

It will not be too late to decide the need of this diversion plan after observing the actual river environment in Zones 2 and 4 after the wastewater treatment systems are completed.

3.3.6 Collection and Disposal of Solid Waste/Excreta

It is very important to reinforce the solid waste and excreta collection/disposal systems which are under management of the Urban Environment Company (URENCO). The following programs should be implemented at the earliest:

- (a) Rehabilitation and Increase of Public Latrines : Improvement of current overloading to the existing latrines
- (b) Reinforcement of Waste/Excreta Collection Force : Procurement of required equipment (approximately US\$15 million)

3.3.7 Non-structural Measures

In addition to the structural measures proposed in Sub-sections 3.3.1 to 3.3.6, the following non-structural measures, which are particularly important for areas where centralized treatment systems are not planned for the near future, should also be implemented.

(1) Obligation of Installation of Household Septic Tanks

At present, about 180,000 people use bucket latrines. An intensive campaign shall be organized (say, by use of mass-media) to encourage the people to install septic tanks as a minimum sanitation requirement. This should be accompanied by financial assistance to people in the form of soft loans as described in Sub-section 3.3.3.

(2) Enforcement of Regulation on Pre-treatment at Factories

There will be no other way than reinforcing the inspection and penalty imposition, so that factories will respect the existing regulations and guidelines. A practical approach will be to enforce the regulations area by area, selecting the priorities based on findings from the SDC's Wastewater Monitoring Program.

Furthermore, as one of the city's re-structuring programs, measures must be made to proceed with the relocation of factories, which are deemed polluters, to industrial zones outside the City core area.

(3) Provision of Soft Loans for Installing Septic Tanks and Community Plants

It is proposed that HPC will establish a Revolving Fund system for providing soft loans to the people for this specific purpose. Within

HPC, the Department of Land and Housing will be in charge of this task.

(4) Public Information and Education

The basic principles of this undertaking are the same as for Sub-section 3.1.5 (4). The main subjects of the campaign would be to disseminate the knowledge that:

- (a) illegal disposal of wastes is an immoral behavior endangering public lives; and
- (b) the importance of care for health must be recognized by all people, as one of public concerns.

(5) Wastewater Monitoring Program

The Wastewater Monitoring Program, commenced by the Sewerage and Dredging Company (SDC)/the Finnish Development Authority (FINNIDA) in May 1993, has been collecting valuable data and information. However, the ultimate success of the Program could be attained only if the observation is continued over a long period. The Program should be financially supported by HPC and incorporated in drainage/sewerage projects to be implemented henceforwards.

3.4 Implementation Cost

The implementation cost of various plans mentioned in Sections 3.1 to 3.3 was estimated as shown below (1994 base price).

Implementation Cost of Proposed Master Plans

(Unit: US\$ million)

Description	Implementation Cost			Remarks
	Total	FC	LC	
<u>Drainage Plan</u>				
A. To Lich River Basin Drainage Plan	317	197	120	See Annex - 3.4 & 3.5
B. Nhue River Basin Drainage Plan	207	129	78	See Annex - 3.4
C. Red River/Nhue River Improvement	-	-	-	-
D. Non-structural Measures	(10)	-	(10)	*
<u>Lake Conservation Plan</u>				
E. West Lake Conservation	(110)	(50)	(60)	*
F. City Lake Conservation	(10)	(2)	(8)	*
<u>Wastewater Disposal Plan</u>				
G. Centralized Treatment System	567	397	170	See Annex - 3.6
H. On-site Treatment System	71	30	41	See Annex - 3.6
I. Flushing Water Diversion Plan	(60)	(40)	(20)	*
J. Public Latrines/Wastes Disposal	-	-	-	-
K. Non-structural Measures	(20)	-	(20)	*

Note: Cost estimate is based on 1994 prices (not including price escalation)

* Approx. figures (excluded from the economic evaluation)

- To be implemented by other agencies

FC (Foreign Currency Portion) and LC (Local Currency Portion) are based on approximate estimate

3.5 Implementation Schedule

This Study aimed to prepare a master plan until the year 2010, following the original scope of works. However, the result of a preliminary review showed that all the plans cannot be completed within 15 years due mainly to financial constraints. Accordingly, the implementation period was extended until the year 2020 and the implementation schedule was formulated as shown in Figure 3.3. In preparing the schedule, the following aspects were taken into consideration:

- (a) Primary priority is given to projects having higher economic viability (for the drainage plan);
- (b) Other than economic viability, specific aspects such as needs by district (e.g. priority for the old City area) and technical requirements (e.g. reduction of pollution load in excessively polluted rivers) are also taken into consideration (for the wastewater disposal plan)
- (c) The Project should be implemented in stages and area by area in order to realize the benefits early in the designated areas.

- (d) Simultaneous implementation of many projects should be avoided in order to minimize the yearly financial burden and also to equalize the technical load of executing agencies as much as possible.
- (e) Non-structural measures, which require relatively small financial resources, should be implemented as early as possible.

3.6 Economic and Financial Evaluation

The economic and financial evaluation was carried out for the main components of the plans (structural measures) proposed in the Master Plan.

3.6.1 Benefits of the Project

Benefits of drainage projects and wastewater disposal projects are complementary to each other and some are common for both types of projects. Reviewing the type and nature of the expected benefits, the Study assumes the following benefits for the drainage project and the wastewater disposal project, respectively (qualitative assessment for some items):

- | | |
|------------------------------|--|
| Drainage Project: | <ul style="list-style-type: none"> (a) Reduction of flood damage (b) Improvement of the living environment and hygienic condition (qualitative assessment) |
| Wastewater Disposal Project: | <ul style="list-style-type: none"> (a) Reduction of diseases (b) Income from tourism (c) Conservation of groundwater (d) Increase of land value (e) Improvement in agricultural and inland fishery production (qualitative assessment) (f) Improvement of the living environment and hygienic condition (qualitative assessment) (g) Beneficial impact to the activation of the City's overall development plans (qualitative assessment) |

Details of the assessment concepts and monetary evaluation are presented in the Main Report and respective Appendices.

3.6.2 Economic Evaluation

(1) Drainage Plan (Structural Measures)

Project	Cost (US\$ x 10 ⁶)		Annual ^{*3} Benefit (US\$ x 10 ⁶)	EIRR ^{*4} (%)	Overall ^{*5} Priority Order
	Financial Cost ^{*1}	Economic Cost ^{*2}			
To Lich Basin Drainage Plan	<u>317.4</u>	<u>285.7</u>	<u>12.6</u>	<u>11.6</u>	
- 1st stage	160.4	146.8	7.6	11.7	1
- 2nd stage	157.0	138.9	5.0	11.4	2
Nhue Basin Drainage Plan	<u>206.7</u>	<u>174.8</u>	<u>2.7</u>	<u>9.3</u>	
- Co Nhue Sub-basin	86.2	73.2	0.2	-	3
- My Dinh Sub-basin	41.0	35.4	1.0	11.1	4
- Me Tri Sub-basin	53.6	42.1	1.0	10.0	5
- Ba Xa Sub-basin	25.9	24.1	0.5	9.3	6
Total	524.1	460.5	15.2	10.9	

Note: ^{*1} 1994 base price (excluding price escalation)

^{*2} Excluding internal transfer cost. Loss of agricultural production (production foregone) is added as cost.

^{*3} Annual average flood damage at the 1994 price level.

In EIRR calculation, the properties value (damage potential) is assumed to increase at a rate corresponding to GDP growth in the area towards 2015 (To Lich: 8%, Nhue: 11% per year).

^{*4} - Negative EIRR (annual cost > annual benefit)

^{*5} Overall assessment incorporating technical aspects

As shown above, the proposed plans are, in general, economically viable. The low EIRR value of the Co Nhue sub-basin plan is due mainly to its relatively small damage potential since the area is located at higher elevations. Nevertheless, the drainage works for the Co Nhue sub-basin should precede those for other downstream basins in order to establish the overall Nhue basin drainage system.

(2) Wastewater Disposal Plan

Projects (Planning Zone)	Cost (US\$ x 10 ⁶)		Annual ^{*3}	EIRR ^{*4}	Overall ^{*5}	
	Financial	Economic	Benefit	(%)	Priority	
	Cost ^{*1}	Cost ^{*2}	(US\$ x 10 ⁶)		Order	
Zone 1-1 ^{*6}	West Lake	26.2	22.5	3.8	4.4	4
Zone 1-2 ^{*6}	Co Nhue	25.0	24.6	1.7	-	9
Zone 2-1	Hoan Kiem-Hai Ba Trung	85.5	82.4	11.3	5.7	1
Zone 2-2	Hai Ba Trung-Thanh Tri	52.5	51.0	3.5	-	5
Zone 3	Ba Dinh-Dong Da	109.8	90.6	15.5	8.2	3
Zone 4	Dong Da	69.5	55.2	8.7	6.7	2
Zone 5	Co Nhue-My Dinh	114.9	111.5	11.2	1.9	7
Zone 6-1	Dong Da-Thanh Tri	45.1	44.2	4.5	2.1	6
Zone 6-2	Me Tri-Ba Xa	89.8	88.5	8.7	1.7	8
Zone 7 ^{*6}	Thanh Tri South	19.6	19.1	0.6	-	10
Total		637.9	589.6	69.5	5.2^{*7}	

Note: ^{*1 - *5} Same as shown in Table (1) above

^{*6} On-site treatment facilities (basically private-owned by communities/households) are proposed. Funding would be in the form of soft loans to communities/ households (see Para. (4) of Subsection 3.6.4 below).

^{*7} Overall EIRR excluding on-site treatment (Zones 1 and 7)

For Zones 1-2, 2-2 and 7, a negative EIRR value was obtained in the evaluation. However, the plans should be assessed on an overall basis (all plans together) in view of the necessity of improving the hygienic environment of the whole of Hanoi City. Overall EIRR of 5.2% is fair enough to justify the sewerage development plan which is aimed at meeting the "basic human needs". It is recommended that all the plans should be implemented.

3.6.3 Financial Aspects

(1) Required Fund

Assuming that the plans are implemented according to the implementation schedule described in Section 3.5, the fund requirement is estimated as summarized below:

Fund Required for Implementation of the Plans (Structural Measures)

Plan	(Unit: US\$ million)				
	1995-2000	2001-2005	2006-2010	2010-2015	2016-2020
	(Yearly Average)				
Drainage Plan	28.6	36.1	26.1	7.1	-
Wastewater Disposal Plan	4.7	25.8	32.1	32.3	31.9
Total	35.3	61.9	58.2	39.4	31.9

Note: See Annex 3.7 for yearly fund requirements.

(2) **Projection of Available Budget for Drainage/Sewerage Development**

Projection of future public works expenditures was attempted on a very preliminary basis as one of the check items to examine the practicality of the proposed Master Plan. In the past 5 years, approximately 5% to 7% of the national development expenditures was allotted to the development of Hanoi City (500 - 600 billion Dong) and another 200 billion Dong was allotted from Hanoi City's own resources, of which about 10% was used in the drainage/sewerage sector. Although the projection of future financial resources is a very difficult task, the Study attempted the projection on the following assumptions:

- (a) The national budget will increase almost in proportion to the GDP growth rate (10% - 12% projected by SPC)
- (b) Approximately 7% - 10% of the national development budget will be allotted to Hanoi City
- (c) Approximately 7% - 12% of Hanoi's development budget will be allotted to the drainage/sewerage sector

Development expenditures estimated on the above premises are as follows:

Projection of Hanoi's Development Expenditures (Preliminary)

	(Unit: US\$ million)		
	2000	2005	2010
Hanoi Total Development Expenditures	343	635	1,081
Allocation to Drainage/Sewerage Sector	34	64	130

The required fund estimated in (1) above is generally within the range of the budgetary resources projected in the above table, though there may be some surplus or shortage each year. Hence, the proposed implementation plan (Figure 3.3) is deemed to be practical.

3.6.4 Financial Resources for Construction and O&M

It is appropriate to mobilize the financing for the implementation of the projects in the following manner:

- (a) The construction cost for both the drainage and wastewater disposal works will be financed from the national development budget .
- (b) O&M cost for the drainage works will also be financed from the national budget.

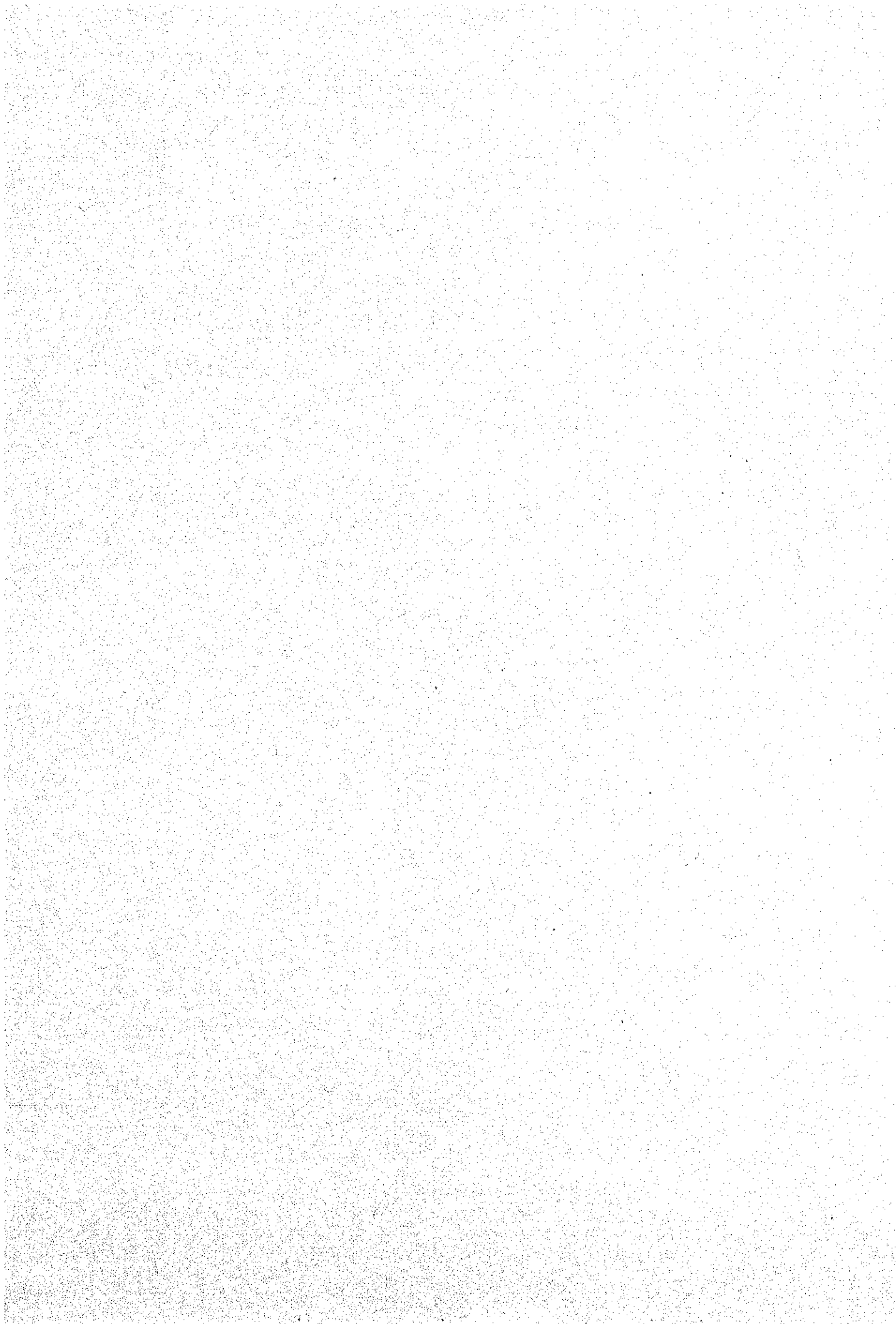
(c) O&M cost for the wastewater disposal works will be borne by beneficiaries. The share of the total O&M cost by beneficiaries is estimated as follows:

- * Household residents : 31%
- * Commercial/factory/public : 69%

The O&M cost to be charged to residents (in the form of a sewer charge) is estimated at US\$5.7/household per year. This is roughly equivalent to 0.6% of the estimated average household income for urban residents (US\$960/year), which seems to be within the people's capacity to pay. Nevertheless, the sewer charge is equal to 67% of the water supply charge which is US\$8.5/household per year (90 l/c/d x 4.3 persons x US\$0.06/m³). This may be considered by the people to be relatively expensive.

A common practice of collecting the sewage charge is to add it on to the water supply charge, however a water supply metering system has not yet been established. It is recommended to expedite the provision of a metering system so that it would be ready before the sewerage service is put into operation.

(d) In the wastewater disposal plan, provision of on-site treatment facilities (household septic tanks and community plants) is proposed for Zone 1 and Zone 7. The facilities are basically privately owned, and hence a financing system separate from the public works expenditures shall be established. The financing would be in the form of soft loans (low interest loans) extended to the communities/people for the installation of their facilities. In the case the financing is made through a Revolving Fund system, the required fund is estimated at about US\$7 million.



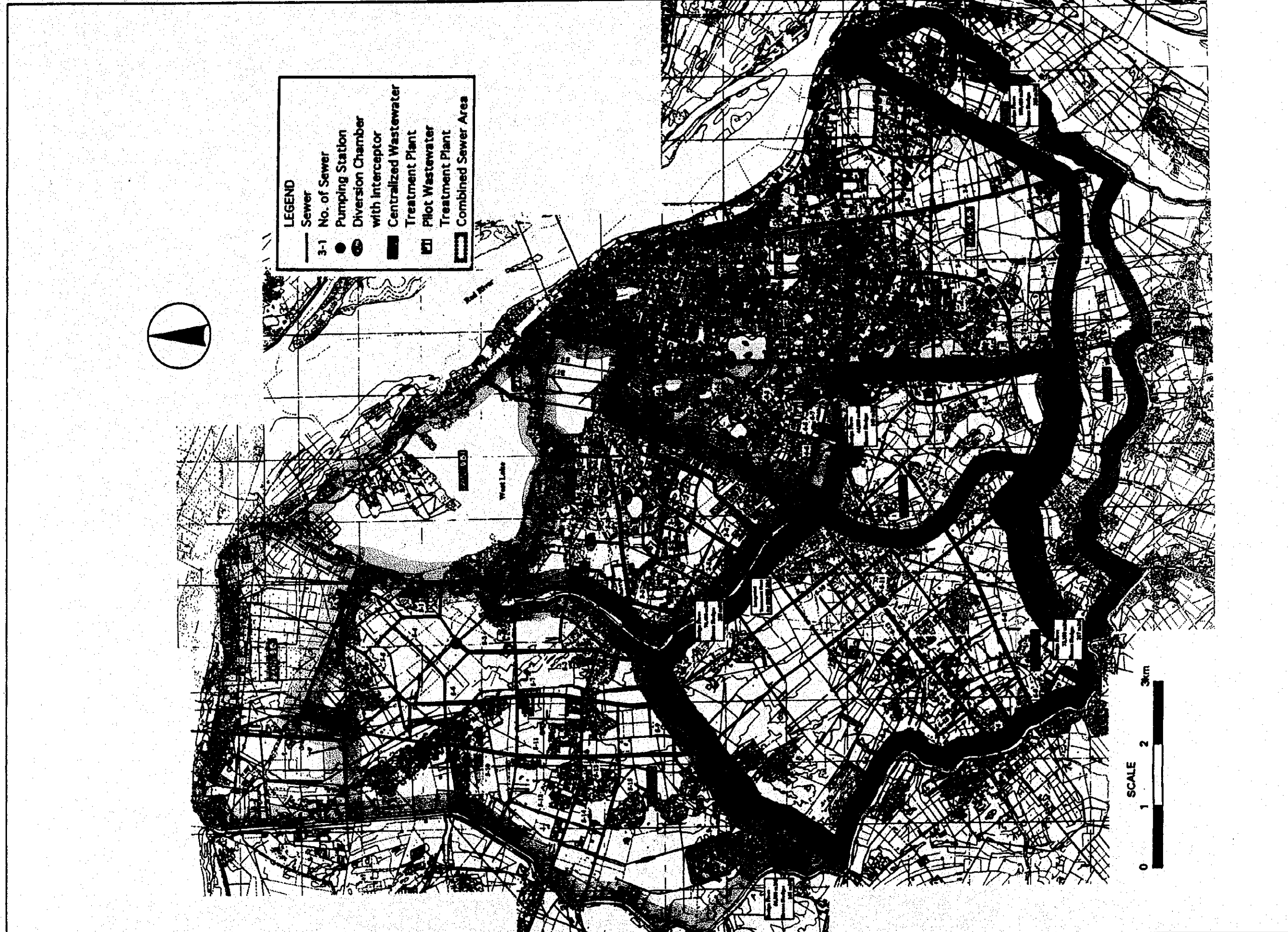
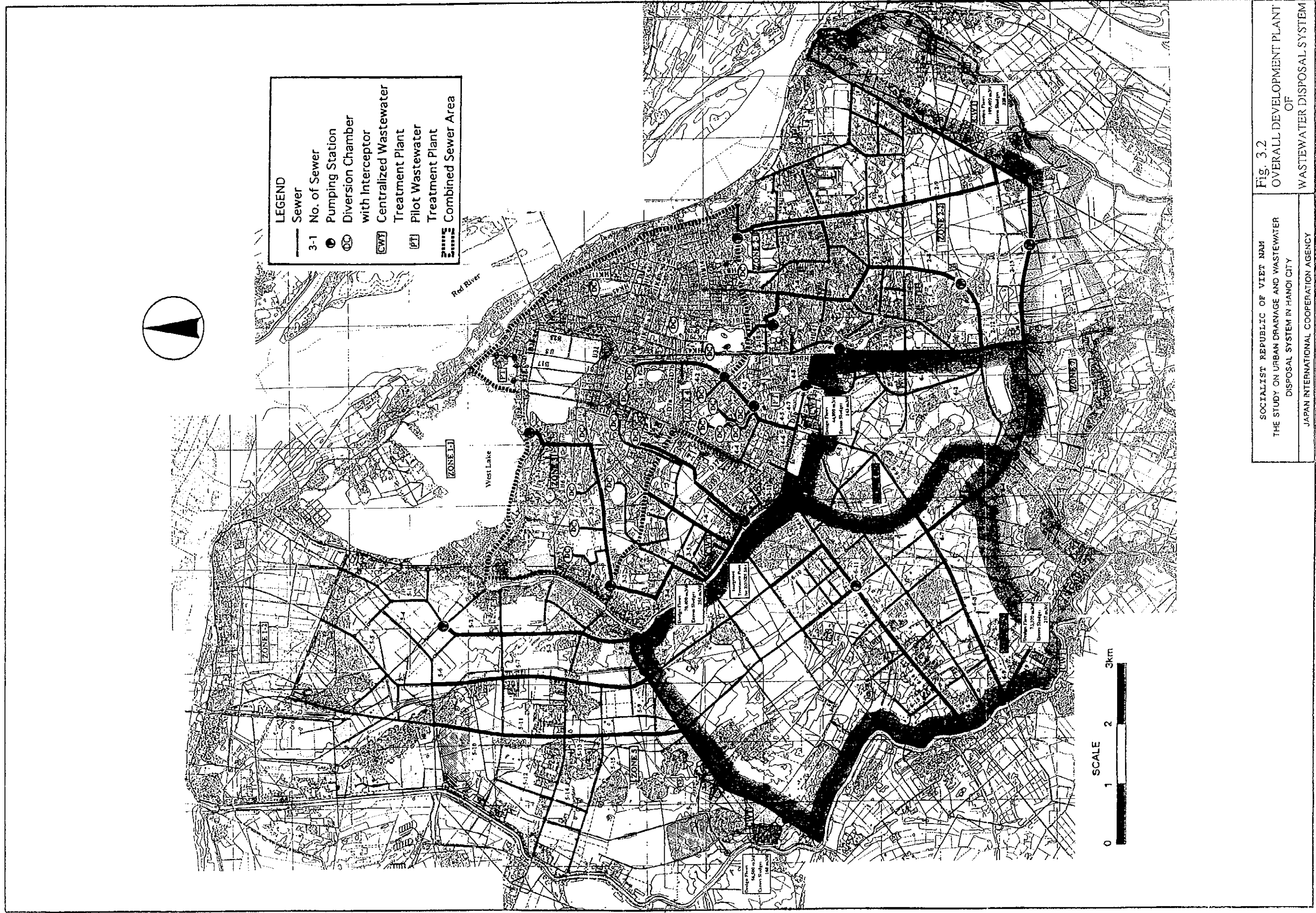
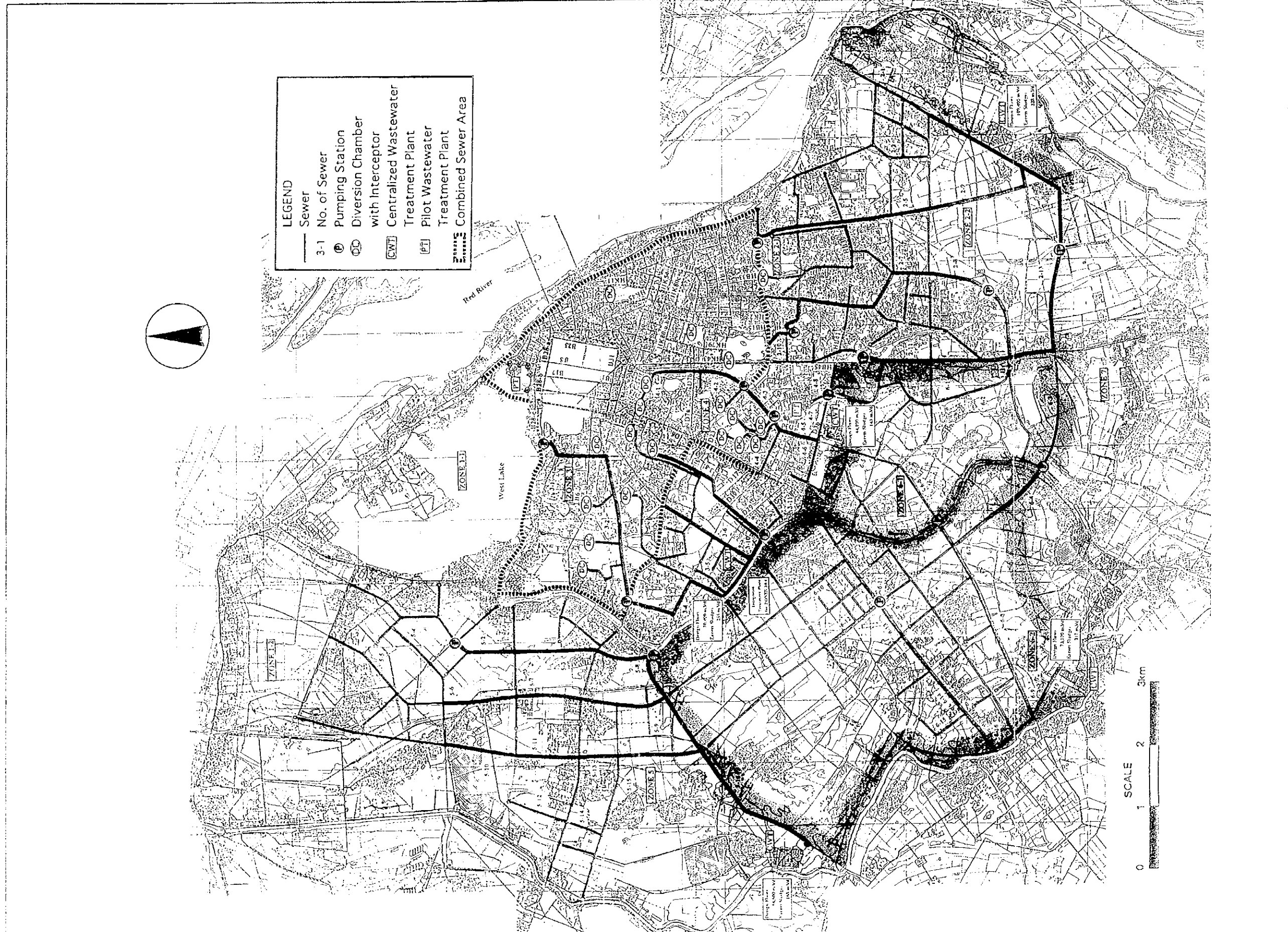


Fig. 3.2
 OVERALL DEVELOPMENT PLAN
 OF
 WASTEWATER DISPOSAL SYSTEM

SOCIALIST REPUBLIC OF VIET NAM
 THE STUDY ON URBAN DRAINAGE AND WASTEWATER
 DISPOSAL SYSTEM IN HANOI CITY
 JAPAN INTERNATIONAL COOPERATION AGENCY





LEGEND

- Sewer
- 3-1 No. of Sewer
- (P) Pumping Station
- (DC) Diversion Chamber with Interceptor
- (CWT) Centralized Wastewater Treatment Plant
- (PT) Pilot Wastewater Treatment Plant
- Combined Sewer Area

Fig. 3.2
OVERALL DEVELOPMENT PLAN
OF
WASTEWATER DISPOSAL SYSTEM

SOCIALIST REPUBLIC OF VIET NAM
THE STUDY ON URBAN DRAINAGE AND WASTEWATER
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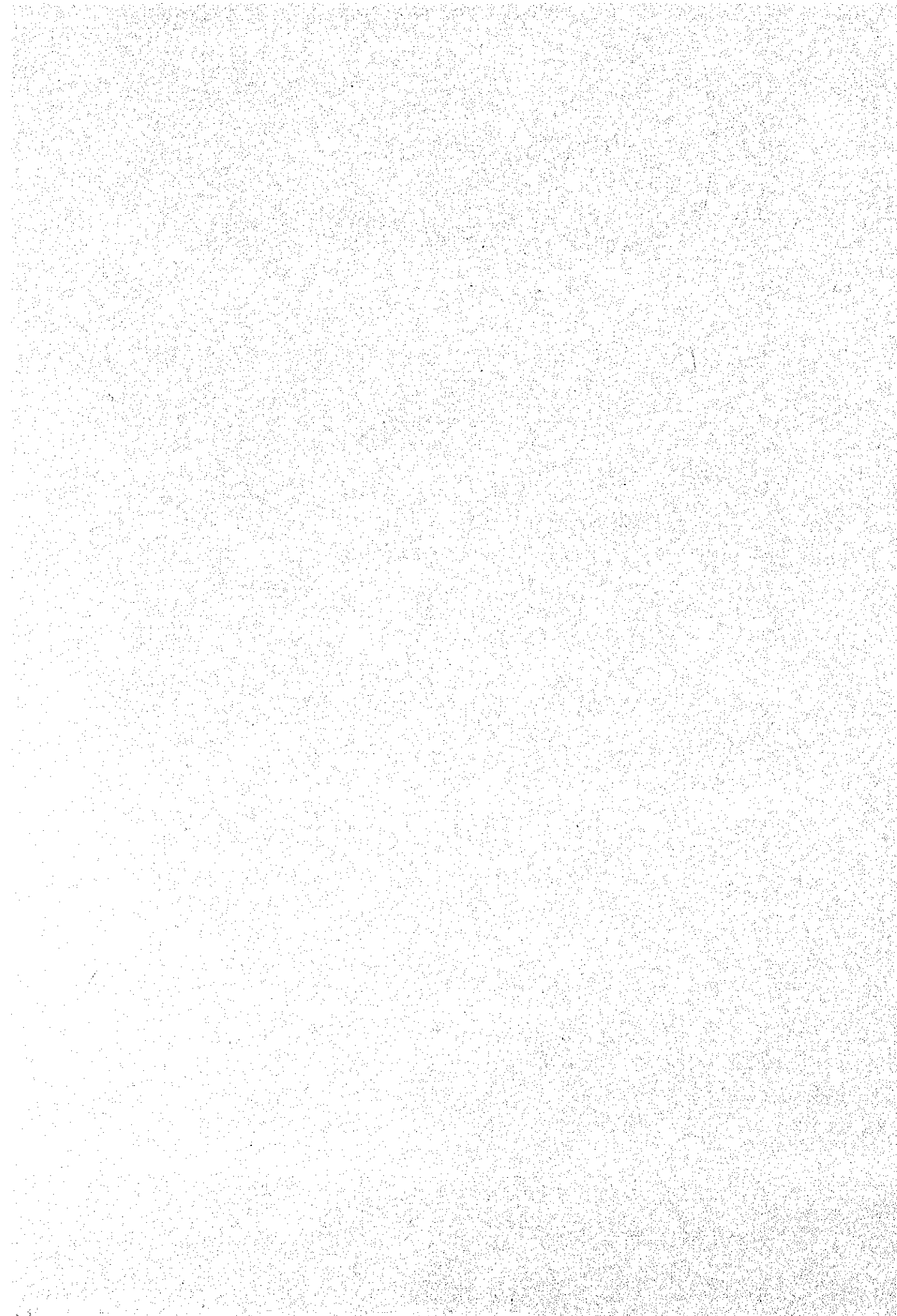


Fig. 3.3 MASTER PLAN - IMPLEMENTATION SCHEDULE (2/2)

No.	Proposed Project	Cost US\$ ml	Y E A R																		Remark					
			94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11		12	13	14	15	16
WASTEWATER DISPOSAL PROJECT																										
H.	CENTRALIZED WASTEWATER DISPOSAL PROJECT	567																								
	H1. Zone-2 Wastewater Disposal Project	138																								
	(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																									
	H5. Zone-6 Wastewater Disposal Project	135																								
	(1) Wastewater Treatment Plant																									
	(2) Wastewater Sewers																									
J.	ON-SITE WASTEWATER TREATMENT PROJECT	71																								
	J1. Zone-1 Community-based Treatment Project	61																			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																			Either sedimentation basin or interceptor basin					
L.	FLUSHING WATER DIVERSION PROJECT	60																								
	L1. Nhue Pumping Station/Diversion Channel																				To be implemented only if the necessity is observed					
	L2. To Lich Diversion Weir																				Increase in capacities of pump, settling basin and channels					
	L3. Canals and Pipes in City Areas																				Rubber dam					
																					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
 Implementation by Other Agencies
 () Approx. Estimate
 Cost: 1994 Base Price (excl. price contingency)

4. TO LICH RIVER BASIN DRAINAGE PROJECT (FEASIBILITY STUDY)

4.1 Selection of the Priority Project

Of the plans examined in the master plan study, the To Lich River Basin Drainage Project has been selected as the priority project for implementation.

Reasons for and background of the selection are as follows:

- (a) The Project is evaluated to have the highest EIRR among the plans proposed in the master plan (11.6%, Ref. Sub-section 3.6.2).
- (b) Frequent inundation and malfunction of the drainage facilities are one of the causes of deterioration of the environment of Hanoi City. The Project will prove to be beneficial not only by solving technical/economic problems but also improving people's livelihood and hygienic conditions.
- (c) The socio-economic interview survey (Ref. Section 2.2) revealed that people recognize the importance of solving the drainage problems and the need for development. The Project covers the most densely populated area and benefits many people (about 1 million people).
- (d) The Project is also accorded the highest priority on a governmental level. In fact, the framework plan for the Project has been approved by the Government. The construction of (i) the Yen So Regulating Reservoir and (ii) the Yen So Pumping Station, which will be the key facilities of the Project, has already been decided.

4.2 Objectives of the Project

(1) The objectives of the Project are as follows:

- (a) Reduction of flood damage caused by improper drainage and inundation (economic benefit); and
- (b) Improvement of the City's hygienic and water front environments (socio-environmental benefit)

(2) **Technical Improvement Requirements and Proposed Measures**

Issues to be Solved	Measures Proposed
Upper Reaches (Urban Area):	
(i) Reduced flow capacities of the existing sewers/drainage channels and worsening of waterside hygienic conditions, due to the accumulation of sediments/sludges.	* Removal of sediments/sludges (as an urgent project)
(ii) Improper urban drainage due to the insufficient discharge capacity of the existing sewers and lack of drainage facilities	* Augmentation of the existing sewers' capacity and expansion of sewer coverage area
(iii) Insufficient discharge capacity of drainage channels, particularly the narrow sections at the existing bridge/culvert sites.	* Improvement of drainage channels * Replacement of bridges/culverts
(iv) Deterioration of lake water quality and shoreline environment, due to the accumulation of bottom sludges, people's encroachment (landfill), and waste disposal.	* Lake bottom dredging * Lake water aeration (as a pilot project) * Lake shore roads and parks (separation of residential areas from water shorelines)
Middle Reaches:	
(v) Flood overflows due to narrow channel sections, particularly at existing bridges/culverts.	* Improvement of river channels, including the provision of diversion floodways. * Reconstruction of bridges/culverts
(vi) People's encroachment (houses and fills) on river areas and illegal disposal of waste.	* Improvement of riverine environments (by the provision of riverside roads and paths, parks, and shoreline revetment)
Lower Reaches:	
(vii) Rise of the Nhue River's water level results in reverse flow (flow upstreamward) and aggravates inundation conditions in the upper reaches.	* Reconstruction of the Thanh Liet Weir
(viii) Gravity drainage is impossible when the Nhue water level rises.	* Construction of the Yen So Pumping Station

(3) Urgent Measures

In view of the urgent need to improve current sewer/drainage channel conditions, the earliest implementation of the measure proposed in (i) above is preferable. Accordingly, Work Item "C" of the master plan (see Figure 3.3) is included in this Project (Work Item "A" in Figure 3.3) to ensure that the above measure is implemented as early as possible.

4.3 Present Conditions of the Project Area

4.3.1 Geography

(1) Administration Units and Population

The proposed Project area covers 7,750 ha of land, which basically comprises 4 urban districts and parts of 2 suburban districts of Hanoi City. This area accounts for about 57% of the total Study Area of the Master Plan.

In 1992, the total population of the Project area was estimated at about 994,000 with an average population density of 128 persons/ha. The population density of the 4 urban districts was as high as 245 persons/ha, while that of the suburban districts was 22 persons/ha.

Administration Units and Population of the Project Area

Administration Unit	Area (ha)	Population (1992)	Population Density (person/ha)
1. Urban District			
- Dong Da	1,282	301,622	235
- Ba Dinh	1,083	186,456	173
- Hoan Kiem	351	147,266	420
- Hai Ba Trung	1,022	283,811	278
(Sub-total)	(3,738)	(919,155)	(245)
2. Suburban District			
- Thanh Tri	2,658	48,893	18
- Tu Liem	787	26,072	33
(Sub-total)	(3,445)	(74,965)	(22)
3. West Lake Area	567	-	-
Total	7,750	994,120	128

(2) Land Use

About 54% of the total Project area comprises residential land, an ancient city area, and government/public buildings areas, which indicates that urbanization is progressing. The industrial area occupies only 5% of the Project area. A particular aspect is that about 26% of land is occupied by lakes and ponds. The area occupied by agricultural land is already relatively small (13%) and will decrease further as urbanization expands in the future.

Land Use in the Project Area

Land Use	Present		Future	
	Area (ha)	%	Area (ha)	%
1. Ancient City/Governmental Offices and Public Buildings	652	8.5	860	11.1
2. Residential (Urban and Suburban)	3,506	45.1	3,892	50.2
3. Industry	385	5.0	425	5.5
4. Lakes/Ponds	2,013	26.0	1,483	19.1
5. Agriculture	1,045	13.5	910	11.8
6. Green Area	149	1.9	180	2.3
Total	7,750	100.0	7,750	100.0

4.3.2 Hydrological Analysis

(1) Design Storm/Design Flood

Runoff measurement records for rivers in the Project area are not available. Hence, the flood runoff analysis was based on rainfall records collected between 1955 to 1993 (39 years) at the Lang Meteorological Observation Station.

The estimated design storm and flood discharge are described in Sub-section 2.4.3. The details are presented in Annex 4.1 (rainfall intensity for the design of sewer drainage) and Annex 4.2 (design flood hydrograph at Yen So/Thanh Liet = 1/10-year probable flood). The flow retardation effect in river channels and lakes and ponds in the upper reaches has been taken into account in the analysis of flood discharge hydrograph.

(2) Relationship between Nhue/To Lich Water Levels and Red River Water Levels

If the water level at Thanh Liet exceeds EL.3.5m, drainage problems in the upper reaches would occur. Hence, the water level at Thanh Liet should be maintained at around EL.3.5m as much as possible. When drainage into the Nhue River becomes impossible due to the rise of its water level, excess water (flood water) has to be disposed of into the Red River. Owing to the difference in water levels between the inland areas (Nhue/To Lich) and the Red River, water has to be disposed of into the Red River by pumps. The relationship between the water levels at Thanh Liet (Nhue/To Lich) and the Red River is shown below:

Relationship between the Water Levels at Thanh Liet and the Red River

(Unit: EL.m)

Description	Thanh Liet Water Level	Red River Water Level	
	(Nhue/To Lich)	Dry Season	Wet Season
Mean Yearly Water Level:			
(a) Recorded Minimum	1.70	2.62	3.13
(b) Dry Year	2.45	2.80	4.50 +
(c) Average Year	3.01	3.03	5.54 +
(d) Wet Year	3.44	3.39	7.46 +
Flood Water Level:			
(a) 5-year Flood	4.85 *	-	10.85 +
(b) 10-year Flood	5.11 *	-	11.42 +
(c) 100-year Flood	5.92 *	-	13.18 +

Note: * Water level at Thanh Liet is higher than EL.3.5m, with flooding upstream
 + Gravity drainage into the Red River is impossible (higher than EL. 3.5m)

4.4 Principal Features of the Proposed Project

4.4.1 Concepts of Formulation of the Plan

Although the formulation of the plan took into account ordinary drainage functions, the size of facilities was determined based on the flood runoff. The general concepts of the proposed measures are described in Section 4.2.2. The basic concepts of drainage operation are (i) primarily, gravity drainage through the Thanh Liet weir, supplemented by (ii) mechanical drainage by the Yen So pumping station in case of excessive flood inflow.

4.4.2 Optimum Combination of Pumping Capacity and Regulating Reservoir Capacity

The Study aimed at selecting an optimum combination of the Yen So pumping capacity and regulating reservoir capacity. The factors examined in the comparative study are as follows:

- (a) City Lakes : To be left in their present state, or to increase the flow retarding capacity (by dredging).
- (b) Regulating Reservoir : Regulation only by the Yen So reservoir, or in combination with the existing Linh Dam Lake/Dinh Cong Lake.
- (c) Pumping Capacity : Alternative plans ranging 30 ~ 60 ~ 90 ~ 150 m³/s were examined.

According to the results of the cost comparison study, a plan in line with the above underlined concepts presents the cheapest solution. The selected plan consists of a 90m³/s pumping station and regulating reservoirs with a total capacity of 5.19 million m³ (Yen So + Linh Dam + Dinh Cong). Figure 4.1 shows an operational plan for pumps and reservoirs in case of the inflow of design flood (10-year recurrence flood).

4.4.3 Outline of Proposed Facilities

(1) Yen So Pumping Station

After comparing alternative sites, the same pumping station site as proposed in the existing plan (by MOWR/HUPI) was selected. The site was chosen in view of the technical advantages: (i) foundation geology, and (ii) laying out of an outlet channel in the Red River area (hydraulically favourable). The layout for the proposed Yen So pumping station is shown in Figure 4.2. (The selection of the pump type is tentative and subject to refinement in the subsequent design stage.)

Proposed Features of the Yen So Pumping Station

(a) Pump and Power Source	: - 3 m ³ /s x 30 units (design head: 10m) - Power received from the Mai Dong substation, with the provision of standby diesel generators capable of meeting 45 m ³ /s operation
(b) Pump Station	: - Pumping station: 120 m wide x 20 m long - Outlet surge tank: 3 units - Operation building: 1 no.
(c) Inlet Channel	: - From the Yen So Regulating Reservoir to the Pumping Station: 1,200 m long - Discharge capacity: 75 m ³ /s
(d) Ordinary Drainage Channel	: - From the Kim Nguu River to the Pumping Station: 1,900 m long - Discharge capacity: 15 m ³ /s (for drainage of small floods)
(e) Outlet Channel	: - In the Red River area: 1,600 m long

(2) Regulating Reservoirs (Yen So + Linh Dam + Ding Cong)

The highest permissible water level in the Thanh Liet - Yen So area will be EL.4.5m, in order to avoid inundation in the upstream area (after river improvement works). Since the initial water level before flood inflow is EL3.5m, the allowable surcharge water depth is only 1.0 m. This constitutes a major constraint for the planning of the reservoir scheme. The principal features of the proposed regulating reservoirs are summarized below. The layout plan and storage allocation plan for the proposed Yen So reservoir are shown in Figure 4.3 and Figure 4.4, respectively.

Principal Features of the Proposed Regulating Reservoirs

Description	Yen So	Linh Dam	Dinh Cong	Total
Flood Regulation Volume (mil. m ³):	3.87	1.07	0.25	5.19
Regulation Water Levels (EL.m):				
- High Water Level	4.5	4.5	4.5	-
- Low Water Level	1.5	3.5	3.5	-
Area (ha):				
- Water Area	130	107	25	262
- Total Lot Area	203	-	-	-

Yen So: New Reservoir, Linh Dam/Dinh Cong: Increase of regulating capacity by dredging

(3) River Improvement

River improvement works are proposed for four rivers: To Lich, Lu, Set, and Kim Nguu, with the objectives of increasing the discharge capacity and improving the riverine environment. In principle, the proposed works are to increase the flow capacity by dredging. The widening of the river channel should be minimized taking into account land acquisition and the resettlement issues. The works include the provision of riverside roads on both banks (3 m wide minimum) for future maintenance.

The river channel is planned to have a natural appearance as much as possible (e.g. sod facing, stone pitching, etc.), but in the urbanized area rubble masonry revetment work will be carried out in view of the constraints of land acquisition. Depending on the land availability, the works will include riverine environment improving measures such as riverside parks, promenades, and tree planting, which will improve the living environment of residents around the area. The work will also take into account the navigation aspect (especially in the lower reaches of the To Lich River).

Proposed River Improvement Works

River	Improvement Length (m)
(a) To Lich (including Thanh Liet Channel), Lower Kim Nguu, Lower Lu	22,100
(b) Set, Upper Lu and Lu-Set Diversion Floodway	7,500
(c) Upper Kim Nguu	3,400
Total	33,000

(4) Drainage Channel Improvement

Drainage channel improvement works will be carried out in the same manner as river improvement works. In view of the difficulty of acquiring land, the width of the channel side roads is planned to be 3 m on one side and 1.5 m on the other.

Drainage Channel Improvement Work

Drainage Sub-basin	Improvement Length (m)
(a) To Lich, Lower Lu and Hoang Liet sub-basins	16,400
(b) Set and Upper Lu sub-basins	3,700
(c) Kim Nguu sub-basins	10,700
Total	30,800

(5) Floodgates and Control Gates

In total, seven floodgates/control gates, including the Thanh Liet floodgate and the West Lake outlet control gate, will be installed under the Project. The reasons for the installation of the above are to shut off backwater (causing reverse flow) from the lower reaches (e.g. Thanh Liet), temporarily store flood runoff (e.g. West Lake outlet), and divert flood flow (e.g. Lu-Set floodway). The details are shown in Annex 4.3.

The operation of the Thanh Liet floodgate is important for maximizing gravity outflow in consideration of the balance between inflow from the To Lich upstream basin and the water level of the lower reaches of the Nhue River. The Thanh Liet floodgate is proposed to be re-built on the Van Dien-Ha Dong road about 400 m downstream of the existing Thanh Liet weir. The conceptual plan for the Thanh Liet floodgate is shown in Figure 4.5.

(6) Bridge and Culvert Improvement Works

There are a number of bridges and culverts on rivers and drainage channels, most of which possess an extremely small water passing section. In addition, owing to their small openings, floating debris (wastes) and riverbed sediments accumulate and further reduce the water passing capacity. The numbers of bridges and culverts requiring improvements or reconstruction and those to be newly constructed are shown below:

Proposed Bridge and Culvert Works

Place	Replacement		Construction		Total	
	Bridge	Culvert	Bridge	Culvert	Bridge	Culvert
Yen So Reservoir Site	2	0	13	0	15	0
Rivers (4 rivers)	17	12	0	0	17	12
Drainage Channels	17	63	0	1	17	64
Total	36*	75	13	1	49	76

Note: * Including 3 railway bridges

(7) Dredging and Conservation Works for City Lakes

In the Master Plan, lake dredging and conservation works are contemplated under separate programs (Ref. Work Items F and G in Figure 3.3). Nevertheless, works for specific lakes which are deemed to have important functions in drainage terms are incorporated in this Project.

Outline of Proposed Lake Dredging and Conservation Works

Proposed Measures	No. of Lakes	Description
(a) Lake Dredging and Conservation Works	18	Increase of storm water runoff retarding capacity, with lake side environment improving measures (see Annex 4.4 for details of the lakes)
(b) Lake Conservation Works	11	Conservation of lakes to be retained for drainage purposes, with lake side environment improving measures
(c) Lake Water Aeration (as a pilot model project)	2	Proposed for a monitoring program for observing the effect of water quality improvement (Thien Quang Lake and Thanh Cong Lake)

Lake conservation works will include (i) removal of lake bottom sludges (water quality improvement), (ii) lake shoreline protection work (lake shoreline conservation and elimination of illegal encroachment), and (iii) provision of lake side promenades and parks (waterfront environment improvement). It is noted that lake aeration work will require O&M costs after the facilities are put into operation; say about US\$ 20,000 annually.

(8) Provision of Sewer Networks

The urbanized area is drained by underground sewers. Of a total drainage basin area of 7,750 ha (6,820 ha excluding the West Lake basin), a sewer network will be provided for 6,200 ha in this area (including areas to be developed).

The basic principle is to rehabilitate or augment the number of combined-type sewers in the existing sewer system (combined system) and to install new storm water sewers in newly developed areas (separate system).

The works will be carried out in stages as shown below:

Proposed Sewer Network Implementation Plan

Stage	Description	Objective Area
1.	Removal of sediments/sludges (as an urgent project)	* For existing sewers (present urbanized area: about 3,000 ha in gross area)
2.	Augmentation of the drainage capacity of the existing sewer system (chiefly by addition of pipes)	* For priority areas within the existing sewer network (about 1,050 ha of total 3,000 ha)
3.	Replacement of old pipes (existing sewers) and expansion of the sewer service area (areas newly developed)	* Entire Project area (6,200 ha)

4.4.4 Estimation of Implementation Cost

The Project implementation cost is estimated to be US\$376.8 million which is equivalent to Dong 4,069 billion at the 1994 price level, including price escalation.

Estimated Project Implementation Cost

(Unit: US\$ million, Dong billion)

Item	FC	LC		Total	
	(US\$)	(US\$ equiv.)	(Dong)	(US\$ equiv.)	(Dong equiv.)
Construction Cost	149.9	55.4	598	205.3	2,217
Procurement of Dredging Equipment	8.8	0.9	10	9.7	105
Sub-total	158.7	56.3	608	215.0	2,322
Government Administration Cost	0	6.4	69	6.4	69
Land Acquisition/Compensation	0	35.2	380	35.2	380
Sub-total	0	41.6	449	41.6	449
Engineering Services	22.9	11.2	121	34.1	368
Physical Contingency	18.6	13.4	145	32.0	346
Total	200.2	122.5	1,323	322.7	3,485
Import Tax	0	7.3	79	7.3	79
Price Contingency	28.1	18.7	202	46.8	505
Grand Total	228.3	148.5	1,604	376.8	4,069

US\$1 = Dong 10,800

FC: Foreign Currency portion, LC: Local Currency portion

A breakdown of the estimate is shown in Annex 4.5.

4.5 Implementation Plan

4.5.1 Phased Implementation Plan

The proposed Project is relatively large, costing as much as US\$376.8 million. Hence, it is appropriate to implement it in stages mainly to distribute the financial burden over a period of years. In this Study, a two-phase implementation is proposed.

Concept of Phased Implementation of the Project

Work Components	1st Stage Construction	2nd Stage Construction
(a) Yen So Pumping Station	- Half of the pumping capacity is installed (45 m ³ /s)	- Remaining half (45 m ³ /s) is installed
(b) Regulating Reservoir	- Construction of the Yen So reservoir (3.87 million m ³)	- Addition of the Linh Dam lake and Dinh Cong lake capacity (1.32 million m ³)
(c) River Improvement	- Construction of all works (phased construction is not suitable)	- (No works)
(d) Drainage Channels	- Removal of sediments (as an urgent project) - Improvement of narrow sections (mainly at existing bridges/culverts)	- Enlargement of channel sections
(e) Floodgates and Control Gates	- All works to be completed (seven places)	- (No works)
(f) Bridges and Culverts	- Reconstruction of selected bridges/culverts which possess extremely small water passing sections (96 places)	- Improvement or reconstruction of the remaining bridges/culverts (29 places)
(g) Lake Dredging/ Conservation	- Dredging of four lakes which do not cause any land acquisition problems	- Dredging of the remaining 14 lakes - Conservation works for another 11 lakes
(h) Sewer Network	- Removal of sediments (as an urgent project) - Addition of sewers in priority areas to augment the existing sewer capacity	- Installation of new sewers in adequate number to meet the design storm and expansion of the sewer service area

Details of the work components scheduled for the 1st Stage and 2nd Stage are described in Annexes 4.6 and 4.7.

4.5.2 Implementation Schedule

The implementation schedule for the Project (1st Stage + 2nd Stage) is shown in Figure 4.6.

4.6 Economic Evaluation of the Project

4.6.1 Implementation Cost by Phase

The implementation cost of each phase according to Sub-section 4.5.1 is summarized below:

Implementation Cost by Phase

(Unit: US\$ million equiv.)

Item	1st Stage Construction			2nd Stage Construction		
	FC	LC	Total	FC	LC	Total
Construction Cost	80.0	23.7	103.7	69.9	31.7	101.6
Procurement of Dredging Equipment	8.8	0.9	9.7	0	0	0
Sub-total	88.8	24.6	113.4	69.9	31.7	101.6
Government Administration Cost	0	3.4	3.4	0	3.0	3.0
Land Acquisition and Resettlement	0	15.2	15.2	0	20.0	20.0
Sub-total	0	18.6	18.6	0	23.0	23.0
Engineering Services	10.7	4.7	15.4	12.2	6.5	18.7
Physical Contingency	9.3	5.5	14.8	9.3	7.9	17.2
Total	108.8	53.4	162.2	91.4	69.1	160.5
Import Tax	0	4.0	4.0	0	3.3	3.3
Price Contingency	9.1	4.4	13.5	19.0	14.3	33.3
Grand Total	117.9	61.8	179.7	110.4	86.7	197.1

Note : Conversion rate: US\$1 = Dong 10,800

FC : Foreign Currency portion, LC: Local Currency portion

4.6.2 Economic Evaluation according to Phased Implementation

After the completion of the 1st Stage Project the area should be sufficiently protected against damage caused by ordinary floods of less than a 2-year recurrence probability. In this case, the average annual flood damage reduction benefits under the 1st Stage Project are roughly estimated at US\$7.6 million, which corresponds to 60% of the total Project benefits (US\$12.6 million, after the completion of the 2nd Stage Project).

EIRR for the respective phases of the Project is analyzed below:

EIRR According to Each Phase

Implementation Phase	Implementation Cost (US\$ mil.)		Annual Benefit (US\$ mil.)	EIRR *2 (%)
	Financial Cost *1	Economic Cost		
1st Stage	179.7	146.8	7.6	11.7
2nd Stage	197.1	138.9	5.0	11.4
Whole Project	376.8	285.7	12.6	11.6

Note: *1 Different from the figures shown in Sub-section 3.6.2 due to the inclusion of price escalation contingency

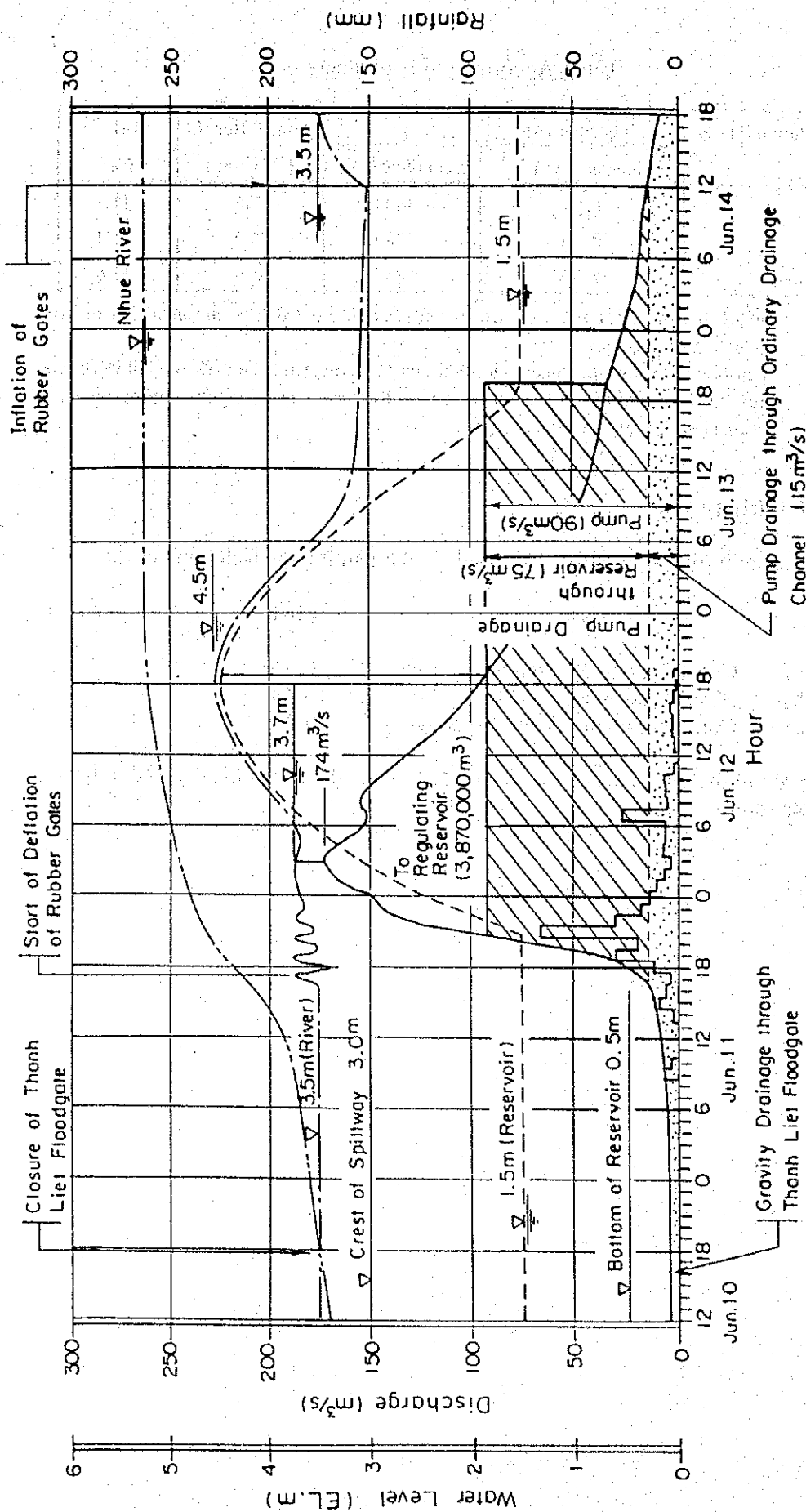
*2 A cashflow is shown in Annex 4.8. O&M cost is estimated to be 0.3% of civil works cost plus 2.0% of equipment/machinery cost. Replacement of equipment/machinery is assumed to be every 25 years.

4.6.3 Sensitivity Test

A sensitivity test of EIRR was conducted assuming the following cases:

<u>Case</u>	<u>EIRR</u>
(a) Construction cost increase of 15%	: 10.5%
(b) Benefits decrease of 15%	: 10.3%
(c) Combination of (a) and (b) above	: 9.2%

Even in the most unfavourable case (c) above, the Project is deemed to have a favourable return.



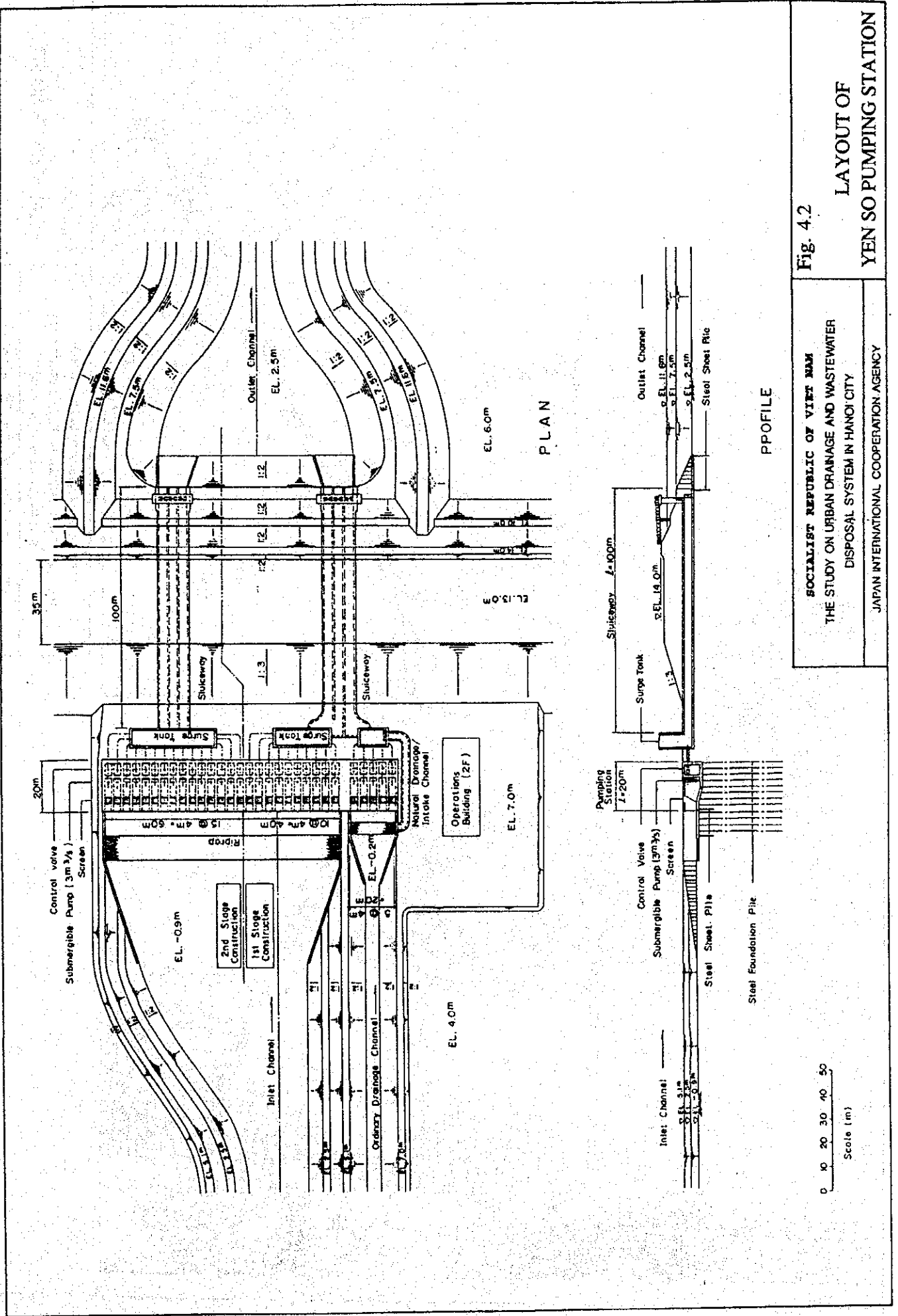
Note:

10-Year return period design flood (1989-Flood Type)

- Legend:
- Water Level
 - Discharge
 - Rainfall

Fig. 4.1
 OPERATION OF PUMPS, RESERVOIR AND FLOODGATE FOR DESIGN FLOOD

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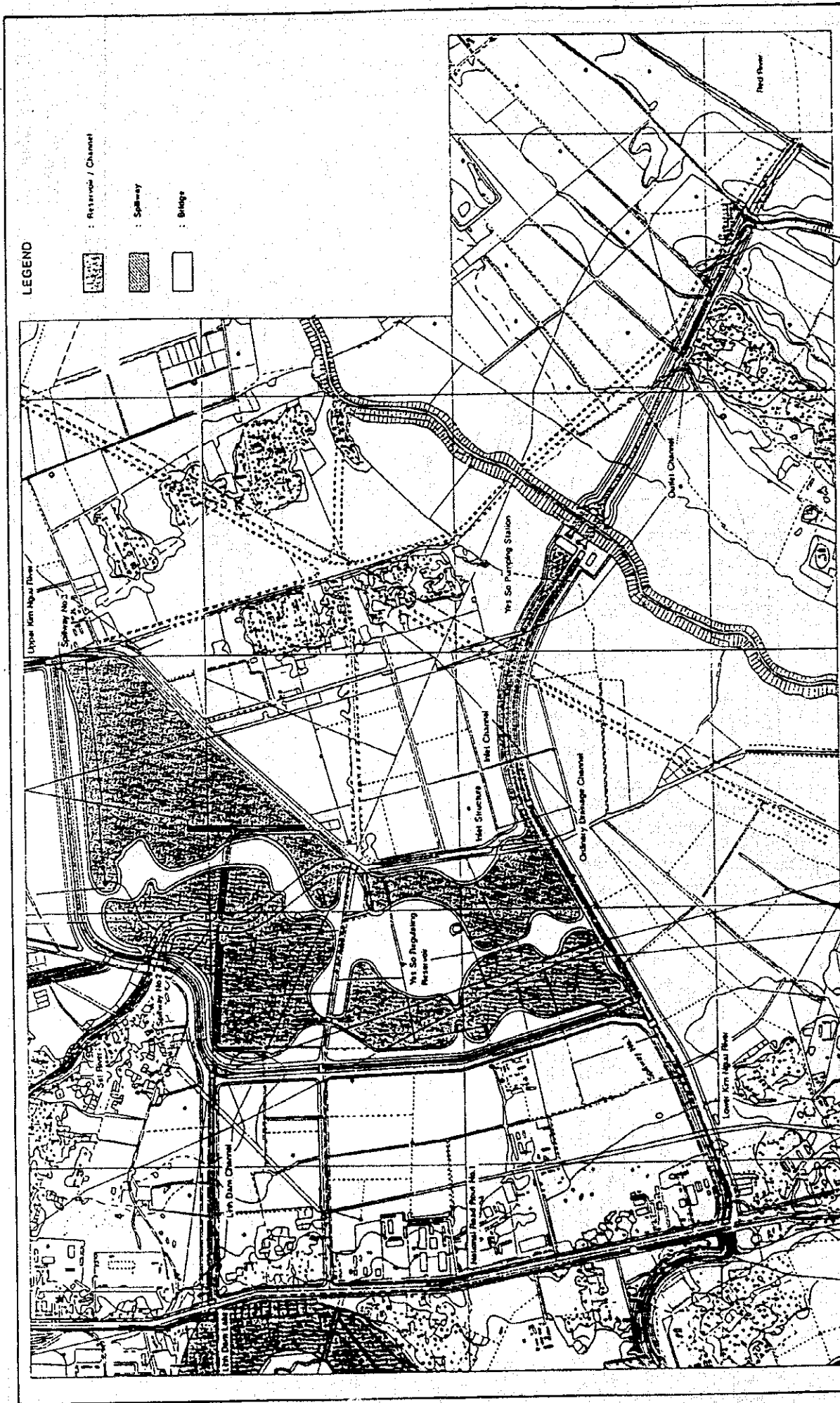


Fig. 4.3
 PLAN OF YEN SO SITE

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Regulating Reservoir (130 ha)

River

Automatic Deflating Rubber Gate

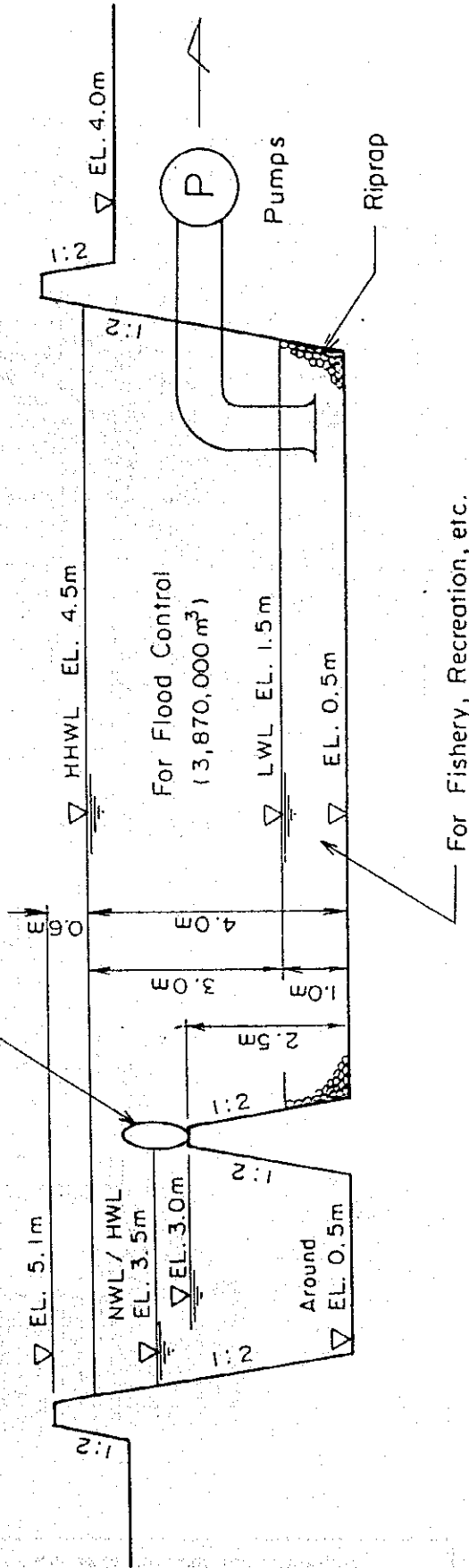


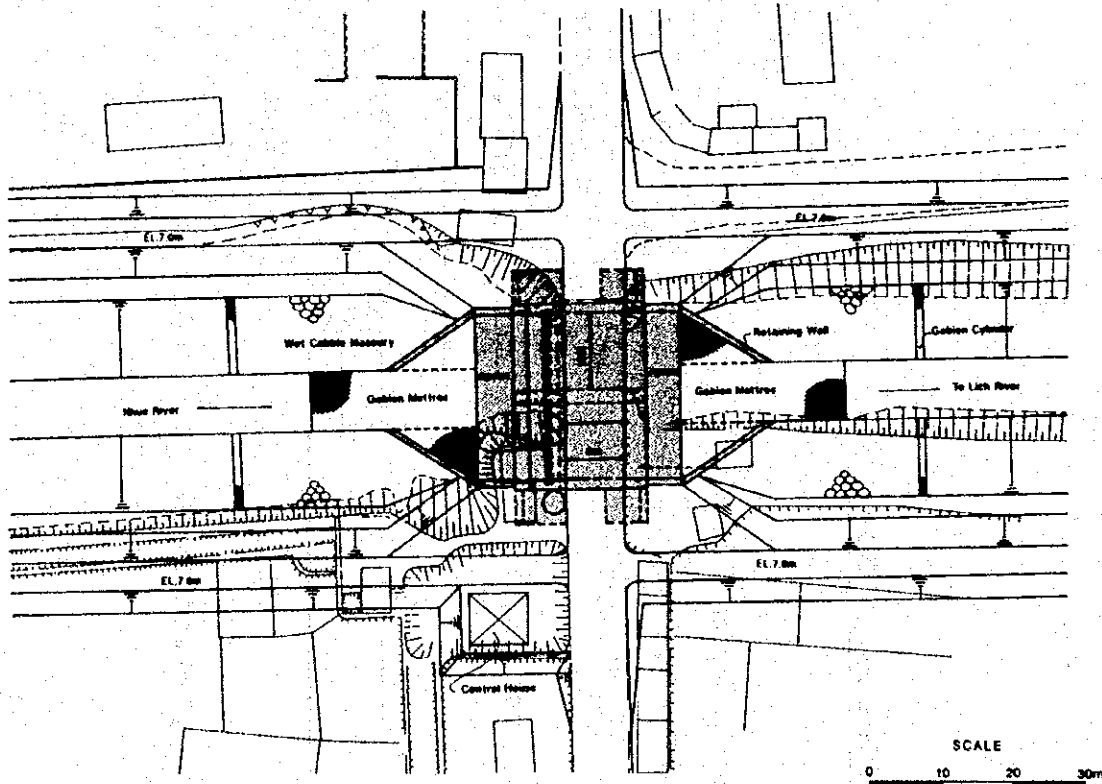
Fig. 4.4

SECTION OF YEN SO
REGULATING RESERVOIR

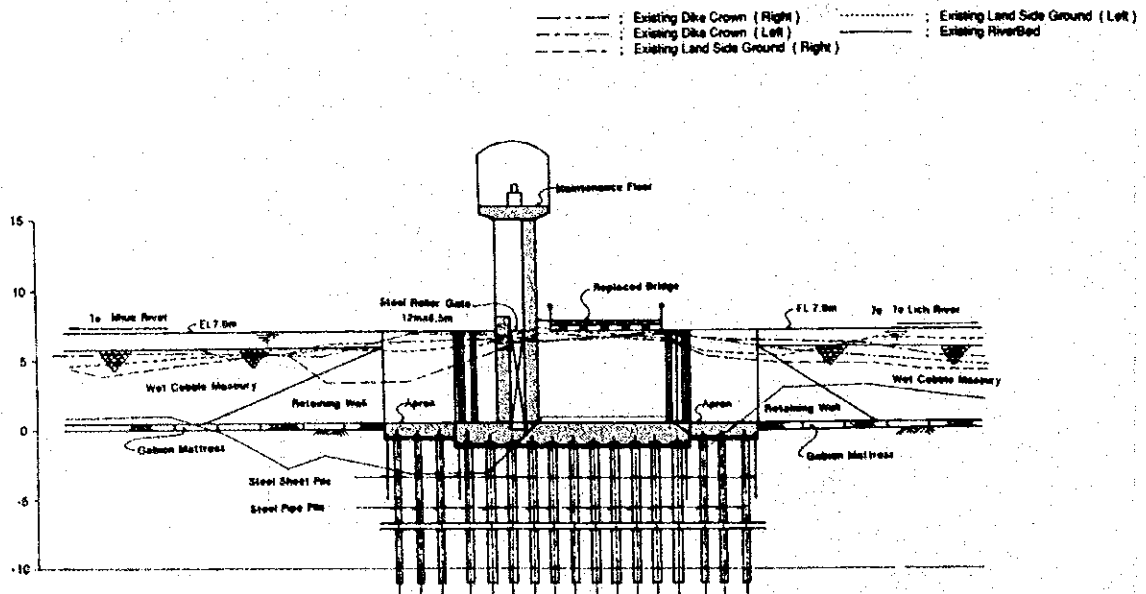
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PLAN



PROFILE



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 4.5 LAYOUT OF THANH LIET FLOODGATE
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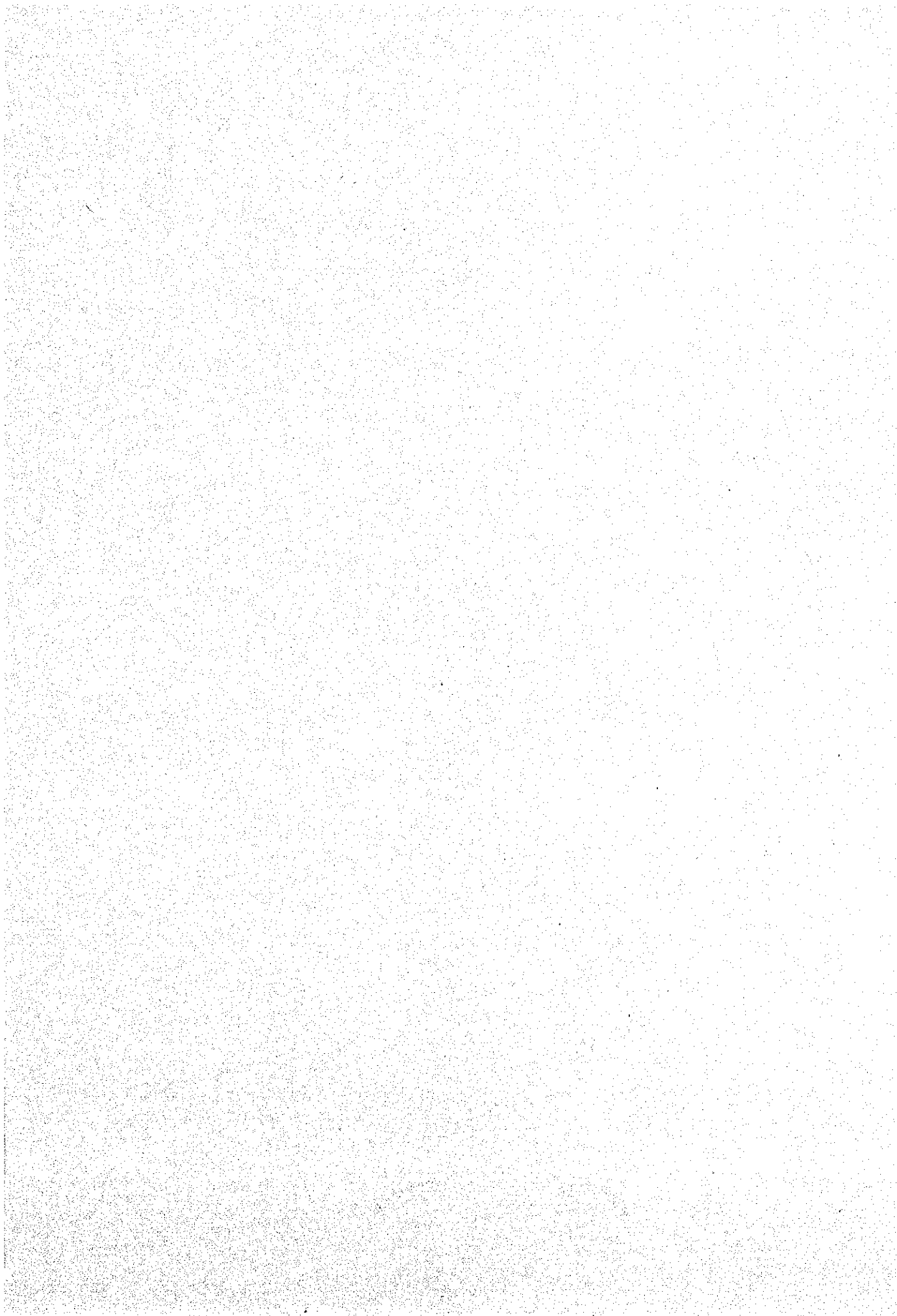
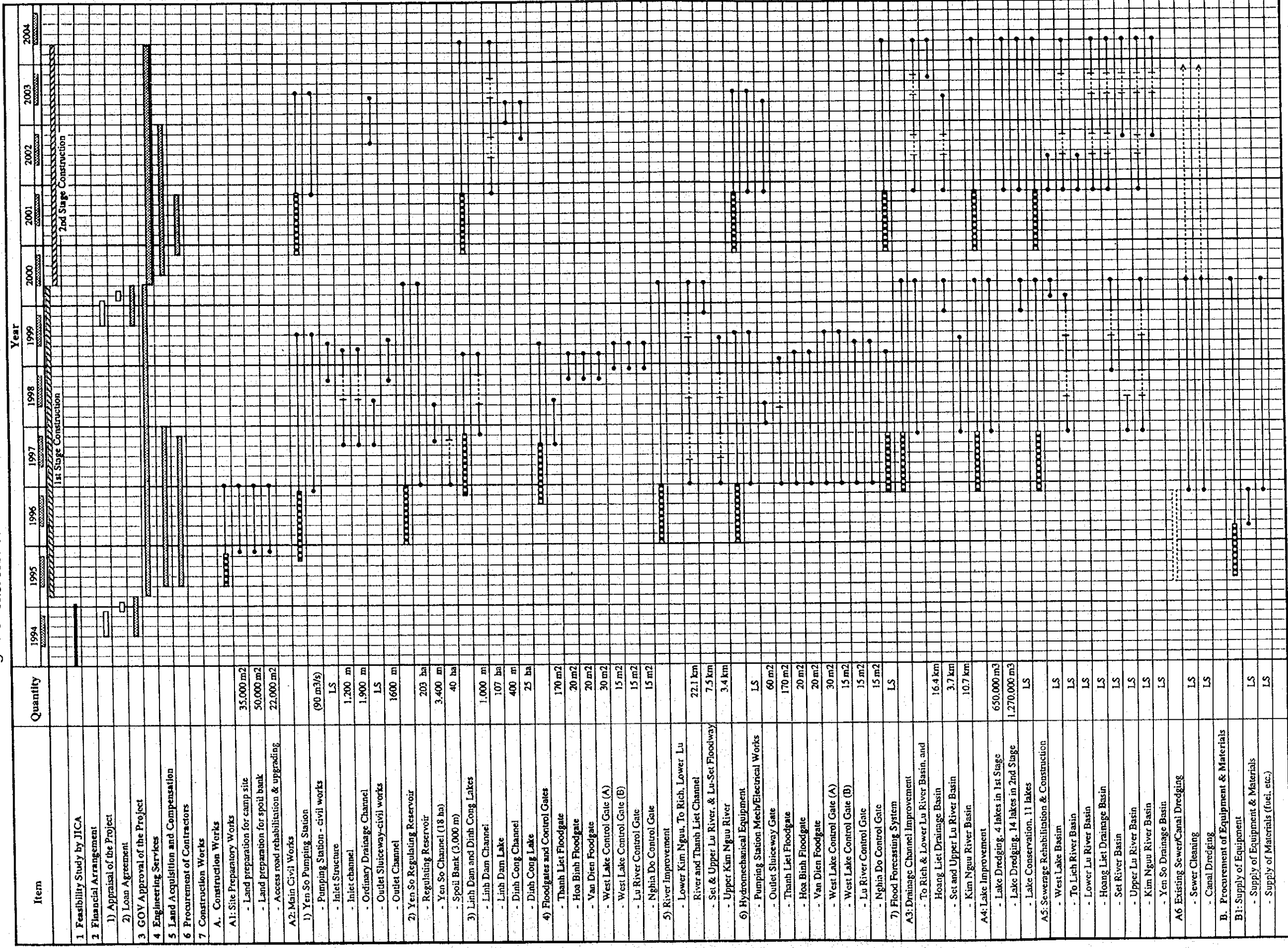
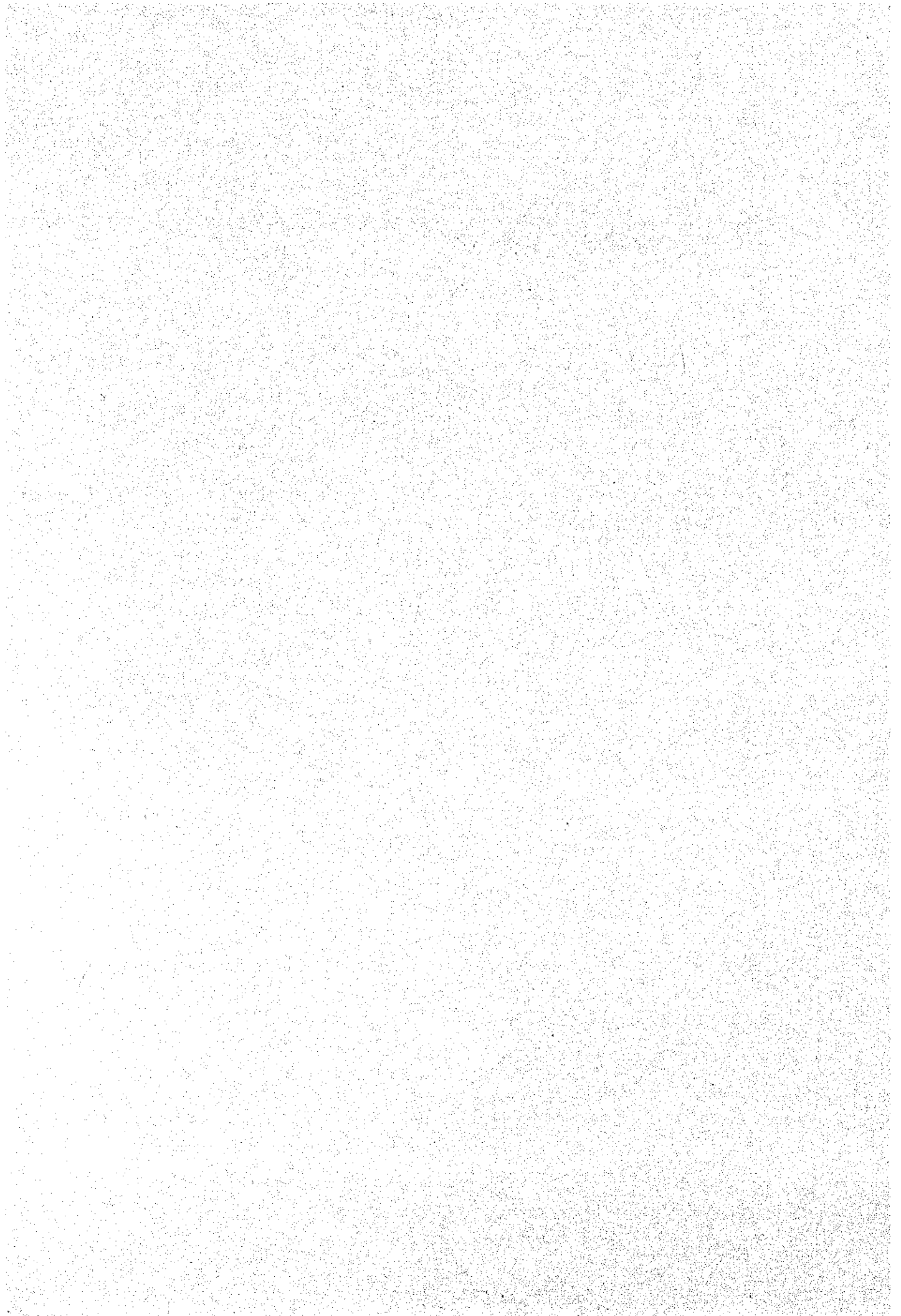


Fig. 4.6 PROPOSED CONSTRUCTION SCHEDULE



■ : Feasibility Study (JICA)
 ▨ : Financial arrangement
 ▩ : Procurement of contractors
 ▧ : Activity by GOV / Consultant
 ▦ : Preparatory works by HSDC
 ▥ : Works by contractors



5. ENVIRONMENTAL ASPECTS

5.1 Environmental Problems in Hanoi City

(1) Drainage and Sewerage Systems

Wastewaters are discharged into the surface water system (rivers and drainage channels) without being treated. This results in the deterioration of surface water quality, which is one of most serious problems affecting the environment of the City. Aspects to be specifically noted are as follows:

- (a) The pollution of groundwater is occurring. This is caused by infiltration of contaminated channel waters and leakage of sewage from old sewers.
- (b) The storm water discharges surface pollutants into rivers and channels. When the area is inundated, direct contamination of water tanks (mostly installed underground) and wastewater spills from septic tanks and sewers are evident.
- (c) The common practice is to throw all kinds of solid waste into the water and carry out illegal landfill. This decreases water quality and water flow.
- (d) The practice of using fresh excreta and sludge from septic tanks, without the proper biological stabilization, results in the pollution of surface water and groundwater. Overhung latrines are still being used, which results in hygienic hazards.
- (e) Collection and disposal of solid waste and nightsoil are also problematic, because the level of facilities is low and inadequate. Uncollected waste is discharged into rivers and channels.

(2) Lakes and Rivers

There are virtually no wastewater treatment facilities in Hanoi City. Accordingly, wastewater purification relies only on the natural biological process in lakes and rivers, which are however, already overloaded. With the effective circulation of water, aeration, and harvesting of water plants, it is supposed that lakes could receive domestic wastewater from half a million people. However, the population has increased to nearly one million.

An additional problem is the high rate of sedimentation and growth of water plants. The velocity of flow in rivers and channels is very low except in the rainy season. Improvement measures such as dredging the bottom sediments, removing water plants, and conveying flushing water (as a likely plan in the future), will be necessary.

(3) Water Quality

The Wastewater Monitoring Program, which started in May 1993, has been carried out by SDC. The objectives of this Program are to obtain information

on water quality in lakes, rivers, and channels which have been polluted by wastewaters, identify the quantity and quality of wastewaters from industries, hospitals, and households, and identify the main polluters. Under this Study, some water quality surveys were carried out at 15 points in order to assist the Program.

According to the observation results obtained to date, the deterioration of surface water quality has progressed to a serious extent as reflected by the following BOD levels.

- Drainage Channels :	30 - 105 mg/l
- Rivers :	45 - 100 mg/l
- Lakes :	15 - 50 mg/l

Water is polluted if the BOD value exceeds 15mg/l. Therefore, all water bodies seem to be polluted, particularly drainage channels and rivers where the situation is serious. Concentrations of ammonium and phosphate are highest in areas where domestic wastewater has been discharged. During the summer, lakes contain little oxygen, but rivers and channels are partly anaerobic.

5.2 Preliminary Environmental Comments for the Master Plan

Drainage and sewerage development, in particular the latter, aims at improving people's living standards and water quality, and hence is regarded to be the development which would improve the City's environment. The plans formulated in the Master Plan are generally in line with this concept and cause no particular environmental problems.

Nevertheless, some aspects require consideration before implementing the plans. The most important aspects are the following;

- (a) One of the negative impacts, which is to some extent unavoidable, is the people's resettlement issue. It is appropriate that the minimization of resettlements be taken into consideration when the plans are formulated.
- (b) Most of rivers and lakes in Hanoi City (except the West Lake) have been dredged many times, which has already changed the original ecosystems. Nevertheless, a survey shall be carried out to examine the need to conserve the ecosystems before undertaking any projects.
- (c) It is necessary to continue the Wastewater Monitoring Program in parallel with the implementation of the projects. It is likely that the Program will provide valuable data and information which would indicate the direction of subsequent development.

5.3 Environmental Impact Assessment of the To Lich River Basin Drainage Project

Overall, the Project will contribute to the improvement of the City's environmental conditions. Flood inundation does not only result in economic loss for the people, but is also one of the main factors aggravating hygienic conditions, which would be mitigated by the Project. Improvement of river and lake facilities will provide places of great value for the people, which will result in the improvement of their living environment.

Several environmental impacts may arise, particularly during construction. The main items requiring attention in the design and construction are as follows:

- (a) Yen So Pumping Station : - Change in natural scenery
- (b) Yen So Regulating Reservoir : - Impact on fish and vegetation due to the changes in water levels (3 m), and also bank erosion
- Sedimentation in the reservoir (requiring periodical dredging)
- (c) Linh Dam Lake : - Coordination with the development of the areas surrounding the lake
- (d) Rivers/Drainage Channels : - Inflow of wastewaters/sludges will continue for the time being until wastewater treatment systems are provided, which will require periodical channel maintenance works such as sludge removal and channel cleaning works
- (e) Resettlement of People : - There will be no major problems in the Yen So area and with the river improvement works. However, care and attention are required for the drainage channel improvement works in the urban areas.

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6. RECOMMENDATIONS ON IMPLEMENTATION PLANS

6.1 Recommendations with Regard to the Implementation of the Projects

(1) To Lich River Basin Drainage Project

- (a)** The 1st Stage Project shall be implemented as early as possible in view of its high economic return and the urgent need for improving the environment.
- (b)** The 2nd Stage Project will raise the flood protection level from that against a 2-year flood (1st Stage) to that against a 10-year flood. Since the damage potential in the Project area is high, protection against a 10-year probability flood is deemed to be the minimum requirement for Hanoi. The 2nd Stage Project should follow the 1st Stage Project as early as possible.
- (c)** In the long term, it may be necessary to further raise the protection level in order to cope with 25-year or 50-year probability floods. Upgrading will comprise the expansion of pumping stations and regulating reservoirs. It is recommended that unused lands adjacent to the Yen So pumping station and reservoir be reserved for the future.

(2) Nhue River Basin Drainage Project

- (a)** In view of the fact that the damage potential in the Nhue River basin is smaller at present compared with that in the To Lich River basin, the Project is envisaged to be carried out after the To Lich Project. Nevertheless, an earlier implementation in parallel with the To Lich Project is preferable, if financial resources are available.
- (b)** The proposed Project includes the construction of a dike along the left bank of the Nhue River, which will worsen flood conditions on the right bank area. Accordingly, flood control/drainage works in the right bank area should be implemented in parallel, or a little later. Investigations and studies thereof, should be conducted as early as possible by MOWR.
- (c)** In future, flood control works shall be provided for the Nhue River downstream areas. With this objective, it is proposed to carry out a comprehensive basin flood control study by MOWR.

(3) Lake Conservation Plans

- (a)** Any works relevant to the West Lake should be preceded by a comprehensive environmental study on the Lake, which should be commenced as early as possible.
- (b)** Lakes and ponds in the City area play a very important role in both drainage and sewerage. They should be conserved for the future (some 86 lakes), and illegal landfills should not be permitted.

(4) Wastewater Disposal Plan

- (a) Substantial improvement of rivers/lakes' water quality cannot be attained unless wastewater treatment systems are introduced. A feasibility study shall be conducted in order to accelerate the program implementation (initially for Zones 2, 3, and 4 which are priority areas proposed in the Master Plan).
- (b) Since the implementation of a substantial number of components of the wastewater disposal Project will take many years, it is recommended that non-structural measures be enforced (see Work Item N in Figure 3.3).

6.2 Recommendation on Environmental Aspects

(1) Environmental Monitoring Program

Virtually no comprehensive environmental survey data have been accumulated until now. It is recommended that an "Environmental Monitoring Program" be implemented separately from other projects. The Program will continuously observe various factors such as the distribution of water plants/algae, the ecosystem of the bottom fauna, aquatic agriculture, and quantity/distribution of sediments, in collaboration with the "Wastewater Monitoring Program" currently being undertaken by SDC.

(2) Ground Subsidence Observation Program

It is presumed that more than a half of the Study Area has been subject to ground subsidence of 5 - 10 mm/year during the past 4 years (1988-1992, HWSP/FINNIDA). Excessive subsidence may cause severe damage to drainage and sewerage facilities. It is necessary to continue the observation of ground subsidences henceforward under a well established program.

6.3 Recommendation on Institutional Reinforcement

Some recommendations are contained in the Main Report and relevant Appendixes, and the items needing early actions include the following:

(1) Sewerage and Drainage Company (SDC)

SDC is the most important agency responsible for the implementation and operation and maintenance of the drainage and sewerage projects henceforwards. Its institutional reinforcement is indispensable. The following measures need to be implemented soon:

- (a) Provision of a sufficient O&M budget from HPC
- (b) Reinforcement of middle to senior class engineers for dealing with the proposed To Lich River Basin Drainage Project

(c) Training of technicians for subsequent O&M works through the implementation of the projects

(2) Hanoi People's Committee (HPC)

In the actual implementation of the Project, HPC envisages to receive various collaborations from several ministries of the Central Government in terms of both management and technical guidance. In this context, HPC shall establish a "Project Cooperation Committee (PCC)" which will discuss and determine all collaborations required to lead the Project to a successful completion. PCC is regarded as the implementing organization directly attached to HPC. A "Project Management Office (PMO)" will be established to handle the technical issues involved in the Project implementation, under HPC.

(3) Urban Environment Company (URENCO)

Until a substantial part of the wastewater treatment systems is completed (year 2000 onward according to the Master Plan), the role of URENCO, which is responsible for the collection and disposal of solid waste and excreta, is particularly important. The reinforcement of this institution, together with the provision of the necessary equipment and facilities, should be carried out under a separate aid program.