Sub - Total)	(70,830)	(1,834)
	Total	637,926	8,037

The centralized treatment plans (Zones 2-1, 2-2, 3,4,5 and 6) will be implemented as a public investment project, while the on-site plans (Zone 1-1, 1-2 and 7) will be implemented by the community or as a private investment. The total required investment is US $ 638 million.

Total annual OM costs for all the wastewater disposal plants are estimated at US$ 8.04 million, US$ 6.21 million for the centralized treatment plants and US$ 1.83 million for the on-site treatment plants.

5.2 Project Evaluation

5.2.1 General

Economic and financial evaluation is conducted for the urban drainage plan and the wastewater disposal plan. To estimate economic benefits, the reduction in flood damage relate to the urban drainage plan, while quantifiable benefits including the reduction in disease contraction, tourism promotion, improved groundwater quality, and increases in land value relate to the wastewater disposal plan.

Construction costs, operation and maintenance costs, and replacement costs are estimated at mid-1994 price levels. Costs exclude price escalations and transfer payments including import tax and other related taxes.

The Economic Internal Rate of Return (EIRR) is calculated for the selected urban drainage plan and the wastewater disposal plan on the basis of their estimated economic benefit and cost, and having a projected economic life of 50 years. The comparison of EIRR between the urban drainage plan and the wastewater disposal plan cannot be made directly, since the benefit estimate methods are different.

For the financial analysis evaluated in line with the government budget and national economy, fund requirements are estimated for the implementation of the selected projects up to the year 2020. Appropriate sewer charges are also judged considering the required operation and maintenance costs and the affordability of the residents.

5.2.2 Economic Evaluation

(1) Drainage Plan

(a) Economic Benefits

The economic benefits expected from the urban drainage plan are derived from reduced flood damage and increased contribution to environmental improvement. However, only the reduction of flood damage is estimated for this economic study. For the estimate, direct damage on property, including houses, household goods, shops, merchandise, public/government buildings and factories, and on agricultural production are initially estimated by applying the damage ratio to the damage potential and flood frequency. Indirect damage is also taken into account; includes damage to transportation and communications, and a loss of income for this factory owners and employees.

The expected reduction is calculated by estimating the difference between the average annual flood damage prior to construction and after completion of the project. After implementation of the drainage plan, the Study Area will be free from floods with a return period of 10-years or less. The estimated annual economic benefits both for To Lich River basin and Nhue River basin are presented below.

Economic Benefit of Urban Drainage

(US$ 1,000)

	Economic Benefit (1994)
To Lich River	
1st Stage	7,537
2nd Stage	5,026
(Sub-total)	(12,563)
Nhue River	
Co Nhue	157
My Dinh	985
Me Tri	1,018
Ba Xa	528
(Sub-total)	(2,688)
Total	15,251

The benefits estimated above are expected to increase at 8 % *1 per annum which corresponds to the economic growth of the region.

*1: Due to the rapid urbanization of the Nhue River basin, an increased rate of 11 % is applied.

(b) Economic Costs

Economic construction costs are estimated using the economic price for land acquisition and compensation, summarized below:

Economic Cost of Urban Drainage

(US$ 1,000)

	Economic Cost
To Lich River	
1st Stage	146,809
2nd Stage	138,894
(Sub-total)	(285,703)
Nhue River	
Co Nhue	73,188
My Dinh	35,430
Me Tri	42,076
Ba Xa	24,147
(Sub-total)	(174,841)
Total	460,544

(c) Economic Evaluation

On the basis of the estimated economic construction cost, OM cost, and economic benefit, EIRRs are calculated for the six plans. For the calculation, all the plans are assumed to be completed within 6 years. The calculated EIRRs are presented below:

	EIRR (%)
To Lich River	(11.6)
1st Stage	11.7
2nd Stage	11.4
Nhue River	(9.3)
Co Nhue	*
My Dinh	11.1
Me Tri	10.0
Ba Xa	9.3

* EIRR is not calculated since the total estimated benefit could not cover the project cost.

As indicated above, the To Lich River drainage plan for the 1st and 2nd stages has the highest economic rate of return, and can be economically justified. In the Nhue River basin, the My Dinh, Me Tri and Ba Xa show reasonable returns though Co Nhue does not produce any justifiable benefits. The Nhue River drainage plan is also economically viable as a basin drainage plan. (The cost benefit stream of the six plans are presented in Table H2.1 to H2.6 in Appendix H).

(2) Wastewater Disposal Plan

(a) Economic Benefit

Through the improvement of the wastewater disposal system, the following economic benefits are expected.

(1) Reduction in disease contraction
(2) Tourism promotion (contribution to increased tourism)
(3) Improvement of groundwater quality
(4) Increased land value
(5) Increase in agricultural and fishery production
(6) Improvement of living environment
(7) Facilitation of urban development in Hanoi city

Only four of the above benefits are estimated quantitatively, and are compared to the economic cost for economic evaluation. The estimated economic benefits per year in the Study Area are summarized below:

(US$ 1,000)

	Economic Benefit (1993)
Reduction in disease contraction	953*
Tourism promotion	2,460*
Improvement of groundwater (for 5 years)	559
Increased land value (for 10 years)	46,500

* The benefits are expected to increase at 8 % per annum which corresponds to the economic growth in the region.

(b) Economic Cost

The economic construction costs of the wastewater disposal plans are estimated by using the economic price for land acquisition and compensation. The estimated economic costs are summarized below.

Economic Cost of the Wastewater Disposal Plan

(US$ 1,000)

	Economic Cost(1994)
Zone 1 - 1	22,488
Zone 1 - 2	24,546
Zone 2 - 1	82,447
Zone 2 - 2	50,981
Zone 3	90,648
Zone 4	55,165
Zone 5	111,542
Zone 6 - 1	44,239
Zone 6 - 2	88,498
Zone 7	19,098
Total	589,652

(c) Economic Evaluation

On the basis of the estimated economic benefit and cost, EIRRs can be calculated for each zonal development plan. For the calculation, all the development plans are assumed to be completed within 5 years. The resulting EIRRs are presented below:

Zones	EIRR (%)
Zone 1 - 1	4.4
Zone 1 - 2	*
Zone 2 - 1	5.7
Zone 2 - 2	*
Zone 3	8.2
Zone 4	6.7
Zone 5	1.9
Zone 6 - 1	2.1
Zone 6 - 2	1.7
Zone 7	*

- EIRR is not calculated since the total estimated benefit did not cover the project cost.

The above results indicate that Zone 3 produces the highest return among the ten zones and can be economically justified, Zones 4, 2 - 1 and 1 - 1 are marginally viable, while Zones 6 -1 , 5 and 6 - 2 do not presently produce any justifiable benefits. Zones 1 - 2 and 7 do not produce sufficient benefit to cover the project costs. (The cost benefit stream of the ten zonal plans are presented in Table H2.10 to H 2.19 in Appendix H.)

5.2.3 Financial Evaluation

(1) Required Government Investment

For the assessment of the financial viability of the project, annual disbursement for the project implementation is prepared on the assumption that all the project components are to be completed by end of 2020. Required annual government investment for urban drainage and wastewater disposal during the period of 1995 - 2020 is presented in Table 5.1.

As presented in the table, the total investment will be US$ 1,162 million during this period (26 years), equivalent to an average of US$ 44.7 million per year.

(2) Government Budget Analysis

To check the financial viability of the project, capital expenditure of the government and of Hanoi city are reviewed. The government capital expenditures during the period of 1989 - 1993 were assessed, indicating capital expenditure at 3.1 - 7.5 % of the GDP averaging at 5.7 % for the past five years.

During the past five years, most capital expenditure was directed to the development of roads and irrigation facilities. The expenditure for other sectors including water supply, drainage and sewerage remains at less than 10 % of the total expenditure. Out of the national capital expenditure, about 5 – 7 % has been allocated to infrastructure in Hanoi city.

At present, capital expenditure is barely adequate to maintain the national infrastructure. For sustaining the economic growth projected in the national development plan, capital expenditure should be drastically increased.

In due consideration of the above, projection of capital expenditure on infrastructure, was made by the State Planning Committee (SPC) assuming that GDP will increase at the relatively high rate of 10 – 12 % during the period up to 2010. The projected capital expenditure is presented in Table 5.2. (The projected expenditure includes loans from international organizations).

Possible national capital expenditure on Hanoi's infrastructure is estimated based on the following assumptions.

(1) Capital expenditure to be allocated to Hanoi city is 7 – 10 % of national capital expenditure.

(2) The allocated amount for drainage and sewerage is 7 – 12 % of Hanoi's capital expenditure.

The estimated possible capital expenditure is presented in Table 5.2. and summarized below:

(US$ million)

	2000	2005	2010
Capital Expenditure in Hanoi	343	635	1,081
For Drainage and Sewerage	34	64	130

Comparing the proposed cost disbursements with the projected capital expenditure results in the following:

(1) During 1996 – 1998, the required fund will be considerably larger than projected capital expenditure. To achieve this, 1.8 to 2.2 % of the national capital expenditure on infrastructure is to be allocated to the Hanoi drainage and sewerage sector.

(2) After 1998, and except 2002 and 2003, the projected government expenditure will provably cover the required investment.

The estimated figures of possible capital expenditure indicate that the proposed investment for drainage and wastewater disposal in Hanoi city can be generally financially justified. Assuming the support of high economic growth during 1994 – 2010, will result in the increase of capital expenditure at the relatively high ratio of 13 % per annum. (SPC projection)

In the case of a more moderate increase of the capital expenditure, say 8 % per year, is assumed, Hanoi city's share of the capital expenditure or investment share for drainage and sewerage is to be raised substantially in order to sustain the required investment.

(3) Finance for On-site Plants

In zones 1 -1, 1 - 2 and 7, on-site plants are proposed. Among these zones, community plants and septic tanks are planned for the general residents in zone 1 - 1 and zone 7, respectively. (In zone 1 - 2, community plants are planned for industrial estates and high class residential estates, which will be financed by private investors.) The on-site plants are planned in principle to be financed by the residents. However, in due consideration of the socio-economic situation of the region, some other financial arrangement seems necessary. One financial arrangement is the setting up of a revolving fund in HPC. Using this fund, a soft loan will be arranged for the installation of the community plants and septic tanks. The soft loan shall cover 90 % of the installation cost with an interest rate of 7 – 10 % per annum and repayment period, after installation, of 5 years. The soft loan would be generated from international financial sources or by local budget allocation.

The required revolving fund is estimated to be about US$ 6.8 million compared to a total investment of US$ 15.5 million. Assuming that repayment of the loan is to be used for new installations and interest will cover cost increases for the future installation.

For loan issuing and repayment and installation, sewer cooperatives will be set up in zone 1 - 1 and zone 7. The loan will be provided to the sewer cooperatives through the Department of Land and Housing (DLH). The overall organizational set-up for the installation and operation of the on-site plants is described in Appendix H of the Master Plan and summarized in Figure H3.1 of the appendix report.

(4) OM Cost and Sewer Charges

In the proposed implementation plan, OM cost for urban drainage is estimated as follows :

2000 - 2006	US$ 0.57 - 1.72 million/per year (To Lich)
2007 - 2016	US$ 1.80 - 2.45 million/per year (To Lich plus Nhue)

According to the HSDC budget in 1994, the allocated amount for the operation and maintenance is 12.8 billion Dong (US$ 1.19 million), while the total budget for the HSDC is 16 billion Dong (US$ 1.48 million). In order to cover the additional OM costs required for the urban drainage plans, the HSDC budget (33 % per year during 92 - 94), is to increase by 7.7 % per year in net value during 1994 – 2006. Taking into consideration of projected future economic growth and the past trends of the HSDC budget (33 % increase per year during 1992 – 1994), this expected increase seems attainable.

OM costs for wastewater disposal or its part is basically recovered by beneficiaries in most developed countries. At present in Hanoi city, 10 % of the water charge is imposed on beneficiaries as a sewer charge, which is used for the operation and maintenance of the sewer system.

In this study, the sewer charge to be collected for recovering the OM cost is estimated on the assumptions that (1) the present ratio of water charges between households and commercial/factories ($ 0.06/m^3 for households and $ 0.3/m^3 for commercial/factories) continues in the future and the sewer charge is assessed corresponding to water consumption, and (2) the total population of the Study Area

excluding zones 1 - 1, 1 -2 and 7 will be 1,460,000 in 2010 and the number of households will be 339,700

The estimated sewer charge enabling recovery of the OM cost is $ 5.7 /household per year. The estimated figure is equivalent to 0.6 % of the estimated average household income for urban residents (US$ 960 / year in 1994). This indicates that the OM cost can reasonably be recovered by the sewer charge if the above share can be maintained.

However, water charges per household are estimated at $ 8.5 per year in 1994 (90 l / day per person, no. of people in household is 4.3, water charge 0.06 $ /m^3) . Compared to this, the sewer charge is about 67 % of the water charge, which is considered high.

5.3 Overall Implementation Plan

The implementation schedule for the urban drainage and wastewater disposal plans is prepared on the basis of the following conditions and assumptions.

Drainage Plan

(1) The To Lich River basin having a higher economic return will have first priority. (1st stage to 2nd stage)

(2) The Nhue River basin drainage plan is to be implemented at a later stage due to its lower economic return and budgetary constraints. In due consideration of their socio-economic and engineering aspects, Co Nhue, My Dinh, Me Tri and Ba Xa sub-basin plans will be implemented in this order.

Wastewater Disposal Plan

(1) Implementation priority for the wastewater disposal plan is determined by various factors, including population density, land use, pollutant load, cost efficiency of disposal, and economic return.

(2) In regard to the above, the highest priority is given to Zone 2 - 1 to be followed by Zones 4, 3, 2 - 2, 6 - 1, 5 and 6 - 2.

(3) Zone 1- 1, 1 - 2 and 7 are on-site plants and are planned to be implemented on a separate basis (private investment project).

Figure 5.1 shows a proposed implementation schedule of the drainage and wastewater development. Based on the proposed implementation schedule, EIRRs are calculated for the overall urban drainage plan and the wastewater disposal plan as presented in Table 5.3 and 5.4.

EIRR for the overall drainage plan	10.9 %
EIRR for the overall wasterwater disposal plan (excl. Zones 1-1, 1-2 and 7)	5.2 %

As indicated above, the overall drainage plan shows a high return and early implementation is justified, while the overall wastewater disposal plan shows a relatively low return.

5.4 Initial Environmental Examination of the Proposed Projects

In general, the proposed projects will not cause adverse effects to the quality of the environment. Environmentally the project creates a positive effect by improving the drainage system of the city. There will be no major environmental problems in implementing the project.

Nevertheless, in further planning and design of the project, consideration should be taken to minimize the possibility of environmental issues arising. The following main topics will be further analyzed in the subsequent environmental assessment (Appendix F).

5.4.1 To Lich River Basin Drainage Project

(1) Yen So Pumping Station

(a) Environmental Impact

The pumping station, will create very little environmental impact, as the area required is relatively small, 1.7 ha. According to the present designs, the buildings barely disturb or change the landscape. However, the channel which connects the regulating reservoir to the pumping station (Inlet channel) and the pumping station to the Red River (Outlet channel) are new structures which cut the natural connection.

The impact on the Red River water quality depends on the use and capacity of the pumping station. Storm water is usually contaminated, with turbidity and the amount of suspended solids high. However, during heavy rain water volume and flow will increase, as will the dilution capacity, ensuring water from the reservoir has only a temporary impact.

(b) Mitigation of Adverse Impacts

The biggest impact will be during the construction work, which will also increase traffic in the area. Erosion has to be eliminated during construction work and use. The maintenance of the channels has to be arranged to ensure there is always enough area for water to flow freely.

(2) Regulation Reservoirs

(a) Environmental Impact

In the Yen So reservoir, the difference between maximum and minimum water levels will be 3.0 meters, having a big impact on vegetation and fauna, and causing erosion on the banks, if changes occur very quickly and often.

Storm water can also have an impact on the water quality of reservoirs. It is very probable the amount of suspended solids, nutrients and bacteria will increase after the discharge of storm water. Water pumped from reservoirs to the Red River may also reduce the water quality in the Red River.

In the Yen So area, the present lakes are used for fish farming. The ponds are emptied and dredged every year, creating conflict between the needs of fish farming and flood controlling. The water level will increase from present levels, and different areas of the reservoir will be enlarged. These will cause changes in fish farming methods, and in maintaining the reservoir.

Besides Yen So two other regulating reservoirs are proposed, Linh Dam and Dinh Cong, with implementation planned during the second stage. These lakes are to be excavated to complete the regulation capacity of the Yen So reservoir. There will also be two new channels, and the flow direction of the Lower Lu River basin will be changed.

The reservoirs, besides being used for drainage purposes, will also be used for fish farming and recreation. The surrounding areas will be parks and/or green areas. According to the City Master Plan, Linh Dam lake will be an important recreational area in the future, and the demand for water quality will be high. There are also many pagodas around the lake.

(b) Mitigation of Adverse Impacts

To keep water quality in reservoirs as clean as possible, there will be provision made for an ordinary drainage channel connecting the river system directly to the pumping station.

Construction work of the reservoir will last about three years, and during that time about 3,500,000 m^3 soil will be excavated. To minimize transportation costs, the soil should be used near the construction area, e.g. as a material for dikes. To prevent erosion, banks have to be covered with grass or other revetment material.

The location, area and depth of the reservoir has to be designed with care, to eliminate groundwater contamination, the lowering of groundwater levels and soil subsidence in Phap Van well field, located next to the reservoir.

(3) River Improvement

(a) Environmental Impact

The planned improvements are limited dredging in upstream and downstream areas of the main rivers, and some bridge re-construction.

(b) Mitigation of Adverse Impacts

The biggest impact will be during the construction work, when there will be disturbance of traffic. Temporary increase in turbidity and suspended solids may be possible during construction. Impacts on water quality can be controlled and measured downstream.

(4) Drainage Channel Improvements

(a) Environmental Impact

The planned improvements are mainly concerned with the re-construction of bridges to increase flow in the channels. Inadequately sized culverts collect floating garbage causing clogging, which prevents the flow. The improvement of the flow is obvious after cleaning the channels.

(b) Mitigation of Adverse Impacts

It is very possible that the soil in the channel banks and the bottom sediment are polluted, because they have long been used as illegal dumping sites. Polluted soil will have to be removed.
The increase of erosion and amounts of suspended solids has to be prevented and measured during construction. Work has to be completed without affecting water quality downstream. Special attention has to be paid to the prevention of erosion during and after construction.

(5) Lake Dredging

(a) Environmental Impact

It is proposed to dredge 18 lakes of which four will be dredged during the first stage of implementation.

Many lake bottoms seems to be devoid of life, so dredging doesn't cause serious harm to the lake ecosystem. One of the biggest environmental problems is the relocation of sludge.

At the same time, attention should be paid to the banks and surrounding areas to improve the whole area and increase the use of the lakes. Lakes which are used for recreation should be conserved for that purpose. Well-maintained lakes and parks increase the value of the living environment.

(b) Mitigation of Adverse Impacts

Water quality, amount and type of sediment, possible bottom fauna and vegetation have to be studied before and after dredging to establish the real impact of dredging. Mitigation of the wastewater load to lakes has to occur at the same time as dredging, otherwise the restoration will only have a minor influence.

The impact of dredging can be mitigated with good work planning. The treatment and storage of the sediment and sludge has to be organized to prevent future problems.

The amount of sediment will be so great, that the timing of the work has to be done carefully. Work has to commence during the dry season to mitigate the impact. There has to be control during the construction work to accommodate any unforeseen changes.

(6) Lakeside Protection Works

(a) Environmental Impact

There is a conservation proposal for 11 environmentally valuable lakes. Proposed conservation methods call for the excavation of sludge from the lake bottom, construction of a different kind of revetment on the slopes, and the aeration of selected lakes.

To prevent erosion, and the illegal construction of houses, and the dumping of garbage, some kind of protection of the lake banks is needed.

(b) Mitigation of Adverse Impacts

The material for the pavement and slope revetment of the bank has to be selected in regard to each lake. Also during the rainy season and flooding the inundation area can be quite large, causing water build up on the sidewalks.

(7) Storm water sewers

- Rehabilitation of existing sewers

- Installation of new sewers

(a) Environmental Impact

The work consists mainly of construction of new sewers. The replacement of pipes will be determined only after inspecting their condition, during the cleaning work.

The present sewers are old and dilapidated and do not provide adequate drainage for even normal rainfall. Therefore it is necessary to clean the old sewers and construct new, sewers commencing with the most serious inundation areas. Increasing the storm water sewer capacity and decreasing the inundation areas improves both the quality of the environment and sanitation.

(b) Mitigation of Adverse Impacts

The present implementation schedule compared to demand, is slow and inadequate. Sludge from the cleaned sewers has to be disposed of without creating harm to people or the environment.

5.4.2 Existing Sewerage / Channel Dredging Projects

- Supply of Dredging/Cleaning Equipment

- Dredging/Cleaning Work

(a) Environmental Impact

Environmentally, the cleaning and dredging of sewers and channels is very important. It has a very positive environmental impact and is highly recommended especially during the rainy season, because clogged and stinking sewers cause serious environmental and sanitation problems.

(b) Mitigation of Adverse Impacts

Sludge and garbage removed from the channels and sewers must be handled with care as it can contain bacteria and other harmful matter. Special attention must be paid to the safe use of equipment and to protection, during the work. It must be noted, that if the pipes are flushed using high pressure, there may be overflow from the manholes, discharging dirty sludge into the streets.

Treatment and storage of the sludge must be arranged to prevent health or environmental problems. Transportation of sludge has to ensure there will not be spillage. If vacuum tanks are not used, the load must be covered.

It would be beneficial when discussing the cleaning, transportation and composting of the sludge, to utilize pilot testing areas. The most critical technical and environmental areas should be studied.

Due to the continual dumping of refuse, open channel dredging is a continuous process. To create long-term benefits, people must be educated in the correct disposal of solid waste.

5.5 First Priority Project for Implementation

(1) Proposed Project

The To Lich River basin drainage project is selected as the first priority project. Early implementation of the project is supported by it's high economic return and also from a technical/environmental aspect. The project is tentatively named, "Hanoi City Drainage and Environmental Improvement Project."

(2) Objective of the Project

The main objective aims of the proposed project are:

(i) The reduction of physical damage presently caused by flood inundation and improper drainage

(ii) The improvement of the urban sanitary environment (through decrease of inundation) and the improvement of the water-front environment (through river/lake conservation work)

(3) Implementation Cost and EIRR

The total cost for the project is estimated at about US$ 317 million. EIRR is assessed as 11.6 %.

(4) Phasing of the Project

The implementation of the project is proposed to be in two stages. The first stage being concerned with selecting the highest priority work of the project relating to the reduction of flood damage.

Table 5.1 PROPOSED COST DISBURSEMENT SCHEDULE

(US$1,000)

		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
I. Urban Drainage Plan	524,107	8,150	29,866	42,762	47,235	27,568	15,780	22,439	57,422	53,534	25,217	21,962	31,806	28,285	27,845	22,023	20,611	18,023	5,629	6,166	5,447						
1 To Lich River	317,409	8,150	29,866	42,762	47,235	27,568	15,780	22,439	57,422	46,841	19,346																
1st Stage	160,470	8,150	29,866	42,762	47,235	27,568	4,889																				
2nd Stage	156,939						10,891	22,439	57,422	46,841	19,346																
2 Nhue River	206,698									6,693	5,871	21,962	31,806	28,285	27,845	22,023	20,611	18,023	5,629	6,166	5,447						
Co Nhue	86,218									6,693	5,871	21,962	23,458	20,892	7,342												
My Dinh	40,950												3,000	2,556	8,916	9,645	8,937	7,896									
Me Tri	53,588												5,348	4,837	11,587	12,378	10,338	9,100									
Ba Xa	25,942																1,336	1,027	5,629	6,166	5,447						
II. Wastewater Disposal Plan	637,926		3,991	5,038	5,933	5,968	7,093	23,553	34,022	36,350	14,181	20,668	31,891	16,809	33,015	32,663	45,970	29,222	35,567	30,720	23,268	42,666	30,382	52,308	39,722	23,019	13,907
(1) 2 – 1	85,522		1,134	1,134	1,870	3,373	2,638	21,415	21,415	23,743	8,800																
(2) Zone 4	69,504		2,857	3,845	3,848	741	249	249	8,358	8,358	3,275	17,473	17,473	2,778													
(3) Zone 3	109,734					360	1,619	360	2,720	2,720	360	1,619	10,739	9,480	23,678	23,678	23,678	8,723									
(4) Zone 2 – 2	52,518													314	2,339	1,066	13,942	13,942	13,942	6,973							
(5) Zone 6 – 1	45,120												189	189	189	1,110	1,541	619	11,893	11,893	11,893	5,604					
(6) Zone 5	114,924																	601	2,923	4,576	2,254	29,289	29,289	29,289	16,703		
(7) Zone 6 – 2	89,774																			469	2,312	2,936	1,093	23,019	23,019	23,019	13,907
(8) Zone 1 – 1	26,233			59	215	1,494	2,587	1,474	1,474	1,474	1,474	1,474	1,474	1,474	1,474	1,474	1,474	1,474	1,474	1,474	1,474	1,242					
(9) Zone 1 – 2	24,990												104	662	3,423	3,423	3,423	1,951	3,423	3,423	3,423	1,735					
(10) Zone 7	19,607							55	55	55	272	102	1,912	1,912	1,912	1,912	1,912	1,912	1,912	1,912	1,912	1,860					
III. Grand Total	1,162,033	8,150	33,857	47,800	53,168	33,536	22,873	45,992	91,444	89,884	39,398	42,630	63,697	45,094	60,860	54,686	66,581	47,245	41,196	36,886	28,715	42,666	30,382	52,308	39,722	23,019	13,907

Table 5.2 PROJECTION OF CAPITAL EXPENDITURE FOR THE INFRASTRUCTURE

(US$ million)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1- Total National Capital Expenditure *1	3390	4220	5060	5979	7010	8220	9650	11020	12857	14920	17100	19250	21870	24570	27950	31310	34490
2- Projected Capital Expenditure on Infrastructure *1	1270	1620	1830	2140	2560	2990	3430	3790	4510	5160	5690	6350	7100	7840	8860	9730	10810
3- Capital Expenditure Allocated to Hanoi City																	
(a) %	7	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10
(b) 2 x 3 (a)	89	113	128	150	179	299	343	379	451	516	569	635	710	784	886	973	1081
4- Capital Expenditure for Drainage & Sewerage																	
(a) %	7	7	7	7	7	10	10	10	10	10	10	10	12	12	12	12	12
(b) 3 (b) x 4 (a)	6	8	9	11	13	30	34	38	45	52	57	64	85	94	106	117	130

*1 Projection by SPC, 1994, Total Capital Expenditure includes expenditure for infrastructure, industry (power), and other sectors

Table 5.3 (1) COST BENEFIT STREAM OF THE PROPOSED URBAN DRAINAGE PLAN (1/2)

(US$1,000)

No.	Year	Cost. Cost							O & M Cost							Total Cost
		To Lich (1)	To Lich (2)	Co Nhue	My Dinh	Me Tri	Ba Xa	Total	To Lich (1)	To Lich (2)	Co Nhue	My Dinh	Me Tri	Ba Xa	Total	
1	1995	5,994						5,994							0	5,994
2	1996	23,867						23,867							0	23,867
3	1997	38,330						38,330							0	38,330
4	1998	46,161						46,161							0	46,161
5	1999	27,568						27,568	342						342	27,910
6	2000	4,889	7,282					12,171	572						572	12,743
7	2001		15,221					15,221	1,143						1,143	16,364
8	2002		50,204					50,204	1,143						1,143	51,347
9	2003		46,841	2,784				49,625	1,143	174					1,317	50,942
10	2004		19,346	1,962				21,308	1,143	289					1,432	22,740
11	2005			19,356				19,356	1,143	579					1,722	21,078
12	2006			20,852	1,344	1,895		24,091	1,143	579	0				1,722	25,813
13	2007			20,892	900	1,383		23,175	1,143	579	82				1,804	24,979
14	2008			7,342	7,812	9,285		24,439	1,143	579	186				1,908	26,347
15	2009			0	8,542	10,076		18,618	1,143	579	273	0	0		1,995	20,613
16	2010			0	8,937	10,338	797	20,072	1,143	579	273	47	54		2,096	22,168
17	2011			0	7,896	9,100	489	17,485	1,143	579	273	80	90		2,165	19,650
18	2012			0	0	0	5,270	5,270	1,143	579	273	159	179		2,333	7,603
19	2013			0	0	0	5,807	5,807	1,143	579	273	159	179	0	2,333	8,140
20	2014			0	0	0	6,337	6,337	1,143	579	273	159	179	35	2,368	8,705
21	2015			0	0	0	5,447	5,447	1,143	579	273	159	179	59	2,392	7,839
22	2016			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
23	2017			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
24	2018			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
25	2019			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
26	2020			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
27	2021			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
28	2022			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
29	2023			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
30	2024			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
31	2025	32,478		0	0	0	0	32,478	1,143	579	273	159	179	118	2,451	34,929
32	2026			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
33	2027			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
34	2028			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
35	2029		16,285	0	0	0	0	16,285	1,143	579	273	159	179	118	2,451	18,736
36	2030			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
37	2031			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
38	2032			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
39	2033			6,660	0	0	0	6,660	1,143	579	273	159	179	118	2,451	9,111
40	2034			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
41	2035			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
42	2036			0	4,776	5,252	0	10,028	1,143	579	273	159	179	118	2,451	12,479
43	2037			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
44	2038			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
45	2039			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
46	2040			0	0	0	3,758	3,758	1,143	579	273	159	179	118	2,451	6,209
47	2041			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
48	2042			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
49	2043			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
50	2044			0	0	0	0	0	1,143	579	273	159	179	118	2,451	2,451
	Total	179,287	155,179	79,848	40,207	47,329	27,905	529,755	51,206	23,623	10,096	5,374	6,051	3,516	99,866	629,621

Table 5.3 (2) COST BENEFIT STREAM OF THE PROPOSED URBAN DRAINAGE PLAN (2/2)

(US$1,000)

Benefit							B-C
To Lich (1)	To Lich (2)	Co Nhue	My Dinh	Me Tri	Ba Xa	Total	
						0	-5,994
						0	-23,867
						0	-38,330
						0	-46,161
3,321						3,321	-24,589
5,979						5,979	-6,764
12,917						12,917	-3,447
13,950						13,950	-37,397
15,066						15,066	-35,876
16,272	3,014					19,286	-3,454
17,573	5,425					22,998	1,920
18,979	11,716	0				30,695	4,882
20,498	12,653	183				33,334	8,355
22,137	13,666	341				36,144	9,797
23,908	14,759	751	0	0		39,418	18,805
25,821	15,939	834	1,572	1,620		45,786	23,618
27,887	17,215	925	2,906	3,001		51,934	32,284
30,118	18,592	1,027	6,445	6,661		62,843	55,240
32,527	20,079	1,140	7,154	7,394	0	68,294	60,154
35,129	21,685	1,265	7,941	8,207	1,274	75,502	66,797
37,940	23,420	1,405	8,814	9,110	2,362	83,051	75,212
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	50,485
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	66,678
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	76,303
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	72,935
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	79,205
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
37,940	23,420	1,405	8,814	9,110	4,725	85,414	82,963
1,460,284	857,344	48,616	290,438	300,183	140,661	779,898	150,277

EIRR = 10.9%

Table 5.4 COST BENEFIT STREAM OF THE PROPOSED WASTEWATER DISPOSAL PLAN (1/2)

(US$1,000)

No.	Year	Cost. Cost								O & M Cost						O & M Cost		Total
		Zone 2 -1	Zone 4	Zone 3	Zone 2 - 2	Zone 6 - 1	Zone 5	Zone 6 - 2	Total	Zone 2 -1	Zone 4	Zone 3	Zone 2 - 2	Zone 6 - 1	Zone 5	Zone 6 - 2	Total	Cost
1	1995								0								0	0
2	1996	1,134	584						1,718								0	1,718
3	1997	1,134	3,845						4,979								0	4,979
4	1998	1,870	3,845	360					6,075								0	6,075
5	1999	1,909	740	1,619					4,268								0	4,268
6	2000	1,174	248	360					1,782								0	1,782
7	2001	21,415	248	2,720					24,383								0	24,383
8	2002	21,415	2,665	2,720					26,800								0	26,800
9	2003	23,743	2,665	360					26,768								0	26,768
10	2004	8,653	3,275	1,619					13,547								0	13,547
11	2005		17,473	1,650					19,123	1,130							1,130	20,253
12	2006		17,473	392		189			18,054	1,130							1,130	19,184
13	2007		2,104	23,678	314	189			26,285	1,130							1,130	27,415
14	2008			23,678	1,607	189			25,474	1,130	900						2,030	27,504
15	2009			23,678	334	1,110			25,122	1,130	900						2,030	27,152
16	2010			7,814	13,942	1,121			22,877	1,130	900						2,030	24,907
17	2011				13,942	200	601		14,743	1,130	900	1,198					3,228	17,971
18	2012				13,942	11,893	2,923		28,758	1,130	900	1,198					3,228	31,986
19	2013				6,900	11,893	2,966	469	22,228	1,130	900	1,198					3,228	25,456
20	2014					11,893	644	2,312	14,849	1,130	900	1,198	577				3,805	18,654
21	2015					5,562	29,289	2,328	37,179	1,130	900	1,198	577				3,805	40,984
22	2016						29,289	485	29,774	1,130	900	1,198	577	517			4,322	34,096
23	2017						29,289	23,019	52,308	1,130	900	1,198	577	517			4,322	56,630
24	2018						16,541	23,019	39,560	1,130	900	1,198	577	517			4,322	43,882
25	2019							23,019	23,019	1,130	900	1,198	577	517	1,082		5,404	28,423
26	2020							13,847	13,847	1,130	900	1,198	577	517	1,082		5,404	19,251
27	2021								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
28	2022								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
29	2023								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
30	2024								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
31	2025								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
32	2026								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
33	2027								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
34	2028								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
35	2029	25,699							25,699	1,130	900	1,198	577	517	1,082	799	6,203	31,902
36	2030								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
37	2031								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
38	2032		18,441						18,441	1,130	900	1,198	577	517	1,082	799	6,203	24,644
39	2033								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
40	2034								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
41	2035			25,736					25,736	1,130	900	1,198	577	517	1,082	799	6,203	31,939
42	2036								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
43	2037								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
44	2038				12,613				12,613	1,130	900	1,198	577	517	1,082	799	6,203	18,816
45	2039								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
46	2040					11,227			11,227	1,130	900	1,198	577	517	1,082	799	6,203	17,430
47	2041								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
48	2042								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
49	2043						21,606		21,606	1,130	900	1,198	577	517	1,082	799	6,203	27,809
50	2044								0	1,130	900	1,198	577	517	1,082	799	6,203	6,203
	Total	108,146	73,606	116,384	63,594	55,466	133,148	88,498	638,842	45,200	33,300	40,732	17,887	14,993	28,132	19,176	199,420	838,262

Table 5.4 COST BENEFIT STREAM OF THE PROPOSED WASTEWATER DISPOSAL PLAN (2/2)

(US$1,000)

Benefit								B-C
Zone 2 - 1	Zone 4	Zone 3	Zone 2 - 2	Zone 6 - 1	Zone 5	Zone 6 - 2	Total	
							0	0
							0	-1,718
							0	-4,979
							0	-6,075
							0	-4,268
							0	-1,782
							0	-24,383
							0	-26,800
							0	-26,768
							0	-13,547
11,831							11,831	-8,422
11,961							11,961	-7,223
12,101							12,101	-15,314
12,253	9,245						21,498	-6,006
12,417	9,347						21,764	-5,388
12,488	9,458						21,946	-2,961
14,679	9,578	16,848					41,105	23,134
12,885	9,708	17,052					39,645	7,659
13,108	9,847	17,273					40,228	14,772
13,349	9,998	17,510	4,337				45,194	26,540
3,508	10,161	17,767	4,449				35,885	-5,099
3,508	10,161	17,768	4,449	5,404			41,290	7,194
3,508	10,161	17,768	4,449	5,404			41,290	-15,340
3,508	2,201	17,768	4,449	5,404			33,330	-10,552
3,508	2,201	17,768	4,449	5,404	13,063		46,393	17,970
3,508	2,201	17,768	4,449	5,404	13,063		46,393	27,142
3,508	2,201	3,468	4,449	5,404	13,063	10,101	42,194	35,991
3,508	2,201	3,468	4,449	5,404	13,063	10,101	42,194	35,991
3,508	2,201	3,468	4,449	5,404	13,063	10,101	42,194	35,991
3,508	2,201	3,468	1,504	5,404	13,063	10,101	39,249	33,046
3,508	2,201	3,468	1,504	5,404	13,063	10,101	39,249	33,046
3,508	2,201	3,468	1,504	1,329	13,063	10,101	35,174	28,971
3,508	2,201	3,468	1,504	1,329	13,063	10,101	35,174	28,971
3,508	2,201	3,468	1,504	1,329	13,063	10,101	35,174	28,971
3,508	2,201	3,468	1,504	1,329	2,823	10,101	24,934	-6,968
3,508	2,201	3,468	1,504	1,329	2,823	10,101	24,934	18,731
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	10,711
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	-7,730
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	10,711
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	10,711
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	-15,025
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	10,711
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	10,711
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	-1,902
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	10,711
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	-516
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	10,711
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	10,711
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	-10,895
3,508	2,201	3,468	1,504	1,329	2,823	2,081	16,914	10,711
232,312	157,091	258,522	75,962	79,291	175,798	130,144	1,109,120	270,858

EIRR= 5.2%

Fig. 5.1 (1) MASTER PLAN - IMPLEMENTATION SCHEDULE

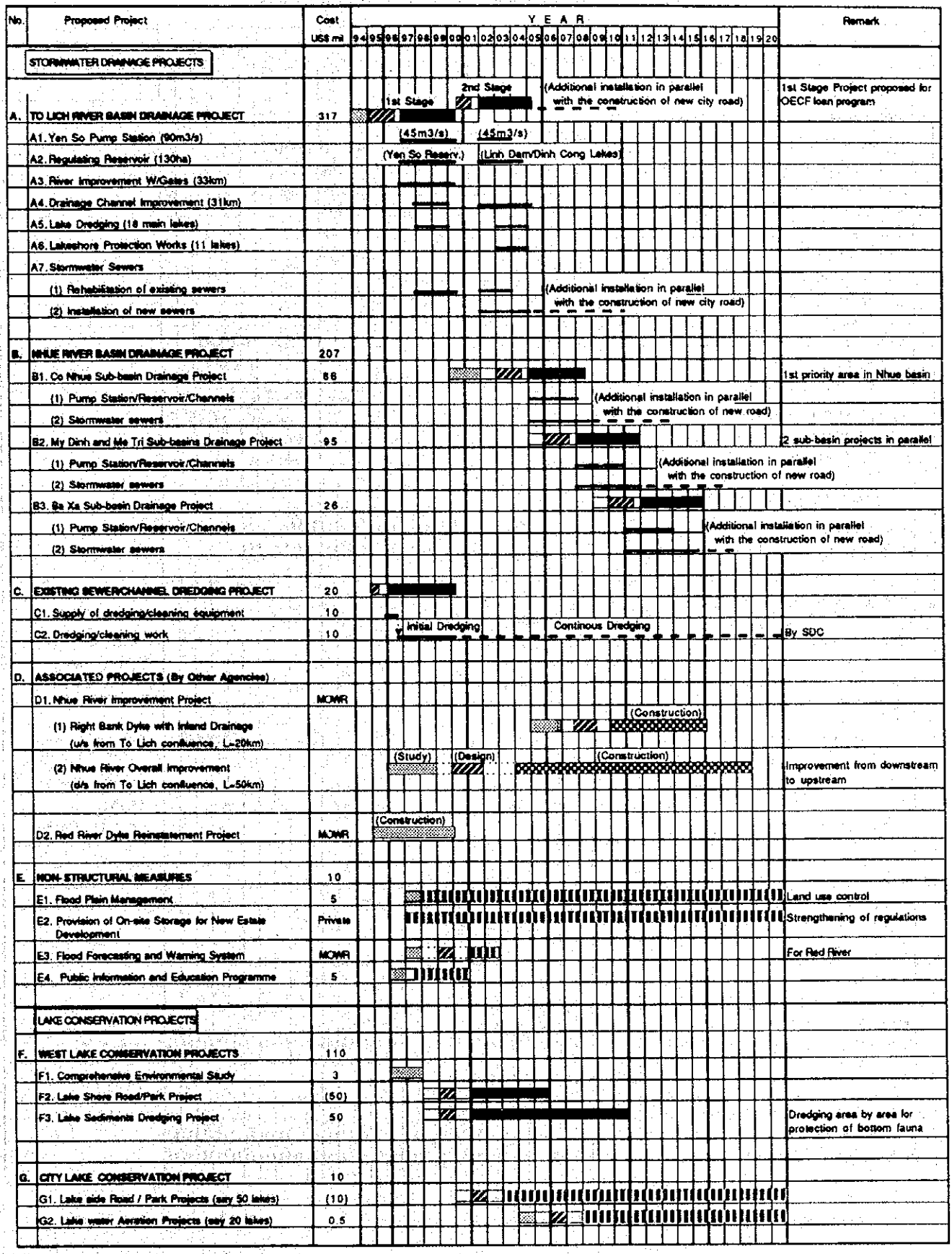

Fig. 5.1 (2) MASTER PLAN - IMPLEMENTATION SCHEDULE

No.	Proposed Project	Cost US$ mil	YEAR 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20	Remark
	WASTEWATER DISPOSAL PROJECT			
H.	CENTRALIZED WASTEWATER DISPOSAL PROJECT	567		
	H1. Zone-2 Wastewater Disposal Project	138	(Zone 2, 3 & 4) (Zone 2-1)	
	(1) Wastewater Treatment Plant			
	(2) Wastewater Sewers			
	H2. Zone-3 Wastewater Disposal Project	110		
	(1) Wastewater Treatment Plant			
	(2) Wastewater Sewers			
	H3. Zone-4 Wastewater Disposal Project	69		
	(1) Wastewater Treatment Plant			
	(2) Wastewater Sewers			
	H4. Zone-5 Wastewater Disposal Project	115		
	(1) Wastewater Treatment Plant			
	(2) Wastewater Sewers		(Zone 6-1)	
	H5. Zone-6 Wastewater Disposal Project	135	(Zone 6-1)	
	(1) Wastewater Treatment Plant			
	(2) Wastewater Sewers			
J.	ON-SITE WASTEWATER TREATMENT PROJECT	71		
	J1. Zone-1 Community-based Treatment Project	51	(Zone 1-1) (Zone 1-2)	For selected areas
	J2. Zone-7 Community-based Treatment Project	20		For selected areas
K.	PILOT WASTEWATER TREATMENT PROJECT	22		
	K1. Kim Lien Rehabilitation Project	6		
	K2. Truc Bach Wastewater Treatment	6		Low level treatment at existing sewer outlets
	K3. Lake Inlet Pollutant Load Reduction	10	(Zone 3 & 2-2)	Either sedimentation basin or interceptor basin
L.	FLUSHING WATER DIVERSION PROJECT	60	(Monitoring in Zones 2 & 4)	To be implemented only if the necessity is observed
	L1. Nhue Pumping Station/Diversion Channel			Increase in capacities of pump, settling basin and channels
	L2. To Lich Diversion Weir			Rubber dam
	L3. Canals and Pipes in City Areas			Extension of canals/pipes area by area
M.	ASSOCIATED PROJECT (by Other Agencies)			
	M1. Upgrading/Increase of Public Latrines	URENCO		
	M2. Reinforcement of Domestic Wastes Collection System	URENCO		
	(1) Solid waste collection/disposal			
	(2) Nightsoil and septic tank sludge collection			
N.	NON-STRUCTURAL MEASURES	20		
	N1. Household's Obligation of Installing Septic Tanks	---		Strict enforcement of regulations
	N2. Effluent Pre-treatment by Industries	---		Strict enforcement of regulations
	N3. Provision of Soft Loan for Installing Septic Tanks	10		Set-up of fund system
	N4. Public Awareness Campaign	5		
	N5. Wastewater Quality Monitoring Program	5		

Study | Design | Financing/Tender-Contract | Construction | Intermittent Implementation

( ) Approx. Estimate | Cost : 1994 Base Price (excl. price contingency) | Implementation by Other Agencies