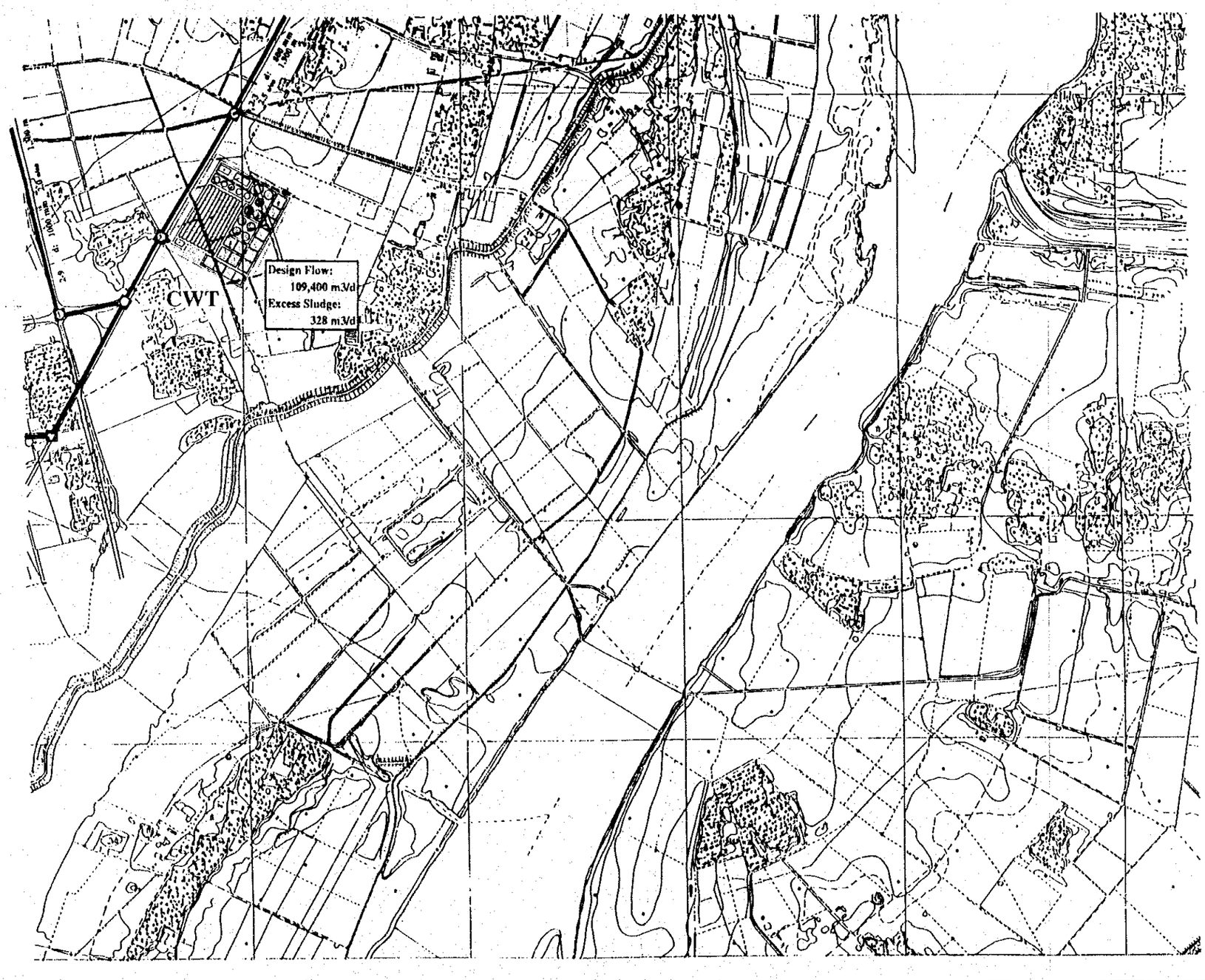
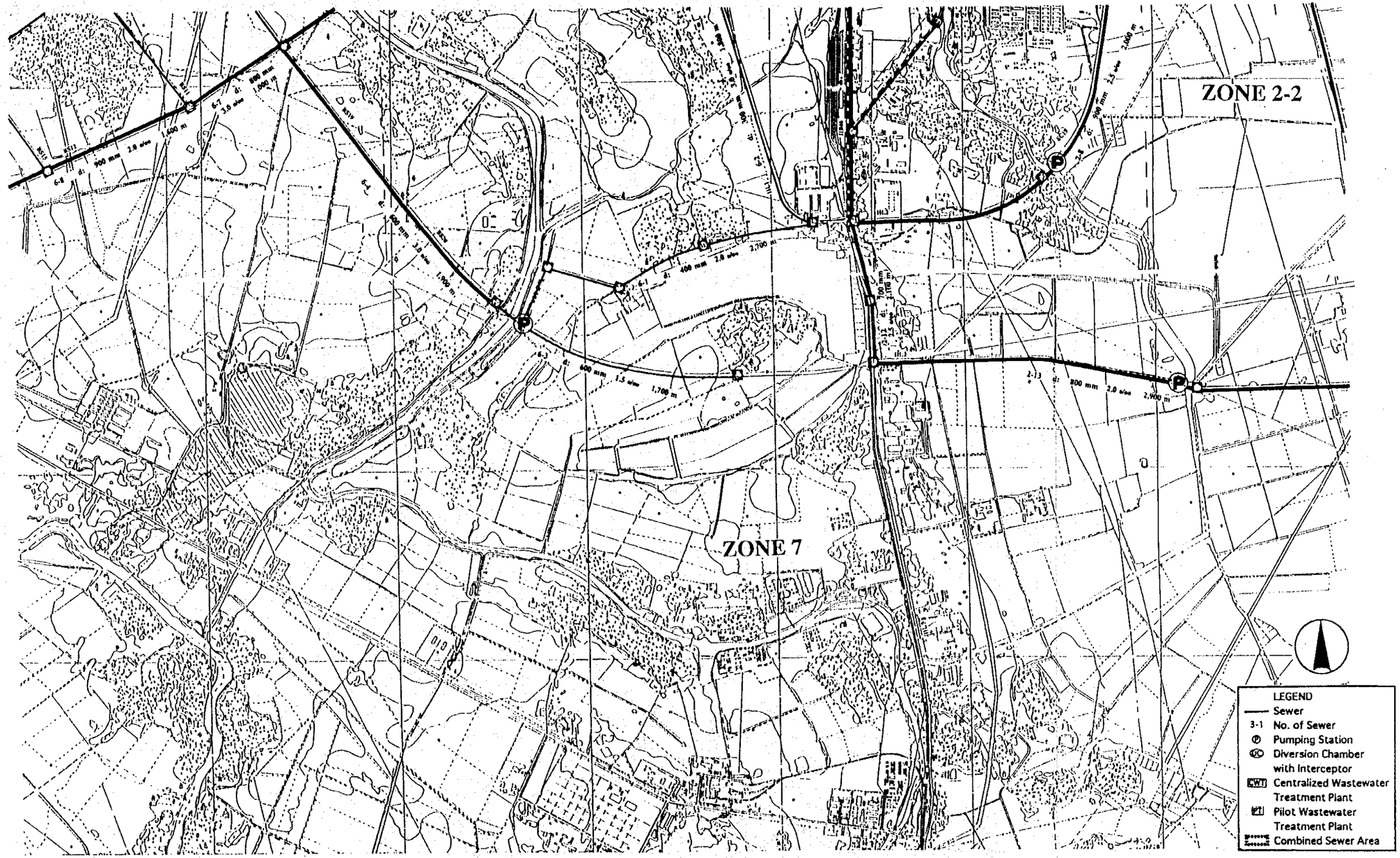


LEGEND
- Sewer
- 3-1 No. of Sewer
- Pumping Station
- Diversion Chamber with Interceptor
- CWT Centralized Wastewater Treatment Plant
- PT Pilot Wastewater Treatment Plant
- Combined Sewer Area

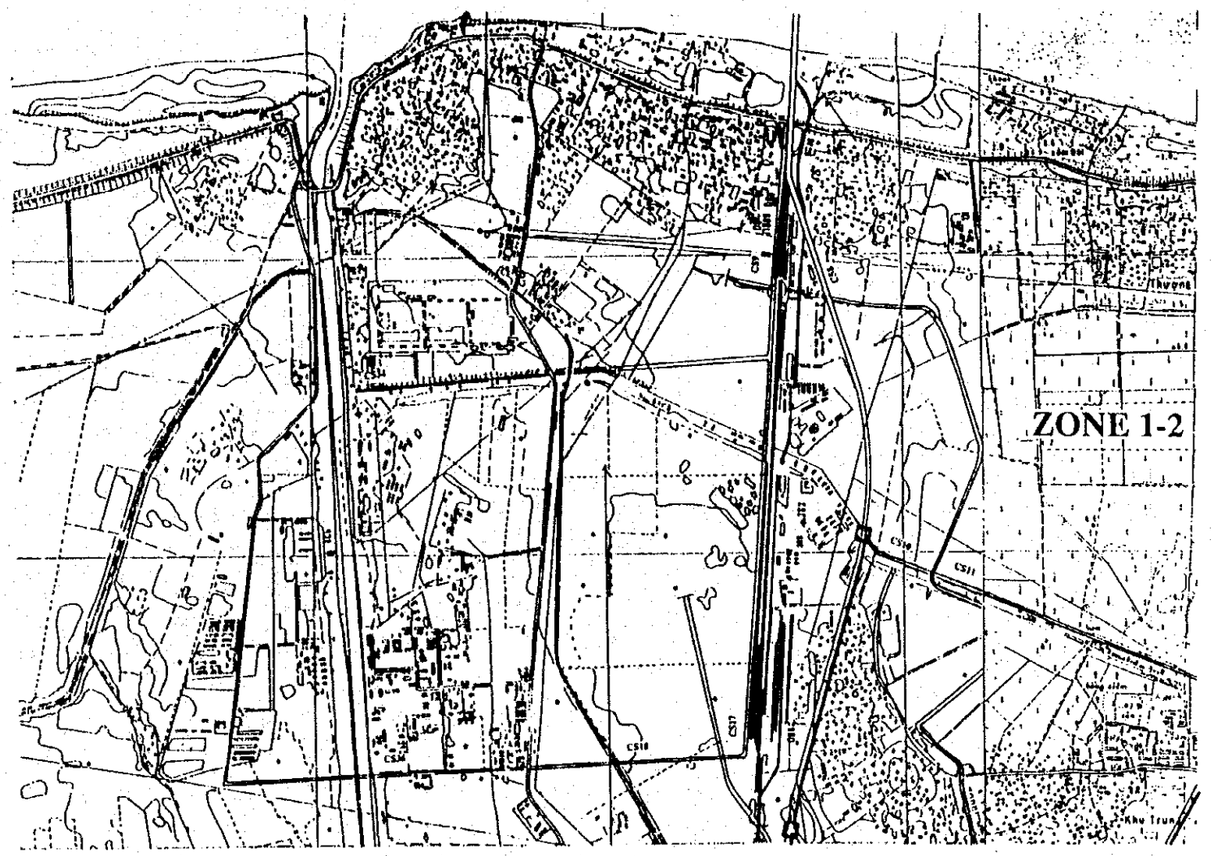
SOCIALIST REPUBLIC OF VIET NAM
THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. E6.5 (5/10)
LAYOUT OF SEWERAGE SYSTEM (5/10)



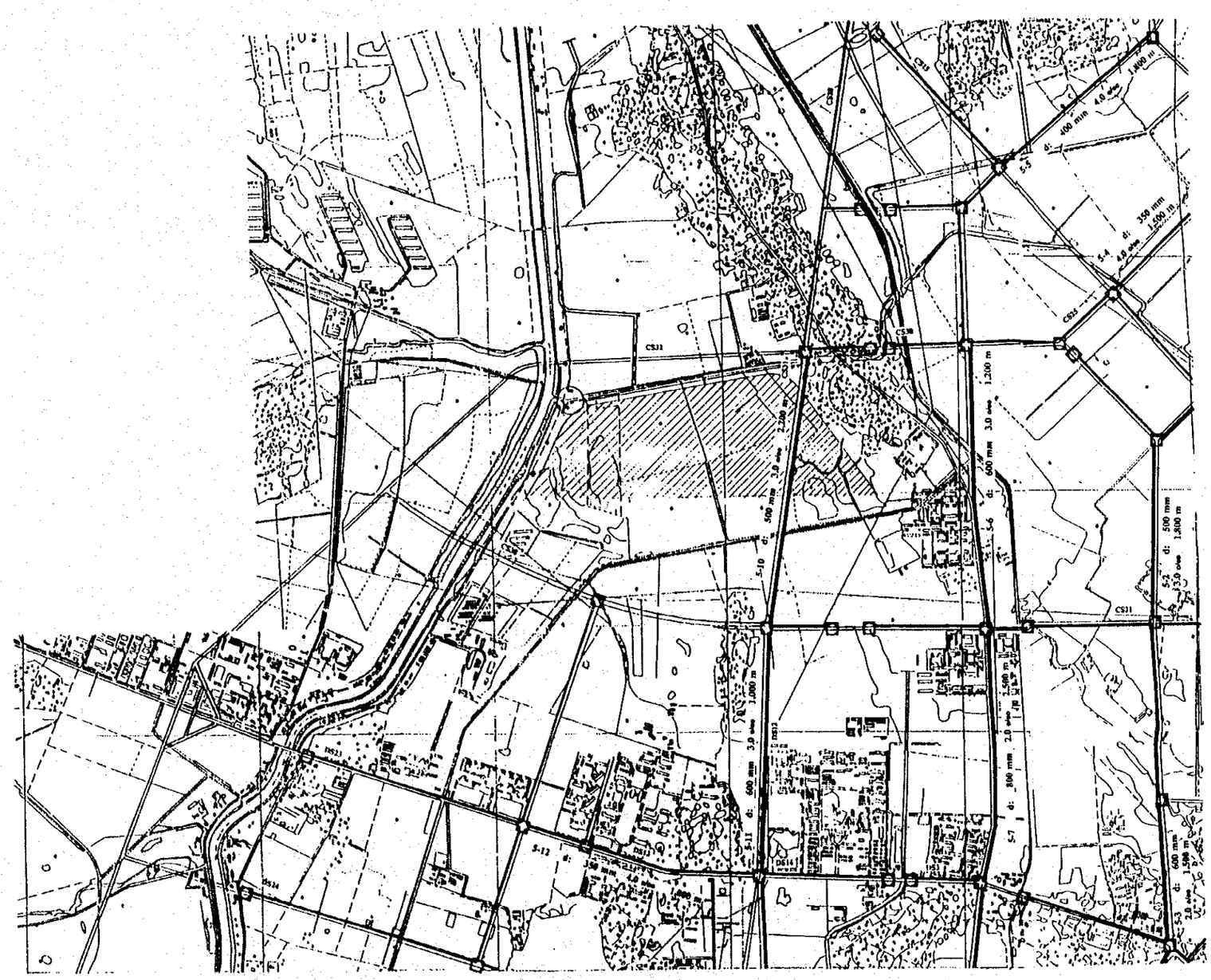
SOCIALIST REPUBLIC OF VIET NAM
THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. E6.5 (6/10)
LAYOUT OF SEWERAGE SYSTEM (6/10)

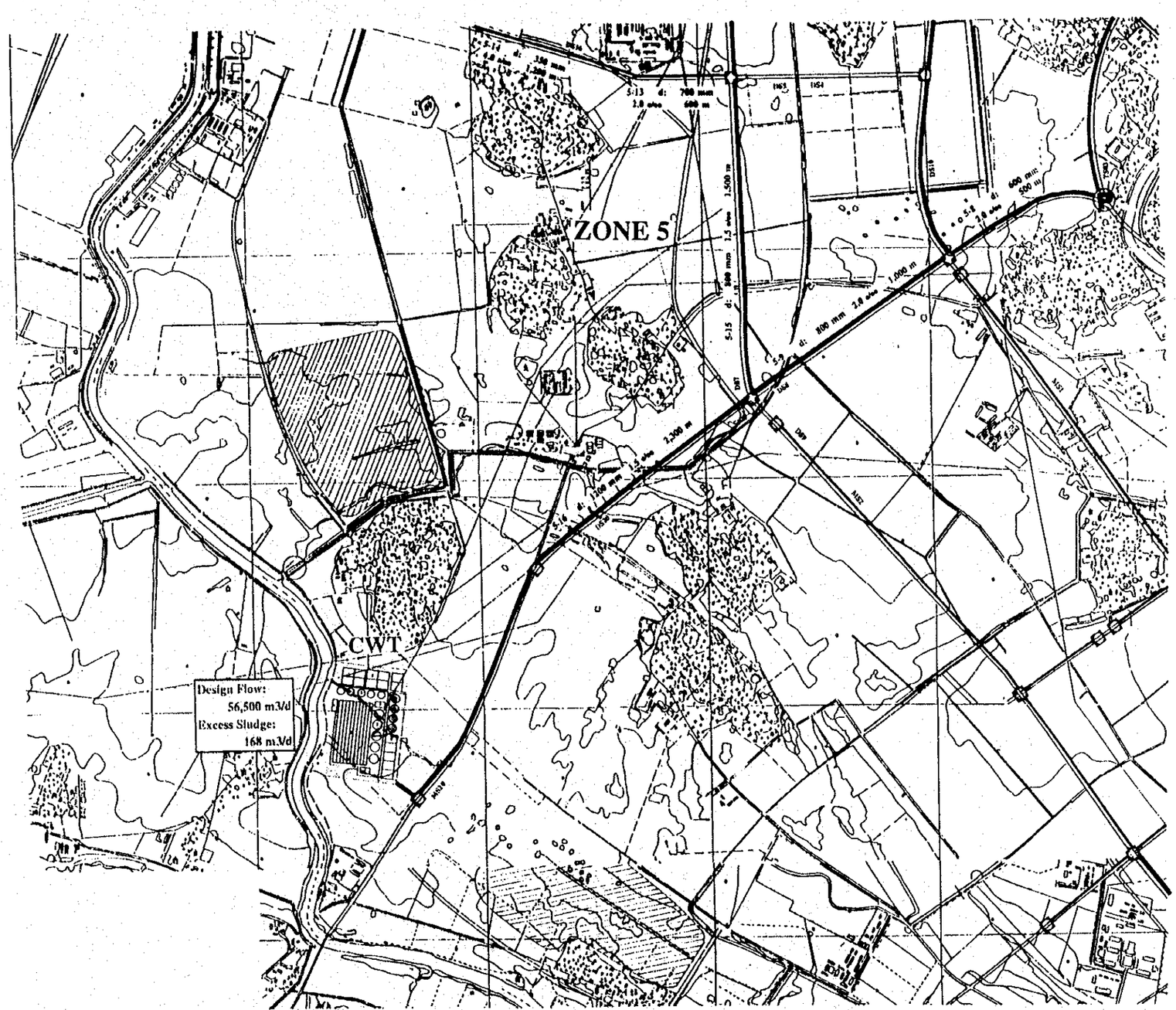


LEGEND
- Sewer
- 3-1 No. of Sewer
- Pumping Station
- Diversion Chamber with Interceptor
- CWT Centralized Wastewater Treatment Plant
- PT Pilot Wastewater Treatment Plant
- Combined Sewer Area

SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. E6.5 (7/10) LAYOUT OF SEWERAGE SYSTEM (7/10)

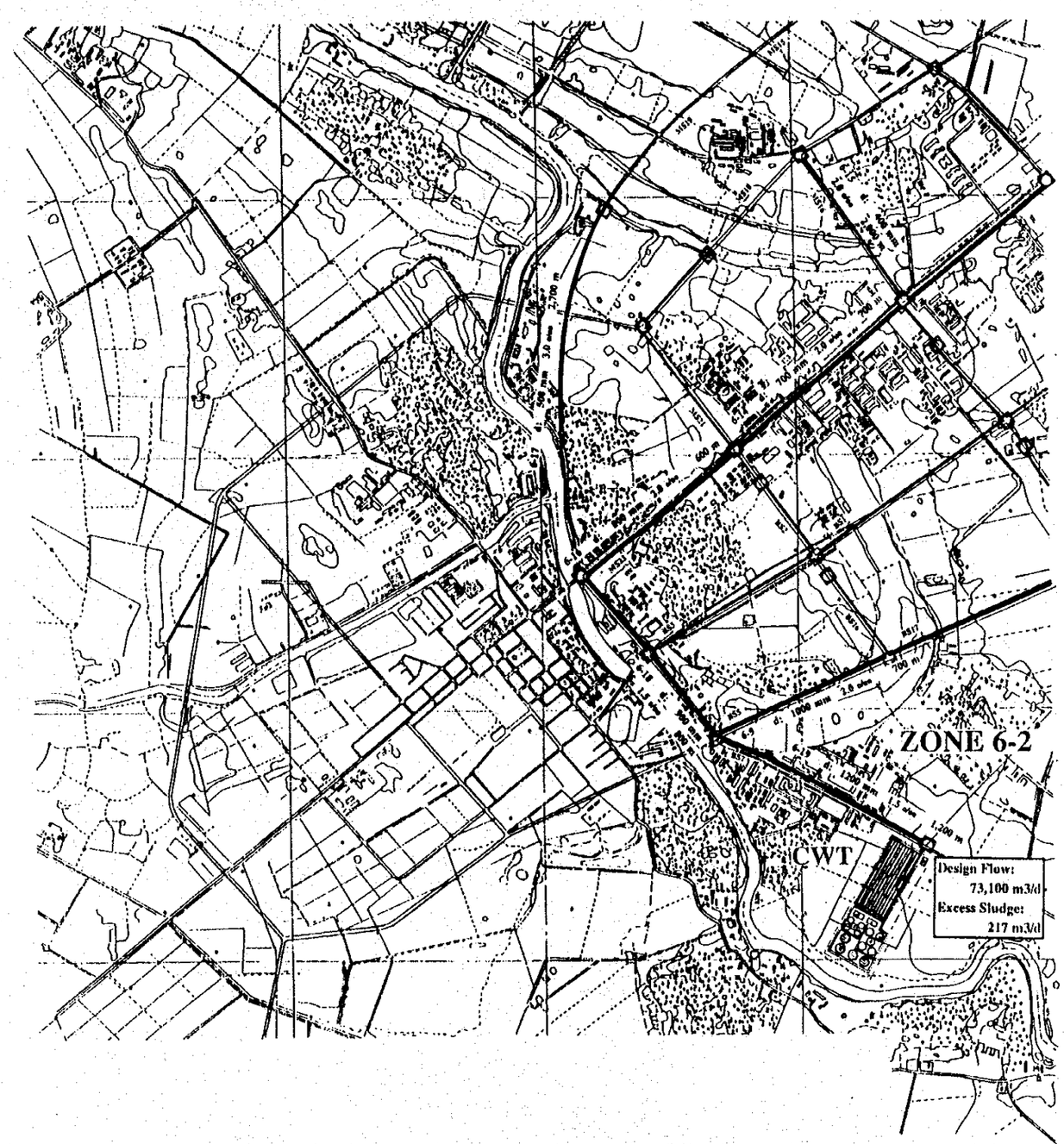


SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. E6.5 (8/10) LAYOUT OF SEWERAGE SYSTEM (8/10)



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

SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. E6.5 (9/10) LAYOUT OF SEWERAGE SYSTEM (9/10)



LEGEND
- Sewer
- 3-1 No. of Sewer
- Pumping Station
- Diversion Chamber with Interceptor
- CWT Centralized Wastewater Treatment Plant
- PTI Pilot Wastewater Treatment Plant
- Combined Sewer Area

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

Fig. E6.5 (10/10)
LAYOUT OF SEWERAGE SYSTEM (10/10)

THE STUDY
ON
URBAN DRAINAGE AND WASTEWATER
DISPOSAL SYSTEM
IN
HANOI CITY

APPENDIX (F)

ENVIRONMENT AND WATER QUALITY

FEBRUARY 1995

THE STUDY ON
URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM
IN
HANOI CITY

APPENDIX (F)
ENVIRONMENT AND WATER QUALITY

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F1. INTRODUCTION

The Study on Urban Drainage and Wastewater Disposal System in Hanoi City is carried out to identify environmental problems and to improve the drainage and sewerage system. The first part of the Project is the Hanoi City Drainage and Environment Improvement Project. The main objectives are to improve the drainage system in the city and to reduce disadvantages and damages caused by floods, and to improve the living environment in the city, particularly concerning health and hygiene.

The inadequate condition and size of the sewerage and drainage system are the biggest environmental and health risks in Hanoi. The collection and reuse of solid waste and nightsoil also cause problems.

Wastewater is discharged straight into channels, rivers and lakes. The actual treatment takes place in the aquatic ecosystem which is overloaded, and may become totally exhausted, by organic matter and industrial wastes. The pressure to the aquatic system nowadays is too strong, and the capacity of biological treatment has been exceeded. Industrial wastewater and solid waste discharges prevent the safe use of water for aquatic production, etc..

During the rainy season there are repeated floods in certain low-lying areas, where the capacity of sewers and drainage channels is inadequate. Floods are frequently causing serious problems and disturbing normal life. Floods cause serious damage not only to the houses but also to the streets, the water supply network and sewers. Storm water penetrates wells and water pipes, and pollutes water. During heavy rain there is overflow from the sewers, where capacity is insufficient to carry sewage water and storm water. Epidemics are possible during floods, because of the amount of polluted water, and people have to wade in deep water in the streets and lanes.

Lakes, rivers and channels are used to collect, drain, and treat all kinds of wastewater and storm water. There are no long-term water quality monitoring data, but it is clear that all lakes and rivers are at least moderately polluted, and all channels are highly polluted. Despite this, many lakes are also used for fish farming, aquaculture and recreation.

All natural areas in urbanized Hanoi are effectively utilized, and the impact of human beings on the environment is great. Banks are used for the illegal dumping of garbage and land fill. A common habit is to throw garbage straight into the water, because the collection of solid waste is not organized, and people don't care about the cleanliness of their living environment.

F2. ENVIRONMENT AND WATER QUALITY IN HANOI

2.1 Environmental Legislation, Standards and Management

2.1.1 Environmental Law and Standards

There is still very little experience in environmental legislation and management in Vietnam, because all organizational arrangements are quite recent. The Ministry of Science, Technology and Environment (MOSTE) was re-organized in October 1992 from the former State Committee for Science and Technology. The main role of MOSTE is to assist the Government in strategies and policy planning matters related to science, technology and the environment.

The Environmental Protection Law was ratified by the National Assembly on December 27, 1993. In the Law, the following main statements have been given: to give general provisions and definitions, to prevent environmental depression, pollution and incidents, to settle international relations on environmental protection, to give penalty against violations of the Law, and to provide implementation.

Environmental management shall be arranged, according to the Law, as following (Article 38): The Government shall unify the State management on environmental protection throughout the country. The Ministry of Science, Technology and Environment shall be the responsible State management organization in the field of environmental protection. The ministries, ministry-ranking bodies, and the offices under the Government shall cooperate with the Ministry of Science, Technology and Environment to implement environmental protection in their branch and the establishments within their direct authority. The People's Committees in the provinces and cities under the central authority shall function as State management organizations concerned with environmental protection in the localities. The Services of Science, Technology and Environment shall be the responsible organizations for environmental protection in the localities.

Beside the Environmental Protection Law, several proposals and versions of environmental and water quality standards have been published in recent years to prevent environmental mitigation and pollution, e.g., Standard for Sewerage and Drainage System and Design Standard of Work (20 TCN-51-84) by the Ministry of Construction in 1989. Ministry for Science, Technology and Environment has published in 1993, Provisional Environmental Criteria and proposals for Vietnamese Environmental Standards.

The Proposals for Environmental Standards cover regulations for land, water, air, noise, and radiation. There are regulations for: 1) level to be used to define the indicators and concentration of pollution caused by chemicals, 2) methods of qualitative and quantitative testing, measuring, defining, analyzing, adjusting, 3) standards and regulations which are used for the management of environmental protection.

There have been also environmental regulations for some big cities. Hanoi People's Committee was governed by the 1990 Decision of Regulations on the Protection of City Environment in Hanoi Capital (No. 5983 QD/UB).

A temporary guidance for the Environmental Impact Assessment for technical-economic projects was proposed by Ministry of Science, Technology and Environment on September 10, 1993 (No 1485/MTg).

2.1.2 Environmental Management in Hanoi

The environmental management in Hanoi has been improved and new instruction and division of duties between companies was confirmed in November 1993. Environmental matters in Hanoi belong to two different organizations under the Hanoi People's Committee, the Department for Science, Technology and Environment (DSTE), the former Hanoi Environmental Committee (HEC), and the Hanoi Transportation and Urban Public Work Service (TUPWS).

DSTE is a state administrative agency for the urban environment and coordinates the development and implementation of the environmental protection plan and its sustainable development.

Important duties have been given to DSTE, but unfortunately these are difficult to fulfill, because there is a serious lack of staff, equipment, financing and power. Therefore it has not been possible to carry out regular inspections and monitoring. However, there is no other realistic alternative to control environmental pollution in Hanoi. Therefore the strengthening and upgrading of DSTE is necessary.

TUPWS has the responsibility for sewerage, sanitation and water supply, and controls the following three companies: 1) Hanoi Sewerage and Drainage Company (HSDC), which is responsible for the management of a part of the sewerage and drainage system, 2) Hanoi Urban Environmental Company (URENCO), which is responsible for solid waste disposal in Hanoi City, 3) Hanoi Water Business Company (HWBSC), which is responsible for the operation and maintenance of the water supply.

2.1.3 Environmental Studies, Reports and Monitoring

United Nations organizations, especially the United Nations Development Programme (UNDP), has paid attention to environmental problems in development co-operation programs and has published the Strategy and Action Plan Concerning Environment and Natural Resource Management. The Vietnam National Plan for Environment and Sustainable Development 1991-2000 has been prepared in co-operation between Vietnamese authorities, UN organizations and the Swedish International Development Authority (SIDA).

Detailed environmental studies of Hanoi have been done by the Finnish International Development Agency (FINNIDA), SIDA and the Canadian International Development Agency (CIDA). For the Hanoi Water Supply Project reports have been done on the Study on Environmental Interactions between Water Projects and the Environment in Hanoi City (1990), Environmental Enhancement and Impacts (1992), and the Water Master Plan of Hanoi City for the Period of 1993 - 2010 (1993). Sweco has drafted an Assessment of Environmental Problems in Hanoi. A report on Urban Waste Management Study Hanoi, Haiphong and Ho Chi Minh City was published by CIDA in 1993. Feasibility and Experimentation of Forced Air

Composting for Solid Waste Treatment in Vietnam was published by Tonkin & Tailor 1991.

A Proposal for Environmental Monitoring Programme concerning this Study has been given to mitigate the adverse impacts of the construction work on regulation lakes and pumping stations (See Appendix F 4.5.1). The programme has been planned separately for different sub-projects, which have the biggest environmental impact and need long-term monitoring.

The proposed monitoring program should consist of studies concerning physical and chemical water quality, algae, bottom fauna, vegetation, amount and quality of sediment and the general condition of surroundings. The monitoring program should be continuous so that it will be possible to control the changes.

2.2 Environmental Problems in Hanoi

2.2.1 Wastewater and Solid Waste Disposal

Presently there is no operational wastewater treatment in Hanoi. At Kim Lien, wastewater from the residential dwellings is, in principle, treated in a primary treatment plant before discharge into the Lu river. However, the treatment plant has never worked properly. There are also two treatment plants at hospitals, but they are only occasionally operational.

The amount of wastewater and solid waste is increasing because of the increasing level of facilities. Due to the low standard of household sanitation, approximately only half of human excreta are flushed into sewers. Wastewater similar to domestic sewage is discharged from offices and small enterprises. The most critical wastewater is from factories, hospitals and other major point-source polluters. The primary objective of wastewater treatment could be to remove organic matter, because phosphorus and nitrogen are the most important reasons for eutrophication. The normal wastewater treatment process also reduces the amount of bacteria.

Wastewater is discharged into the surface water system, which is also used for fish-farming, irrigation and recreation. The actual wastewater treatment takes place in the aquatic ecosystem, which is overloaded, or at the limit to become overloaded, and may become totally exhausted by organic matter and toxic industrial wastes. The pressure to the aquatic system is, at present, too strong, and the capacity for biological treatment has been exceeded. Industrial wastewater and solid waste discharges prevent safe use of water for aquatic production, etc..

The practice of using fresh excreta and septic tank sludge without proper biological stabilization can cause pollution of surface water and groundwater. Overhung latrines are still in use, especially near channels, which cause a direct hygiene hazard.

A common practice is to throw solid wastes and landfill into the water, which decreases water quality and prevents water flow, increasing the possibility of flood. Sedimentation is increasing, and water bodies have to be cleaned frequently.

According to the above it is evident that the inadequate condition and size of the sewerage and drainage system are the biggest environmental and health risks in Hanoi. The collection and reuse of solid waste and nightsoil also causes problems because the level of facilities is low and inadequate.

2.2.2. Surface Water Quality

There is no long-term monitoring of water quality, but according to the available data and site visits, it is clear that all the lakes and rivers are at least moderately polluted and channels are highly polluted by domestic and industrial wastewater.

Pollution and eutrophication decreases the water quality, causes a lack of oxygen, and increases sedimentation. Turbidity and concentration of suspended solids is high in all areas.

Nutrients enter into lakes from several different sources. The most important in Hanoi is the direct lakeside input through human activities, because domestic and industrial wastewaters are discharged directly into the lakes.

Storm waters may contain high concentrations of suspended solids, phosphorus, ammonia, and nitrate as well as iron, silica, and salts, and different kinds of bacteria.

2.2.3 Groundwater Quality

The groundwater pollution caused by wastewater is very possible, because leaks in sewers are frequent, due to the age of the pipes and their thin soil cover. During the rainy season when the groundwater level is high, groundwater penetrates into the pipes, and during the dry season when groundwater level is lower, wastewater infiltrates into the surrounding soil, increasing the risk of groundwater and soil pollution.

2.2.4 Floods

Storm waters are very often polluted by faecal bacteria, suspended solids, toxic heavy metals and organic pollutants. Water tanks and pipelines are contaminated because of leakages. On the other hand, flooding has a flushing effect on streets and channels, carrying away dust, sediments and solid waste.

Storm waters are drained through a system of channels, rivers, and regulating lakes and ponds into the Nhue River. The drainage situation in Hanoi is very difficult, because of the location of the city in a heavily cultivated delta with a comprehensive irrigation system, the topography of the city itself, with a number of low-lying areas, and particularly its low elevation in relation to the Red River.

2.2.5 Air Pollution

Air pollution in Hanoi is becoming more serious due to industry, increased traffic and household cooking. Dust, sulphur dioxide, carbon dioxide and carbon monoxide are detected in industrial areas. And nitrogen oxides and lead content in dust are also detected along the streets.

2.3 Lakes in Hanoi

2.3.1 Identification

There are over a hundred lakes and ponds in Hanoi (Figure F2.1), but only 16 are under the management of HSDC. The lakes are used for flood and drainage reservoirs, wastewater treatment, fish-farming, aquaculture, and recreation. All the lakes are polluted and eutrophicated by both domestic and industrial wastewaters.

In the Hanoi area, there are five main rivers or channels, the Nhue River, the To Lich River, the Lu River, the Set River, and the Kim Nguu River. In practice all of these rivers are used mostly for drainage and wastewater discharge, and water quality is almost the same as the quality of wastewater, except in the Nhue River.

2.3.2 Sediment and Bottom Fauna

Bottom surveys have been carried out in seven lakes, but only Giang Vo belongs to the list of lakes which are proposed to be dredged. The thickness of the sediment in many lakes was surprising small, necessitating detailed studies and planning before any dredging is undertaken.

The type of bottom has been studied in the lakes which are proposed to be dredged during the first stage. Near the shore there is quite little sediment and on the bottom there is mostly sand and gravel (Giang Vo and Thanh Nhan 1) and clay (Dong Da). From Thanh Nhan 2 it was possible to take a sample from the middle of the pond, showing a thick layer of clayey sediment.

Living mussels, snails and small crabs have been found only in Thanh Nhan 1. The bottoms of other studied lakes seem to be dead. Bottom fauna studies have to be carried out to discover the real situation before dredging.

2.3.3 Aquaculture and Vegetation

Special attention has been paid to the vegetation in the water and on the shores. In general, versatility is quite low, with only a few species. The most common species in the lakes are water hyacinth, water spinach and duckweed. Some banks and even lakes are covered with vegetation, but many banks are bare and covered only with sand and garbage.

In inner city lakes which are used for recreation, the amount of water plants is very small or non-existent. In lakes which are used for fish farming or flood

controlling there are a lot of water plants, and in some lakes, water hyacinths cover the whole water area. The harvesting of water plants is not always effective.

In some rivers, the amount of water hyacinths prevent flow. In channels there are very little water plants, or any other life, because of the low water quality.

Water plants can be harvested and used for many purposes including, food for people and animals, compost, organic fertilizers, green manure, material for biogas, pulp, paper and fiber, and for biological wastewater treatment.

Water plants are very productive, especially the water hyacinth, which can also cause serious problems, if the growth is not controlled and harvested. Some typical problems caused by water plants include, clogging of waterbodies and prevention of flow, reduction of fish yield and the prevention of fishing activities, public health problems through the creation of habitats for disease carrying insects, and the conversion of shallow water to swamps. These problems can mostly be avoided with the effective harvesting and use of water plants.

2.3.4 Condition of Lakesides

The banks of Giang Vo and other lakes in the inner city area which are basically used for recreation, are usually paved with stones or concrete, and natural banks cannot be found. On the banks there are trees but the lawns are in bad condition and worn-out. Very often houses or concrete covered yards reach down to the water.

Well-maintained areas are very difficult to find, because all banks, even in the city center, are full of garbage and used as public toilets. Banks in the city are all used for illegal landfillings and the dumping of garbage on the banks.

All banks are very dirty, uncomfortable and environmentally destroyed because the collection of solid waste is not organized. Cleaning of the banks is not effective as the people don't pay any attention in keeping the environment clean and healthy. The people who are complaining about the condition of their surroundings also throw their own garbage on the street and in the water.

There are plenty of latrines situated next to the water, and on the channel banks there are over-hung latrines. Wastewater from houses near to the lakes, rivers and channels is discharged directly to the water untreated.

As a result, it is very clear that wastewater and solid waste in the channels and channel banks create a very serious threat, not only to the environment, but also to the health of the people residing near the polluted water.

2.3.5 Lakes and Ponds as Wastewater Treatment System

Lakes, ponds and channels of the city area are used to collect and to drain wastewater and storm water. They are overloaded by organic waste and nutrients, and at least the bottom layers and sediment are anaerobic.

There is a need to dredge these structures regularly, due to the high rate of sedimentation and the growth of water plants. Except in rainy periods, the velocity of flow in the channels is very low.

A reasonable amount of clean incoming water to ponds and channels could be secured by the additional flow of dilution water. Unfortunately, this idea seems to be against the traditional recirculation and regulation practices of Hanoi water bodies. When gravitional intake from the river is possible, the pumping of outlet waters should be increased. The regulating dams and pumping stations are administrated by the water resource authorities and the agricultural needs of greater Hanoi area seem to dominate hydrological planning.

However, special regulation of bigger lakes is, in any case, necessary to manage urban flooding and in this context, emphasis should also be given to the possibility to dilute city waters during the dry season. The area of ponds and channels is inadequate to provide appropriate storage volume, but the bigger volume of lakes, and additional water from rivers, could most probably be utilized in the rehabilitation of these minor water bodies.

Based on ecological capacity pilot test in 1991-1992, the rough estimate of the rate of biological productivity in Hanoi City waters is about 1 kg fresh biomass/m^2/day. The respective yield of organic carbon would be about 100 g/m^2/day. The amount of assimilated nitrogen is about 10 g/m^2/day and the amount of phosphorus, 1 g/m^2/day.

With the effective circulation of water, aeration, and the harvesting of waterplants, Hanoi lakes could receive domestic wastewater from half a million people. In theory, the respective production of aquatic primary plant biomass could be 1,500 tons/day. However, the maximum utilization of biological productivity does not harmonize with other uses of the city lakes.

The ecological capacity of city waters has been preliminary evaluated and further approach is recommended in the surroundings of the main well fields. The intrusion of polluted surface water can be limited or prevented in many cases, by developing the utilization of their ecological capacity.

2.4 Water Quality

2.4.1 Water Quality Reports and Monitoring Programs

General information about surface water quality, especially from previous years, has been published in the Ministry of Water Resources report. There is not very much data available for wastewater, and it is very difficult to draw any meaningful conclusions. UNDP, Hanoi University and the Civil Engineering College of Hanoi have done some wastewater quality studies, but the information is scattered among several sources and is quite difficult to utilize and unfortunately, the former results are not very reliable.

Some studies and results of water quality are included in environmental reports, and nowadays there are also regular monitoring programs. The Hanoi Water Supply Project, financed by FINNIDA, started a Surface Water Monitoring Program

of the Red River Basin in July 1992. The Hanoi Water Supply Project is also advising and supervising the Wastewater Monitoring Program for some lakes, main rivers and channels, and for some big factories and hospitals. The Wastewater Monitoring Program has been carried out by HSDC since May 1993.

The objectives of the HSDC Study have been to evaluate the water quality of some lakes, rivers and channels, polluted by wastewaters, and to identify the quantity and quality of wastes from industry, hospitals and also households, and to identify the main polluters.

According to the results of the HSDC Study the influence of wastewaters is evident, especially in the channels. In channels, BOD varies between 30-105 mg/l, in rivers 45-100 mg/l and in lakes 14-50 mg/l. Amounts of ammonium and phosphate are the highest in places where domestic wastewater is discharged. During summer there is a small amount of oxygen in the lakes, but rivers and channels are partly anaerobic.

It seems that the load to lakes and rivers is quite stable. Rainfall has a significant dilutive effect on water quality, and variation during summer mainly depends on rainfall.

Industrial wastewater samples have been taken by HSDC from textile and foodstuff factories, and breweries, etc.. Unfortunately there are only nutrient results from the wastewater of industries and hospitals. However, it can be seen that the nutrient load, and probably also the BOD and COD load, from factories and hospitals, is quite remarkable.

2.4.2 Water and Sludge Quality Investigations under the Study

(1) Investigation Programs

During the dry season there were a total of 15 sampling points: three points at the lakes, eight points at the main rivers, and four points at the channels. The first samplings were done in the middle of December 1993 and second in the middle of January 1994.

During the rainy season on-site water quality analyzing was done at the lakes that are proposed to be dredged during the first stage of implementation of the To Lich River Basin Project. On-site analyzing, especially for the needs of the aeration pilot project, continued in September 1994. Also during September, water samples were taken from a total of twenty lakes, of which three were also included in the Wastewater Monitoring Program carried out by HSDC.

(2) Results During The Dry Season

Results from the dry season confirm the fact that all the lakes, rivers and channels in Hanoi are at least moderately or even highly polluted by domestic and industrial waste water (Table F2.1). Pollution and eutrophication by organic matter decreases the water quality and oxygen, and at the same time increases sedimentation. Turbidity and concentration of suspended solids is high in all areas.

All three lakes, Hoan Kiem, Van Chuong and Bay Mau, which belong to sampling program, are polluted. The situation is worst in Van Chuong Lake, which is heavily polluted by industrial wastewater from textile factories, etc. Water quality in the outlet was about the same level as the wastewater, e.g. average of BOD 76 mg/l and average of COD 141 mg/l, also the concentrations of nutrients were high.

Hoan Kiem Lake was dredged in Autumn 1993. The water color was green and algal bloom was visible. There was also an oversaturation of oxygen and the pH level was high. The amounts of BOD and COD were high, but the concentration of nutrients was reasonable.

Also, Bay Mau Lake was dredged in year 1993. The water color was brown and at least some parts of the bottom were anaerobic. The BOD and COD levels were lower than in other lakes, but the concentration of nutrients was high, due to domestic wastewaters, which are discharged into the lake. The oily film on the water originated from wastewater from a locomotive factory and the textile industry area of Minh Khai and Mai Dong.

All the main rivers in Hanoi, To Lich, Lu, Set and Kim Nguu, are shallow with a low flow rate especially during the dry season. There are a lot of water hyacinth, water spinach and duckweed in many of the rivers. All the rivers are polluted and the dilution capacity is inadequate. The average of BOD was about 40-65 mg/l and COD 76-163 mg/l. Water quality was best, downstream in the Nhue River, where water volume is greater and therefore the dilution capacity is higher than in other rivers. In Nhue River the average BOD was only 6 mg/l and COD 17 mg/l (Figure F2.2).

In the channels there was mainly wastewater during the dry season. Water color was brown or black, there wasn't any oxygen, and presence of domestic wastewater caused strong odor and a high concentration of nitrogen-ammonia.

The analyzed amounts of bacteria seemed to be too low compared with the normal bacteria amounts in wastewater.

Heavy metals were analyzed from water and sludge of five points (Tables F.2.2 and F2.3). The amount of sludge was surprising small, only a trace of black and oily sludge was detected.

The color of the sludge varied from black/grey to dark black, and oil was detected at the sampling points of Lo Duc and Bay Mau Lakes. The content of sludge was heterogenous, and there were a lot of garbage, plastic, stones, sand and organic matter. The smell of the sludge was organic or domestic wastewater. The bottoms of the channels were practically dead, only sewage fungus could be found in some places.

Some of the concentrations of heavy metals were a little bit high, but all are still under the Vietnamese standards. No mercury (Hg) and very little cadmium (Cd) was found. In general the heavy metal concentrations were the highest in the Lo Duc outlet and in Bay Mau Lake.

(3) Results During the Rainy Season

August 1994 water quality results from lakes which are proposed to be dredged during the first stage are as follows:

Parameter	Giang Vo	Dong Da	Thanh Nhan1	Thanh Nhan 2
pH	7.4	7.9	8.6	8.3
Cond. uS/cm	432.0	470.0	412.0	456.0
DO mg/l	1.3	2.9	15.3	10.8
NH3-N mg/l	13.7	6.5	4.3	5.5
NO3-N mg/l	2.1	1.5	1.5	0.9
Turbidity NTU	24.0	46.0	60.0	53.0
SS mg/l	16.0	38.0	49.0	52.0
Color PtCo				
unfiltered			320.0	288.0
filtered			169.0	119.0

In August there was a oversaturation of oxygen in the lakes, producing visible algae blooming and strong green water color. The next measurements were done in September, when oversaturation of oxygen was reduced, because storm waters had flushed the lakes. Oversaturation depends on temperature and the amount of rainfall.

Results from September 1994 are presented in Table F.2.4. Sampling was done after heavy rain and flooding, and the lakes were full of water. The amount of nutrients was high in lakes where the impact of floods and discharged wastewater is the greatest. Turbidity and suspended solids had already become steady after the first peak of storm waters.

Because of the exceptional heavy rains, the amount of nutrients decreased from August to September. Storm waters had a flushing effect in the water bodies and retardion shortened in lakes. Turbidity and suspended solids remained at high levels, and especially during the rains, they peaked. There were not enough samples taken to analyze the impact of storm waters on BOD and COD.

Water quality was also checked visually, and special attention was paid to the color of the water, which is usually green or green/grey. Algae causes the green color and brown and grey color originates from the bottom sediment and the surrounding areas.

At the end of September there was an on-site analyzing of dissolved oxygen from selected lakes, to establish the need of aeration. Measurements were done from different water layers (See Table F2.5), but no stratification was found.

In general all water areas seem to be polluted, untidy and foul smelling. Lack of sewers, wastewater treatment and adequate solid waste and nightsoil collection, cause the biggest environmental problems in Hanoi. This is especially in the density populated inner city area where there are no possibilities for on-site waste water treatment.

F3. INITIAL ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED MASTER PLAN

Descriptions of the initial environmental impact assessment are based on the master plan implementation schedule presented in Figure F3.1. A detailed environmental impact assessment of the To Lich River Basin Project is presented in chapter F4.

3.1 STORMWATER DRAINAGE PROJECTS

3.1.1 To Lich River Basin Drainage Project

(1) Yen So Pumping Station

(a) Environmental Impacts

The pumping station causes minimal environmental impact, and requires minimal land, 1.7 ha. At least according to the present designs, the buildings do not disturb or change the landscape very much. Instead, the channel connecting the regulating reservoir to the pumping station (Inlet channel) and the pumping station to the Red River (Outlet channel) are new structures, cutting the natural connection from area to area.

The impact on Red River water quality depends on the use and capacity of the pumping station. Storm waters are usually contaminated, and turbidity and the amount of suspended solids are high. During heavy rain, however, there will be a greater load to the Red River, creating an effective dilution capacity, resulting in waters from the reservoir having only a temporary impact.

(b) Mitigation of Adverse Impacts

The biggest impacts will be during the construction work, which will also increase traffic in that area. Erosion has to be eliminated during construction work and during use. The maintenance of the channels has to be organized to ensure water to flow freely.

(2) Regulation Reservoirs

(a) Environmental Impacts

In the Yen So reservoir, the difference between maximum and minimum water levels will be 3.0 meters. This will have great impact on the vegetation and fauna, and erosion of the banks, if the changes happen very quickly and often.

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

In the Yen So area, the present lakes are used for fish farming and the ponds are emptied and dredged every year, showing the needs of fish farming and flood controlling, especially concerning water levels, can conflict. The water levels will be higher than present, and different parts of the reservoir will be enlarged. This will cause some changes to fish farming methods, and in the maintenance of the reservoir.

Besides Yen So there are two other proposed regulating reservoirs, Linh Dam and Dinh Cong, which are planned to be implemented during the second stage. These lakes are proposed 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 will be used for drainage purposes, 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 used as a recreational area in the future, demanding high water quality. There are also many pagodas around the lake.

(b) Mitigation of Adverse Impacts

To keep water quality in the reservoir as clean as possible, an ordinary drainage channel will be provided to connect the river system directly to the pumping station.

Construction work of reservoir will last about three years, and during that time about 3,500,000 m^3 soil will be excavated. To minimize transportation, the soil should be used near the construction area, e.g. as material for dikes. To prevent erosion, the 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, lowering of groundwater level and soil subsidence in Phap Van well field, which is located just next to the reservoir.

(3) River Improvement

(a) Environmental Impacts

Planned improvements include quite limited dredging upstream and downstream 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 a disturbance for traffic. A temporary increase of turbidity and suspended solids is possible during construction. The impact on water quality can be controlled and measured downstream.

(4) Drainage Channel Improvements

(a) Environmental Impacts

Planned improvements concern mostly re-construction of bridges to increase the flow in the channels. Insufficiently sized culverts collect floating garbage and clogged culverts prevent flow. Improvement of flow is obvious, especially if the channels are cleaned.

(b) Mitigation of Adverse Impacts

It is very possible that the soil in the channel banks and the bottom sediment are polluted, as the channels and banks have been continually used as illegal dumping sites. Polluted soil has to be removed.

The increase of erosion and the amount of suspended solids have to be prevented and measured during the construction work. Work has to be done so that water quality doesn't change downstream. Special attention has to be paid to the prevention of erosion during and after construction.

(5) Lake Dredging

(a) Environmental Impacts

18 lakes are proposed to be dredged, with four lakes being dredged during the first stage of implementation (Figure F2.1).

Many lake bottoms are lifeless, so dredging usually doesn't cause serious harm to the lake ecosystem. One of the biggest environmental problems is storage of the sludge without harming any other lakes or rivers.

At the same time, attention should be also paid to the banks and surrounding areas to improve the whole area and the use of the lakes. Recreational lakes should be conserved for that purpose. Well-maintained lake parks increase the value of living environment and welfare.

(b) Mitigation of Adverse Impacts

Water quality, amount and type of sediment, and possible bottom fauna and vegetation have to be studied before and after dredging to find out the real impact of dredging. The mitigation of wastewater load to the lakes has to happen at the same time as dredging, otherwise restoration has only a very short influence.

The impacts of dredging can be mitigated with good work planning. The treatment and location of sediment and sludge has to be arranged so that the problem is not only moved from place to place.

The amount of sediment will be so great, that the timing of the work has to be done carefully. Implementation has to be done during the dry season to mitigate the impacts. There also has to be control during the construction work to prevent surprising and unforeseen changes.

(6) Lakeside Protection Works

(a) Environmental Impacts

There is a conservation proposal for 11 environmentally valuable lakes (Figure F2.1). The proposed conservation methods are excavation of sludge from the bottoms, construction of a different kind of revetment on the slopes, and aeration of selected lakes.

To prevent erosion, the illegal construction of houses and the dumping of garbage, it is good to have some kind of protection of the lake banks.

(b) Mitigation of Adverse Impacts

Materials for paving and slope revetment have to be selected for each lake. Some examples are presented in Figure F3.2. It has to be considered that during the rainy season and floods, the inundation area can be quite large and resulting in water on the sidewalks.

(7) Storm water sewers

- Rehabilitation of existing sewers
- Installation of new sewers

(a) Environmental Impacts

The work is principally the construction of new sewers. Replacement of old pipes will be determinated only after inspection of the condition of the existing pipes during the cleaning work.

The present sewers are old, in bad condition and do not have the capacity for even normal rainfall. Therefore it is necessary to clean old sewers and construct new, starting at the most serious inundated areas. Increasing the storm water sewer capacity and decreasing the inundation areas improves the quality of environment and hygiene.

(b) Mitigation of Adverse Impacts

The implementation schedule is quite slow and inadequate compared with the demand to improve the sewer system. Sludge from the cleaned sewers has to be stored without causing harm to people or the environment.

3.1.2 Existing Sewerage/Channel Dredging Projects

(1) Supply of Dredging/Cleaning Equipment

(2) Dredging/Cleaning Work

(a) Environmental Impacts

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

(b) Mitigation of Adverse Impacts

Sludge and garbage removed from the channels and sewers have to be handled with care because it can contain bacteria and other harmful matter. Special attention has to be paid to the safe use of equipment and also protection during the work. It has to be considered, that if the pipes are flushed with high pressure water there might be overflow from the manholes causing dirty sludge to be discharged to the streets.

The treatment and final location of the sludge have to be arranged without causing health or environmental problems. Transportation of the sludge has to done without any loss of the load. If vacuum tanks are not used, the load has to be covered,.

It would be good to utilize pilot areas to test how to arrange the whole chain for cleaning, transportation and composting. The most critical areas, technically, and environmentally, should be studied.

The dredging of open channels is continuous, because people throw all kinds garbage to the channels. People have to be trained to dispose of garbage in legal areas. It is really important to improve the collection of solid waste, otherwise the cleaning will have only a very short influence.

3.1.3 Nhue River Basin Drainage Project

(1) Co Nhue Sub-basin Drainage Project

(2) My Dinh and Me Tri Sub-basin Drainage Project

(3) Ba Xa Sub-basin Drainage Project

Pump Stations / Reservoirs / Channels

(a) Environmental Impacts

There are proposed four pumping stations along the Nhue River (Figure F2.1) with the total capacity of 35 m^3/s and a total volume of 7,800 m^3. The total

area is 202 ha and the net area is 187 ha. The length of channels proposed to be improved is 54,000 m, and the number of bridges, to be re-constructed is 92. Each pumping station has an outlet sluiceway and a floodgate for natural drainage.

The combined proposed pumping stations are remarkably smaller than the Yen So pumping station. The pumping stations will be operated in the high water stages of the Nhue River. When the water stage is lower than the ground elevations, natural drainage is available. For this purpose floodgates are provided adjacent to the pumping stations.

The impact on the water quality is temporary and occurs mostly during flooding. The biggest impacts are during the construction work. The proposed reservoirs will cause local impact, especially the Co Nhue and the My Dinh as they are totally new reservoirs.

The channel improvements are concerned mostly with the re-construction of bridges to increase the flow in the channels. The amount of work and the number of bridges is high and will cause wide impact because work will be done along the whole river. Channel improvement and re-construction of bridges can cause erosion, decreasing the water quality.

(b) Mitigation of Adverse Impacts

In general, water quality in the Nhue River is a little better than in inner city rivers, because the flow and dilution are greater. Decreasing the water quality has to be prevented.

The exact location, size and shape of the reservoirs have to be planned to create as little impact as possible. Necessary site-clearance and resettlement has to be done in good time and negative socio-economic impacts must be mitigated. Soil subsidence and pollution or lowering groundwater has to be considered, as well.

Erosion and the increase of suspended solids have to be mitigated during all construction work. The quality of sludge and excavated soil has to be analyzed, and the location of possible contaminated soil has to be arranged without causing harm to people or environment. The amount of suspended solids in the river must not increase.

Work should be started downstream. General studies concerning fish and bottom fauna should be done before construction.

(5) Stormwater Sewers

(a) Environmental Impacts

Sewer construction is highly recommended because it decreases the impact of flood and inundation areas. Sewers instead of open channels, also usually improves the health situation. At the same time solid waste collection must be organized to ensure a cleaner environment

(b) Mitigation of Adverse Impacts

The location of soil and sludge during the construction work has to be done not to cause harm to the environment or the people who live in that area.

3.1.4 Associated Projects (By Other Agencies)

(1) Nhue River Improvement Project

- Right Bank Dike with Inland Drainage (Upstream from the To Lich Confluence)
- Nhue River Overall Improvement (Downstream from the To Lich Confluence)

(a) Environmental Impacts

The improvement of dikes and flood control usually has a positive socio-environmental impact. Damages caused by floods will decrease, and the living environment will be safer and more comfortable.

(b) Mitigation of Adverse Impacts

Designs and construction work of different projects should be coordinated to avoid overlapping and to minimize adverse impacts to the people and the environment.

(2) Red River Dike Reinstatement Project

(a) Environmental Impacts

The Red River Dike Reinstatement Project is to rehabilitate and reinforce the existing dike along the right bank of the Red River. The length of the dike to be improved is about 45 km. The construction method will be a combination of strengthening the dike foundation and facing the slopes with clay.

The maintenance and strengthening of the dikes will decrease leakages and erosion from both sides of the dike. This secures socio-environmental aspects.

(b) Mitigation of Adverse Impacts

Construction work has to be done without causing disturbances to the surroundings.

3.1.5 Non-Structural Measures

(1) Flood Plain Management

(a) Environmental Impacts

Urbanization is expanding rapidly in the southern and western parts of the city where there are serious inundation areas. In certain areas, even after the completion of the project, there will be inundation during very heavy rain.

Because it is not possible to change the growth development of the city, there should be methods to prevent and mitigate the damage caused by floods. These systems include controlling of reclamation heights, provision of access roads, conservation of rivers and lakes and the preservation of paddy fields and fishponds. People awareness should also be increased through training, preparing to help during flooding.

(b) Mitigation of Adverse Impacts

No adverse impacts.

(2) Provision of On-site Storage for New Estate Development

(a) Environmental Impacts

Urbanization is changing the land use and normal flood controlling in the newly developed areas, requiring a system to regulate the outflow from the catchment to the rivers and channels.

(b) Mitigation of Adverse Impacts

Storm waters should be held for considerable periods in the catchment area to reduce peak flow rates, and then discharged into rivers and drainage channels. Dissipation can also occur through infiltration, percolation and evaporation. Possible systems are : permeable pavement, infiltration trench and catch basin, infiltration wells and gutters.

There should be adequate storage ponds in the newly developed areas. This should already be taken care of during the planning and design of the land use in the new areas.

(3) Flood Forecasting and Warning System

(a) Environmental Impacts

Flooding starts within few hours after the beginning of rainfall. Usually there is no time or even need to evacuate people.

With respect to the floods caused by the Red River, the establishment of a warning system is effective in preventing damage. There will be a complex network of flood control and drainage facilities that will require close coordination between the different authorities and the pumping stations. There should be a telecommunication system between these places.

(b) Mitigation of Adverse Impacts

No adverse impacts.

(4) Public Information and Education Program

(a) Environmental Impacts

Damage and many problems can be avoided and mitigated if people know and are willing to do something to protect their houses and property. Nowadays people are quite passive and think that floods cannot be prevented.

There should be preparation of a flood risk map, boards to show the maximum water levels in the most serious places, and a campaign to increase awareness of how important flood control and drainage is. Information should also be provided in regard to the connection between flood controlling and cleaning of the channels and dredging of the lakes. The importance of a clean environment and hygiene has to be emphasized.

(b) Mitigation of Adverse Impacts

No adverse impacts.

3.2 Lake Conservation Projects

3.2.1 West Lake Conservation Projects

(1) Comprehensive Environmental Study

(a) Environmental Impacts

A detailed environmental study on the real situation of West Lake is essential before attempting any radical changes. The required studies include, regular water quality analyzing, amount and type of load into the lake, and studies concerning bottom fauna, other fauna and flora, algae and sediment. The study should include the whole catchment area, and special attention should be paid to socio-economic and land use aspects.

TUPWS has created a future land use plan concerned especially with construction of the West Lake catchment area, but not concerning the environment and socio-economy. There is proposal to make a separate West Lake master plan study.

(b) Mitigate Adverse Impacts

West Lake is one of the most important tourism areas and there are a lot of new houses. Construction of the area has to be planned and implemented so that the area will become inhabitable. Wastewater treatment and collection of solid waste has to be effectively arranged.

(2) Lake Shore Road / Park Project

(a) Environmental Impacts

Plans for the construction of West Lake shores are presented in the future land use plan prepared by TUPWS. According to the plan there will be park land in many areas between the lake and roads.

In general, the road around the lake in the city area is acceptable even environmentally, because there will be a buffer zone between the water and the road. The road at least prevents large scale construction work, but does not totally stop garbage disposal, and may even increase it.

(b) Mitigation of Adverse Impacts

The width between water and road has to be considered, as well as the use of that area, and how the shores can be strengthened. If there is only concrete, there will be no place for the natural water ecosystem, but it will be easier to keep the shores clean. Special attention should be paid to the maintenance of the park.

Drainage and discharge of storm water behind the road has to be arranged without causing any new swampy wasteland areas.

(3) Lake Sediment Dredging Project

(a) Environmental Impact

Until now, the dredging of lakes in Hanoi has not been exactly planned and the designs have not been followed through. The background information of the needs of dredging has been too limited, and the targets have not been clear enough.

The sediment thickness has to studied carefully, in order to determine the amount. The common opinion is, that there is several meters of sediment in the bottom of lakes, but there are no reliable studies to prove this.

Flood controlling and increasing the regulation capacity are not the only reasons for dredging, but also the improvement of water quality is very important. All the drainage, flood controlling and dredging work in West Lake should be planned and designed very carefully, considering the whole system. West Lake is the biggest lake in Hanoi, the water quality is a little bit better than in other lakes, and it is very probable that the ecosystem is more variable than in other lakes.

Because of the size and importance of West Lake, it is not possible to dredge the whole lake at the same time, and the location of the large amount of sludge has to be arranged. The impact of dredging is not as effective as in small lakes.

(b) Mitigation of Adverse Impacts

The need and impact of the dredging of West Lake has to be studied more carefully than other lakes. It would be better to start the dredging somewhere other than from West Lake.

Possible dredging has to done area by area. The amount of sludge has to be estimated carefully, and discharging the sludge has to be arranged so that it does not decrease water quality e.g. in the Red River.

3.2.2 City Lake Conservation Projects

(1) Lake Side Road / Park Projects

(a) Environmental Impact

Lakeside parks are recommended, especially around lakes which are used for recreation. Parks and roads around the lakes makes maintenance easier, and prevents landfilling and garbage disposal. At present, many lakeshores are paved with stones and concrete, and the natural or valuable shoreline ecosystem has been destroyed.

(b) Mitigation of Adverse Impacts

Maintenance and cleaning of parks has to be arranged well and illegal garbage dumping prevented.

(2) Lake Water Aeration Project

(a) Environmental Impact

The causes and not only consequences of eutrophication and anaerobic conditions have to be eliminated. The most important conservation method is decreasing the load to lakes, if that is not done, all other methods will not be effective.

Aeration is not the only method for improving water quality, and is usually not adequate when used alone. The lakes are very shallow, there is no stratification, and sometimes no oxygen at all. Aeration may also cause mixing of the sediment, temporarily increasing turbidity in the water.

With aeration, it is possible to decrease the load from the sediment, because aerobic conditions prevent the leaching of nutrients from the sediment and helps to decrease eutrophication. Increasing the oxygen in water improves the normal life and increases the number of species. There are only a few species which can survive in anaerobic conditions.

Improvement in water quality can usually be seen only after some time, and sometimes, in the beginning, water quality can even decrease, before the system settles down.

(b) Mitigation of Adverse Impacts

Aeration is a new conservation method in Hanoian lakes, and it would be practical to start with smaller lakes in order to gain practical experience about local conditions.

The origin of the load, water quality, bottom contours, and quality and thickness of sediment should be studied before starting aeration.

Practically, the aeration method should be selected with care. The method should be easy to use for operation and maintenance.

Aeration doesn't have a negative impact on the other lake uses, and doesn't prevent any other use.

3.3 Wastewater Disposal Projects

3.3.1 Pilot Wastewater Treatment Project

(1) Kim Lien Rehabilitation Project

(a) Environmental Impact

The rehabilitation of Kim Lien can be the first step in improving the existing sewage system. It would be beneficial if the existing facilities would be utilized as soon as possible. Kim Lien can be used as a pilot area, and also to estimate environmental improvement after wastewater treatment, as there are already some available data.

(b) Mitigation of Adverse Impacts

The operation and maintenance of the treatment plant, and the control of treated wastewater discharge points has to be arranged in sustainably.

(2) Truc Bach Wastewater Treatment

(a) Environmental Impacts

Truc Bach is situated next to West Lake and belongs to the same important tourism and recreational area. There are a lot houses around the lake. Truc Bach also belongs to Zone 1-1 in the wastewater disposal zoning and on-site/community treatment is proposed with septic tanks for residential areas and community plants for hotels. Truc Bach area is suitable to gain experience from small-scale wastewater treatment systems.

(b) Mitigation of Adverse Impacts

Water quality in Truc Bach and its treated wastewater quality has to be controlled.

(3) Lake Inlet Pollutant Load Reduction

(a) Environmental Impacts

One of the most important improvements in the quality of the environment is to reduce the wastewater load to lakes. For example, before it is possible to discharge wastewater to treatment plants, there should be interceptor chambers in the inlets. To use aquatic weeds, e.g., water hyacinths, bulrush or reeds for biological treatment is also recommended.

(b) Mitigation of Adverse Impacts

Interceptor chambers and aquatic treatment systems have to be maintained properly to achieve good results.

3.3.2 Centralized Wastewater Disposal Project

(1) Environmental Impacts (in general)

Wastewater disposal and treatment is an essential part of the improvement of the living environment and water quality. Without proper wastewater treatment the smell, insects, and health problems will constantly increase. The facilities of houses are getting better, increasing the amount of wastewater. At the same time demands concerning a better and healthier living environment are increasing.

Sewerage development zones have been divided according to the technical and economic study. Special attention has been paid to the quality of sewage, pollution load, and geographic conditions (Figure F3.3). Characteristics of zones and priority of implementation of zones is given in Table F3.1.

The first priority is to start the implementation from the inner city area where the problems are greatest. However, it is very important to develop simultaneously wastewater disposal and treatment in new construction areas. At the very beginning in the new areas, preparation for a water supply and wastewater system, and if possible wastewater treatment should be made, otherwise environmental problems will be more difficult to solve later. Sewer construction inside the houses should be done properly, especially in multi-storied houses.

Site selection of wastewater plants has been carried out according to the following concepts: The plants should be located at sites where wastewater from the sewered area can be mostly collected by gravity flow. There should be enough space to construct treatment facilities. The plants should be located at sites where environmental impact on the surroundings during the operation is not significant. The plants should be located near to the discharging points. Sites should be selected among green areas, farmland and open areas according to the Future Land Use Plan prepared by UPI. The plants should be located so that the treated wastewater may be reused as flushing water for rivers and lakes/ponds in the urban area during the dry season.

It might be difficult to find a suitable place for treatment plants in the city area, as there is not very much available land for this use, and a lot of land is needed for construction. It is very necessary to reserve suitable and as soon as possible,

because it will be more difficult in the future, and site-clearance and resettlement takes a long time.

The construction of wastewater treatment plants will not be completed for some time, causing environmental problems to increase. If it is not possible to speed up the construction schedule, priority should be given to improve, the cleaning of the house surroundings, collection of nightsoil, and the emptying of septic tanks. At present, the situation is unbearable, especially in multi-storied housing areas.

In general the same environmental impacts have to be considered inside and outside the city, but the level of demand is lower in the newly developed areas. These areas are not as densely populated as the old areas, and there is more available land. The proposed wastewater treatment systems are medium-scale, on-site/community, and in the rural area, no treatment at all.

(2) Mitigation of Adverse Impacts

The type and process of the wastewater treatment plant have to be selected in regard to technically reliability, and ease of operation and maintenance. The oxidation ditch method is recommended, because it is evaluated as the most moderate and all-round wastewater treatment method and is suitable for this kind of conditions. The maintenance has to be arranged on a sustainable basis. The possibility of overflow from the treatment plant has to be considered.

Very special attention has to be paid to the training of the staff. If the treatment process is not working correctly it will create more problems than benefits, especially, if a lot a untreated wastewater is discharged from one point.

When selecting the treated water discharge places, water quality and quantity must be considered. The quality of treated water has to be better than the water quality of the receiving waterbody, and there has to be enough water, especially in lakes, during the dry season. It is not good to discharge all treated wastewater far from it's origin. The dilution capacity of receiving water has to be adequate. Water in these areas cannot be used for domestic purposes.

Very special attention has to be paid to the water quantity of existing rivers and channels, which are also used for irrigation. There always has to be enough water in rivers and channels. If wastewater is discharged in sewers, it would be possible to discharge storm water to channels and rivers as is done at present.

The leakages from sewers should be minimized to prevent the contamination of soil and groundwater.

(3) Zone-2 Wastewater Disposal Project

- Wastewater Treatment Plant
- Wastewater Sewers

(a) Environmental Impacts

In the combined sewer area of the Old City, the population density is the highest, and the need for wastewater collection and treatment is the most urgent, and also technically very difficult. It is necessary to have at least some

kind of wastewater treatment system. Any improvement is better than the present situation where wastewater is discharged directly to lakes and rivers.

A large-scale centralized system has been proposed for Zone-2, which has been divided into two parts. Zone 2-1 is located in the Ancient City and Old City areas and has the first priority for implementation. The proposed wastewater treatment plant for Zone 2 is located in Tran Phu, in Zone 7.

Zone 2-1 is densely populated, the condition and amount of sewers is inadequate, and the environmental problems are the greatest. Therefore, the need for a wastewater disposal and treatment system is the most urgent.

Wastewater will be discharged into the Kim Nguu River, which can be considered nowadays as an open channel and not a real river, and cannot be used for any purpose other than wastewater discharge.

In Zone 2-2 the population density is not very high, but there are a number of industrial areas. A large-scale centralized system is proposed, and its implementation priority is five.

(b) Mitigation of Adverse Impacts

A large-scale centralized system is the only possible system, because there is no place for any kind of on-site/community treatment in densely populated areas. The amount and quality of the water in the city lakes and rivers has to be guaranteed after implementation.

(4) Zone-3 Wastewater Disposal Project

- Wastewater Treatment Plant
- Wastewater Sewers

(a) Environmental Impact

Zone-3 is densely populated, and there is also new construction areas. Priority is three. A medium-scale centralized system is proposed, and will be located in Lang Ha in Zone-3 or Trung Hoa in Zone-5. Treated wastewater will be discharged to the To Lich River.

(b) Mitigation of Adverse Impacts

A centralized system is the only possible system, because also there is no available land. The amount and quality of the lake water has to be guaranteed after the implementation.

(5) Zone-4 Wastewater Disposal Project

- Wastewater Treatment Plant
- Wastewater Sewers

(a) Environmental Impacts

In Zone-4, the population density is very high, and therefore the implementation priority is two. A medium-scale centralized system is proposed, and will be located at the Bach Mai Airforce area in Zone 6-1, or if that is not possible in Trung Hoa in Zone-5. Wastewater is discharged into the Lu River, which is considered an open channel.

(b) Mitigation of Adverse Impacts

A centralized system in the only possible system, because there is no available land. The amount and quality of the lake waters have to be guaranteed after the implementation.

(6) Zone-5 Wastewater Disposal Project

- Wastewater Treatment Plant
- Wastewater Sewers

(a) Environmental Impact

In Zone-5, the population density is not very high, and there are also many open areas and paddy fields. The priority of implementation is seven. However, this area is one of the future developing areas. A medium-scale centralized system is proposed and the location of the treatment plant is in Me Tri. Wastewater is discharged into the Nhue River.

(b) Mitigation of Adverse Impacts

For future needs, a centralized system is recommended.

(7) Zone-6 Wastewater Disposal Project

- Wastewater Treatment Plant
- Wastewater Sewers

(a) Environmental Impact

Zone-6 is divided into two parts. The implementation priority of Zone 6-1 is six, and Zone 6-2 is eight. Zone-6 is in the future development and industrial area. A medium-scale centralized system is proposed and the location of the treatment plant is Tan Trien.

(b) Mitigation of Adverse Impacts

For future needs, a centralized system is recommended.

3.3.3 On-Site Wastewater Treatment Project

(1) Zone-1 Community Based Treatment Project

(a) Environmental Impact

Zone-1 is divided into two parts, Zone 1-1 covers the area around West Lake. The implementation priority is four, because the West Lake sub-basin will be the core of the tourist and recreational area of Hanoi.

An on-site community disposal system is the most suitable system for Zone 1-1 in regard to minimizing the environmental impact according to the development of land use and geographical conditions. The proposed system is a semi-closed system according to the existing six drainage sub-basins. These are presented in the future land use plan prepared by TUPWS, according to the Hanoi City Master Plan.

Zone 1-2 is mostly a low populated rural area. The implementation priority is nine and proposed method is a community treatment system. Wastewater is discharged into the Nhue River.

(b) Mitigation of Adverse Impacts

Special attention should be paid to Zone 1-1 although it is not as highly populated as many other areas. Wastewater is discharged into the West Lake, those condition must be considered very carefully.

(2) Zone-7 Community Based Treatment Project

(a) Environmental Impact

Zone-7 consist mostly of paddy fields and fishponds. The population density is very low compared with other areas. An on-site/community system is proposed and the implementation priority is ten. Wastewater is discharged into the To Lich River.

(b) Mitigation of Adverse Impacts

The amount of wastewater is quite small compared with the flow of To Lich River. On-site treatment is adequate for rural areas.

3.3.4 Flushing Water Diversion Project

(1) Environmental Issues (in general)

The amount of water in inner city lakes and rivers should be kept as it is now or even increase the amount especially in dry season to avoid the situation that lakes will be become stinking, shallow and covered with water plants. Landfilling of inner city lakes should be stopped, and there should be enough place for storm water to be used as flushing water.

The demand of flushing water will be quite stable through the year, and also quality of used water should be stable. However, water quality of the Red River, especially amount of suspended solids, varies remarkably during the year. In rainy season amount of suspended solids can be several kilograms/mg and in dry season only few grams/m^3. Besides that it is not possible to estimate the changes between different years. This means that it is not possible to guarantee and control the quality of flushing water.

The water used for flushing needs at least pre-sedimentation before pumping into inner city water system. Otherwise the amount of sedimentation in lakes would increase. Diversion of river water with high amount of suspended solids might also disturb the results of possible aeration of lakes and decrease the impact of dredging. All this is against the ideas and targets of restoration and conservation plans, and improvement of water ecosystem.

Construction of pumping station is not enough, but there should also be a place for sedimentation unit. It has been noticed that sedimentation is difficult process in this kind of river water and use of chemical has to be selected carefully. One of the biggest problems will be the maintenance of diversion system which has to be kept clean and solid waste disposal has to be prevented, same as sedimentation and erosion.

Other possibilities than diversion from the Red River should be considered, too. However, this plan will be implemented after quite long time and before that all possible solutions and impacts should be studied. If the level of waste water treatment is good enough it might be possible to discharge also diluted treated waste water into lakes.

To make the decision and design there should be more information about water quality and ecosystem in lakes, rivers and channels. According to the present knowledge diversion of flushing water from the Red River to inner city lakes and rivers is not recommended for environmental reasons, but further studies will be needed.

(2) Assessment of Proposed Plans

- Nhue Pumping Station/Diversion Channel
- To Lich Diversion Weir
- Canals and Pipes in the City Area

(a) Environmental Impacts

The source for flushing water is proposed to be from the Red River near the To Lich River where there is adequate flow. The impact on the improvement of the water quality is not effective, and the costs are too high compared with the advantages. The extension of channels and pipes for the flushing water has to be considered carefully. These projects will be implemented only if necessary and implementation time is very far in the future.

(b) Mitigation of Adverse Impacts

Flushing can cause more disadvantages than advantages, and therefore the real need has to be analyzed before any construction.

3.3.5 Associated Project (By Other Agencies)

(1) Upgrading/Increase of Public Latrines

(a) Environmental Impact

Increasing the number and quality of public latrines is very important, because in certain areas the number of people who are using the same latrine can be very high. Information on how to keep latrines clean should also be given to the people. Because there is lack of latrines, people are using lake, river, and channel shores as "public toilets".

All this causes serious health, hygiene and odor problems in several places, and decreases the environmental quality of even the most important lakes, including Hoan Kiem. Because of this low hygienic level there are a lot of intestinal diseases.

(b) Mitigation of Adverse Impacts

The number and quality of public latrines should be increased rapidly. The cleaning and maintenance of latrines and the collection of excreta have to be arranged so that there will be no mitigation of environmental quality. Overhung latrines from the shores of lakes, rivers and channels should be removed.

(2) Reinforcement of the Domestic Waste Collection System

Solid waste collection / disposal

(a) Environmental Impact

For many reasons, reinforcement of garbage collection is one the most important aspects in improving, the quality of the environment hygiene, and health conditions. Direct influences on the environment are, less organic matter and nutrients, less odor, less insects and animals, less chemicals and heavy metals, and less bacteria.

Presently solid waste fills the channels and disturbs the hydraulic condition and decreases flow. If channels can be kept open, it will also mitigate floods and the needs of dredging.

It is essential to offer institutional reinforcement and training at the same time to get the most effective results. Authorities provide instructions and regulations on how to organize garbage collection. People have to be advised to dispose of garbage correctly. The importance and reasons for garbage collection have to be made clear, so that people can understand how they can improve their own living conditions.

Training and collection is not enough, so arrangements must be made for the transportation and re-cycling/destroying of garbage. The quality of the environment does not change, if the problem is only moved from place to place.

(b) Mitigation of Adverse Impacts

The whole chain from collection to transportation and location of the garbage has to be planned at the same time. There should be several dumping-grounds and especially composting areas.

Sorting and re-cycling of garbage is quite common, and it should be encouraged, to decrease the load to the dumping-grounds.

Instructions, regulations and training will help achieve results, and also increase environmental knowledge.

(3) Nightsoil and septic tank collection system

(a) Environmental Impact

The impact of the collection of nightsoil is nearly the same as the collection of solid waste. Nightsoil collection is very important especially in improving hygiene, health conditions, and water quality.

Any reduction of load is better than the present situation, because in practice there is a lot of overflow from septic tanks, which are not emptied frequently, if at all. There are also holes in tanks, often made on purpose, so that septic tanks leak and contaminate the soil and groundwater.

Institutional reinforcement is essential as well as training of the people about the health risks associated with the miss-handling of nightsoil.

(b) Mitigation of Adverse Impacts

The improvement of nightsoil collection must co-incide with the education in the proper way to use nightsoil as fertilizer, presently raw nightsoil is used as fertilizer. There should be enough composting areas to stabilize the nightsoil.

It is absolutely forbidden to empty the contents of septic tanks in to lakes, rivers and channels.

3.3.6 Non-Structural Measures

(1) Household's Obligation of Installing Septic Tanks

(2) Provision of Soft Loan for Installing Septic Tanks

(a) Environmental Impact

All possibilities which reduce the load to the sewer system or environment are recommended. Regulations are necessary as "tools" for the authorities. Only

training or legal enforcement are usually inadequate, so there should be some financial or other benefit offered to get the idea approved. Adequate septic tanks should be demanded in all new houses.

Besides installing septic tanks, maintenance and emptying should be organized at the same time, to achieve the best results.

(b) Mitigation of Adverse Impacts

No adverse impacts.

(3) Effluent Pretreatment by Industries

(a) Environmental Impact

Industries discharge the most harmful wastewaters, which contain all kinds of chemicals, heavy metals, oils and fats.

The first step for regulations is that factories have to inform which chemicals and other harmful or hazardous items they are using in their process. It has to be possible to take samples and analyze the content of the solid waste, wastewater and air. Presently some factories refuse to give permission to take samples.

The pre-treatment of wastewater is necessary in factories, and it can often be arranged in a simple mechanical way using an interceptor, sedimentation, and/or filtering.

There should be standards set for the condition of sewers and other facilities in factories. A major problem is that many factories are old, and in such bad condition that repairing is impossible, and they should be closed down.

Especially for new enterprises, there should be strict regulations and location permission. The new environmental law will help in this problem, at least in theory.

(b) Mitigation of Adverse Impacts

The location of the sludge has to be arranged properly to ensure there will be no harm to the people or environment.

(4) Public Awareness Campaign

(a) Environmental Impact

There is already some experience of campaigns. TV-programs, advertisements, posters, training in phuongs, and training at schools, which is especially necessary, when thinking of the future, are all effective.

It is necessary to add general awareness and the level of knowledge concerning drainage and sewerage and at the same time environmental issues. The connection between the level of wastewater treatment and the quality of the environment and health is not made clear enough for the people.

There should be information how wastewater moves from homes through the pipes/channels, to the lakes and rivers, and what are the contents and effects of the wastewater. Also the meaning of wastewater treatment should be clarified.

People should know what they can do themselves, to have a better and healthier environment, e.g. building and using of latrines, no spilling of garbage, no breaking of sewers, etc.

The upgrading/reinstatement of septic tanks is useful, but it should be also stressed why septic tanks and their maintenance are necessary, and what the people can do to improve their own living conditions.

(b) Mitigation of Adverse Impacts

No adverse impacts.

(5) Wastewater Quality Monitoring Program

(a) Environmental Impact

To get enough frequent and reliable information about the wastewater quantity, it is very important to support and enlarge the on-going Wastewater Quality Monitoring Program carried out by HSDCo.

(b) Mitigation of Adverse Impacts

No adverse impacts.

F4. ENVIRONMENTAL IMPACT ASSESSMENT OF HANOI CITY DRAINAGE AND ENVIRONMENT IMPROVEMENT PROJECT

4.1 Description of the Project

In the Hanoi City Drainage and Environment Improvement Project there are two main objectives: 1) to improve the drainage system in the city and to reduce disadvantages and damages caused by floods, 2) to improve the living environment in the city, particularly concerning health and hygiene.

The Project will be implemented in two stages. The First Stage Project will be implemented immediately, and financing is proposed to be covered by the OECF loan program. The First Stage Project will deal with the following components: 1) construction of drainage facilities in the To Lich River Basin, including the Yen So pumping station and regulating reservoir, 2) urgent supply of dredging equipment to clean sludge and sediments from sewers and drainage channels and 3) engineering services covering the detailed design and construction supervision.

An environmental Impacts Assessment has been done concerning the implementation of the First Stage.

4.2 Identification of Environmental Issues

4.2.1 Socio-economic Issues in the Total Study Area

(1) Area and Population

The total area of Hanoi is 924.5 km^2, of which 135 km^2 covers the area of the Study on Urban Drainage and Wastewater Disposal System in Hanoi City. The area of the To Lich River Basin Drainage Project is 77.5 km^2.

The total population of Hanoi city was estimated to be 2.1 million in 1992. The population of the Study Area is about 1.2 million, and the population density is 93 persons per ha. In the four urban districts, population density is 241 persons per ha, which means that Hanoi is one of the most densely populated areas in the world. The highest population density is in Hoan Kiem District, where there are 410 persons per ha. The most densely populated phuong is Hang Bo, where the density is 1263 persons per ha. In the suburban districts the population densities are lower and varies between 20 - 30 persons per ha.

The average size of the household in Hanoi is about 4.3 persons. In the urban districts the average size is 3.9 and in the suburban districts 4.5. The total number of households in the Study Area is estimated to be about 280,000.

(2) Health Situation

Water related diseases consist of diarrhoea, dysentery and other intestinal problems. Eye diseases are also common. Other diseases such as typhoid, cholera and polio have seldom been recorded in recent years. The official statistics show a

low number of patients, as only serious cases are treated by doctors. The amount of medical facilities in Hanoi seems to be sufficient, but the quality, including equipment and medicine, is inadequate, particularly in rural areas.

Personal hygiene is better than many other developing countries. The morbidity and mortality rates indicate that the health status seems to be better or at least average compared with other countries of similar income level.

(3) Regional Economy

The regional economy of Hanoi has developed, and the structure of the economy has changed, very rapidly after the economic reform in 1989. Agriculture shares only 6 % of the Regional Gross Domestic Production (RGDP), but 35 % of the employees. Respectively, industry shares 23 % of RGDP and 34.5 % of employees. The service sector, including finance and insurance, shares 39 % of RGDP, and is growing all the time. The importance of tourism is also growing rapidly.

The growth rate of RGDP in Hanoi is 11.8 % per annum, which is remarkably higher than the national average growth rate, which is 6.8%. The rate of unemployment is estimated to be 7.6 % in Hanoi city.

Although services, industry and other business are becoming more and more important, agriculture still has an important role in Hanoi. Agriculture land in the total study area is about 4,700 ha, or 35 % of the area. The main products are rice, vegetables, maize, potato and sweet potato. Drainage is a big problem also in agriculture, and it is estimated that 1,900 - 2,400 ha or 40 - 50 % of the agricultural land is inundated yearly.

Fisheries are another important livelihood in the study area. Most of the lakes in the Project area are used for fishery. West Lake is the most important for fisheries. The cultivated fish species include tilapia, carp, and black carp. In the total study area, about 5,000 tons of fish is harvested yearly. Fish farming is also being affected by floods and water pollution.

The tendency is to move industry from the most densely populated inner city area to the suburban and special industrial zones, but it will take long time for many small industries to be relocated, which can cause even hazardous pollution of environment.

The amount of traffic, and especially motorbikes, is growing very rapidly, and causing traffic jams, accidents and pollution air. Traffic will be one of the biggest problems in the future.

4.2.2 Environmental Problems

(1) Nature and Parks

Land in urbanized Hanoi is already effectively used, and there is hardly any original environment anymore. The impact of humans on the environment is very great. However, there are a lot of parks and avenues enhancing the environment. There are also many parks around the inner city lakes, but maintenance is insufficient, and they are very worn-out and dirty.

On one hand, the environment is worsening, but on the other hand, demands for a better environment are growing. The recreational use of lakes and parks is quite effective. Lakes and parks also play an important role in tourism.

(2) Wastewater and Solid Waste Disposal

The lack of wastewater treatment, the poor condition of sewers, and the lack of proper collection of solid waste and night soil, are causing the biggest and the most serious environmental problems for Hanoi.

There are not enough sewers, and untreated wastewater is discharged through the open channels into lakes and rivers. This causes odor, health problems, and creates a dirty and uncomfortable living environment. The purification capacity of the receiving water bodies has already been exceeded.

Economic growth and the development of industry will increase the amount of wastes, and the number of risks and stress for the environment. The standard of living is increasing very rapidly, and the amount of wastewater will also increase with the level of facilities. Also the amount of solid waste is increasing, and garbage is very often thrown straight to the water or the banks.

(3) Floods and Inundation Areas

During the rainy season there are repeated floods in certain low-lying areas, where the capacity of sewers and drainage channels is inadequate. Floods are frequently causing serious problems and disturbing normal existence.

The improvement of the drainage system in Hanoi will have a direct and/or indirect impact on the biggest part of the inhabitants of the city, especially in the inner city area, where there are several inundation areas and many lakes, rivers and channels. The most serious and largest flooding areas are located on the main streets, where traffic is also heavy. The disturbance of traffic causes the biggest impact to daily life, as people have to travel through inundation areas, although their houses and/or working places are in dry areas.

Floods cause serious damage not only to the houses but also to streets, water supply network and sewers. During flooding, rain water will create holes in the streets and disperse sand, gravel and garbage everywhere. Storm water penetrates into wells and water pipes and pollutes the water. During heavy rain, there is an overflow from the sewers that do not have the capacity to carry both sewage water and storm water.

Epidemics are possible during floods, as people must wade through deep polluted water. Flooding also occurs in the houses. The collection of garbage is not possible during flooding, and rotten garbage in the houses can cause health problems.

Personal losses and damages to property are increasing with the standard of living. Shopkeepers with large stores should be especially protected against floods.

4.2.3 Condition and Use of Lakes, Rivers and Channels

(1) Water Quality

There are no long-term water quality analyses, but according to the available data and site visits it is clear that all the lakes and rivers are at least moderately polluted, and the channels are highly polluted. The results of water quality studies from September 1994 are presented in Table F2.4.

The water is considered to be polluted when BOD is higher than 15 mg/l. The highest results are from lakes where there is a direct discharge of wastewater. The water quality in all water bodies will worsen, if the discharging of wastewaters continues as present untreated.

All the lakes are quite shallow, and can be covered by water hyacinths, if there is no harvesting and conservation. Floating plants will grow phenomenally, producing thick floating mats. From the viewpoint of aquatic ecology, these mats can dramatically upset the oxygen balance of lake, because decomposition increases the oxygen demand.

The dredging of bottom sediments, increases the volume of lake, and mitigates the internal load. In the long run the only way to improve water quality in lakes is to decrease the nutrient load discharged into them.

(2) Nutrient Load

Nutrients enter into lakes from several different sources. The main source in Hanoi is direct lakeside inputs through human activities, as domestic and industrial wastewater is discharged directly into the lakes.

Storm water may contain high concentrations of suspended solids, phosphorus, ammonia and nitrate as well as iron, silica and salts and different kinds of bacteria and virus.

Lake sediment is also a very important source of nutrients including the resuspension of sedimented material and the decomposition of vegetation. Recently groundwater input as well as atmospheric precipitation and dry fall out are usually small.

Nutrients can be expelled from the lakes through discharge, sedimentation or harvesting of biomass.

(3) Use of Lakes, Rivers and Channels

The lakes, rivers and channels are used to collect, to drain and to treat wastewater and storm water. Most of the lakes are overloaded by organic wastes and nutrients, and at least, the bottom layer and sediment are anaerobic.

With the effective circulation of water, aeration, and the harvesting of water plants, lakes could receive the domestic wastewater of half a million people. However, the maximum utilization of biological productivity does not harmonize with other uses of the city lakes.