5.3 Conditions for Privatization

5.3.1 General Aspects of Privations

Privatization of state enterprises and institutions in Albania started in 1991, when Law 7512 (dated August 10, 1991) "On Sanction and Protection of Private Property and the Free Initiative of Independent Private Activities and Privatization" came into effect. After the law was enacted, many state-owned enterprises have been privatized in two ways: (1) privatization; and (2) creation of joint-venture enterprises with foreign partners. The following list shows the stages involved in Albania's move towards privatization.

- Stage one: privatization of commercial and trading enterprises
- Stage two: privatization of small- and mid-scale construction enterprises
- Stage three: in 1995, the voucher system was introduced and the privatization process for large-scale enterprises was commenced

Since 1992, 160 enterprises have either been privatized or have been slated to be privatized. The number of enterprises actually privatized is as follows: three in 1992, 49 in 1993, 44 in 1994, 20 in 1995 and nine in the first half of 1996. Out of the 160 enterprises, 22 companies are joint-ventures, and 125 enterprises had been privatized as of June 1996.

Many enterprises have been privatized—for example, all construction enterprises have been privatized--, however, conditions of the state-owned enterprises at the time of privatization was very grave. These enterprises were almost not functioning, and were having financial difficulty to the point that it was difficult to support even their basic operations. Moreover, their technology was obsolete, and they had a surplus of manpower on the payroll. Due to these conditions, the only way to save them from bankruptcy was to transform them into private companies.

5.3.2 Executive Organ in Charge of Privatization

Each year, the Ministry of Finance decides which enterprises will be privatized. Based on this schedule, the candidate enterprises then prepare documentation which state the value of the enterprise, its location, and projects currently underway.

These documents are then distributed to the District Council, the specific Ministry the enterprise is dependent on, the Ministry of Finance and the National Privatization Agency, which is responsible for the actual privatization process. The enterprises which are dependent upon local governmental organs (districts and municipalities) prepare the documentation and pass them to the local governmental organs and the National Privatization Agency. With the new government established after the May 1996 elections, the Ministry of Privatization was established, so the above procedure has now been changed.

5.3.3 Privatization of Water Supply and Sewerage System Enterprises

To cope with the process of privatizing water suppliers and providers of sewerage services, Law 8103, along with Law 8102 (both enacted on March 28, 1996) "On Regulatory Frameworks For Water Supply, Sewerage Systems And The Waste Water Treatment Sector" were enacted. This took place after the enactment of other laws regarding public enterprise privatization, such as Law 7512 (1991), "On Sanction and Protection of Private Property, Free Initiative, Free Private Activities, and Privatization"; Law 7582 (1992) "On State Enterprise"; Law 7638 (1993) "On Commercial Companies"; and Law 7926 (1995) "On Concession and Participation of Private Sector in Public Service and Infrastructure".

As demonstrated by Law 8103, it is very clear that the government intends to privatize the water supply and sewerage system enterprise. However, this law does not explicitly lay out a procedure for privatization; rather, it just says "they may become private companies." The World Bank is doing a preparatory study on the privatization of the Tirana Water Supply Enterprise, which is slated to be completed by July 1997. But, it is not clear whether the water supply and sewerage enterprise enterprises will be fully privatized, or privatized partially using BOT, BOO or another such method.

5.3.4 Privatization of Water Supply Enterprise of Tirana

Water supply is one of the most strategic elements of economic development. The Albanian government has decided to privatize the Tirana Water Supply Enterprise, and a World Bank project is now underway to make the preparation stages of this possible. This project was started in July 1996. The first phase was completed in November 1996, and included a physical inventory of the fixed assets of the Enterprise. The second phase includes the preparation of the required documentation and arrangements, and opening the bidding for selling the Enterprise. The preparation phase and also the identification of strategic investors is slated to be finished between March and May of 1997. In May, bidding of the Enterprise will commence. This process is planned to be completed by July 1997 at the latest.

However, informal discussions are still continuing on the issue of privatization, regarding whether or not it is feasible to take the Enterprise to the private sector A major point of discussion is that the total privatization of a water supply enterprise may not be a good solution, and a consortium might be more suitable for providing better water supply services to consumers. So far, there are only two French companies showing interest in buying the Water Supply Enterprise : Layonnaise Des Eaux; and Sogea.

CHAPTER 6

WATER QUALITY EXAMINATION

CHAPTER 6 WATER QUALITY EXAMINATION

6.1 General

A series of water quality examination was conducted as a part of the field work in the Study to grasp characteristics of wastewater being discharged from different pollution sources and to reflect upon the framework of future sewerage system as well as identification of urgent/priority project for improvement of urban environment and conservation of public water body.

Water sampling was carried out at different sampling locations covering the Tirana River, the Lana River and existing sewer lines to obtain water samples of domestic sewage, and at discharge points of industrial and agricultural wastewater. Water sampling/examination was repeated in two different seasons; dry season in September to October, 1996 during the Stage 1 field work and rainy season in January to February, 1997 during the Stage 2 field work.

Existing laws and regulations pertaining to the environmental conservation, hygiene and sanitation were also reviewed to reflect upon the evaluation of water quality examination results and the framework of future sewerage system.

Current water pollution conditions were likewise evaluated based on the above mentioned water quality examination and study results.

6.2 Laws and Regulations on Environmental Protection

At present, the "Law on Environmental Protection" is effective pursuant to Article 16, No. 7491, dated August 1991 "on the main constitutional dispositions" at the proposal of the Council of Ministers, the People's Assembly (national congress) of the Republic of Albania and under jurisdiction of the "Committee of Environmental Protection" in the Ministry of Health and Environmental Protection (hereinafter referred to as the "MOHEP"). The official English translation of the said Law on Environmental Protection is contained in Supporting Report 6.2.1.

For execution of this law, the "Guideline for Environmental Impact Assessment" has been drafted by the MOHEP and is subject to the adoption by the People's Assembly. This guideline is available only in Albanian language and no English translation has been issued yet.

In the execution of Environmental Impact Assessment (EIA) in this Study, the said law and guideline will be referred to in principle and the implementation detail will be subject to mutual discussion and agreement with the Committee of Environmental Protection.

6.3 Water Quality Examination

6.3.1 Water Sampling Program

(1) Restrictive conditions on water quality examination

Prior to the preparation of water sampling program, Albanian organizations undertaking water quality examination were inquired to identify their capability. Two official institutes responded as follows:

1) The Institute of Public Health (Ex. Research Institute of Hygiene and Epidemiology)

This institute is attached to the MOHEP and is only one official organization which undertakes research and examination of public hygiene and sanitation aspect. However, due to recent change of social, administrative and economic set-up of the country, some laboratory apparatus, particularly BOD examination instruments, have not been properly maintained and spare parts are not yet procured. BOD examination acceptable at present are limited to only four (4) water samples at one time and other water quality indices are also limited to 10 to 20 samples at one time.

To improve present equipment and facilities in the institute, the Swiss government has commenced the technical and financial assistance in sometime August, 1996. Partial delivery of laboratory equipment has also been started, but massive improvement and modernization will take considerable time.

The water sampling program was then formulated taking into account the above mentioned capability of the institute.

2) Tirana University

The university is closed until the beginning of October and is not available to analyze BOD. Owing to this situation, this university was excluded from programming water quality examination.

(2) Water sampling program

Water sampling program was prepared to cover the following survey points as originally planned in the Inception Report and indicated in Figure 6.3.1.

1) Tirana River (each one point in upstream and downstream)
2) Lana River (each one point in upstream and downstream)
3) Domestic sewage (4 points)
4) Industrial wastewater (4 points) and agricultural wastewater (2 points)

Numbers of water sample were however reduced to a total of 66 samples in each season, due to the aforementioned capability of the Institute of Public Health. To compensate these restrictive conditions on water quality examination, composite samples were prepared by mixing individual samples collected through 4 hour interval from 6:00 to 22:00 at respective sampling points (Tirana River, Lana River and domestic sewage). The rest of water samples individually collected from factories and agricultural area were examined for each water quality indices including BOD.

Table 6.3.1 shows the water sampling program implemented during the Stage 1 field work. The same program was repeated during the Stage 2 field work in January and February, 1997.

A series of water sampling was carried out by four times from September to October, 1996 and from January to February, 1997 according to the sampling schedule as shown in Table 6.3.2.

In addition to the above, supplemental water sampling and water quality examination were carried out at the discharge point of the proposed sewage treatment plant to the Tirana river.

Table 6.3.1 Water Sampling Program in Each Season

Mode of Sampling and Water Quality Analysis	Tirana River	Lana River	Domestic Sewage	Industrial Wastewater	Agricultural Wastewater
1. Sampling Location	1-Upstream 1-Downstream	1-Upstream 1-Downstream	4-Sewer Line	4-Discharge Point	2-Discharge Point
2. Sampling Method (1) Frequency	Once	Twice	Once	Once	Once
(2) Individual Sample	4 hour interval 6:00, 10:00, 14:00, 18:00 and 22:00			One time	
(3) Composite Sample	1-composite sample by mixing of 5 individual samples for every sampling point			No composite sample	
3. Water Quality Analysis (1) BOD, COD, SS, pH, Temp., Transp., Coliform	2-composite samples	4-composite samples	4-composite samples	4-individual samples	2-individual samples
(2) COD, SS, pH, Temp., Trans., Coliform	10-individual samples (5 samples x 2 points)	20-individual samples (5 samples x 2 points x 2 times)	20-individual samples (5 samples x 4 points)	Not applicable	

Table 6.3.2 Sampling Schedule

Series of Sampling	Tirana River	Lana River	Domestic Sewage	Industrial Wastewater	Agricultural Wastewater	Total
1st Batch	2 points	2 points				4 points
(Sep. 26, '96 & Jan. 15, '97)						
Composite Sample	2*	2*				4*
Individual Sample	10	10				20
2nd Batch		2 points	2 points			4 points
(Oct. 2, '96 & Jan. 22, '97)						
Composite Sample		2*	2*			4*
Individual Sample		10	10			20
3rd Batch			2 points	2 points		4 points
(Oct. 9, '96 & Jan. 29, '97)						
Composite Sample			2*			2*
Individual Sample			10	2*		10+2*
4th Batch				2 points	2 points	4 points
(Oct. 16, '96 & Feb. 5, '97)						
Composite Sample						
Individual Sample				2*	2*	4*
Total	2 points	4 points	4 points	4 points	2 points	16 points
Composite Sample	2*	4*	4*	-	-	10*
Individual Sample	10	20	20	4*	2*	50+6*

Note: Samples marked "*" are subject for BOD analysis.

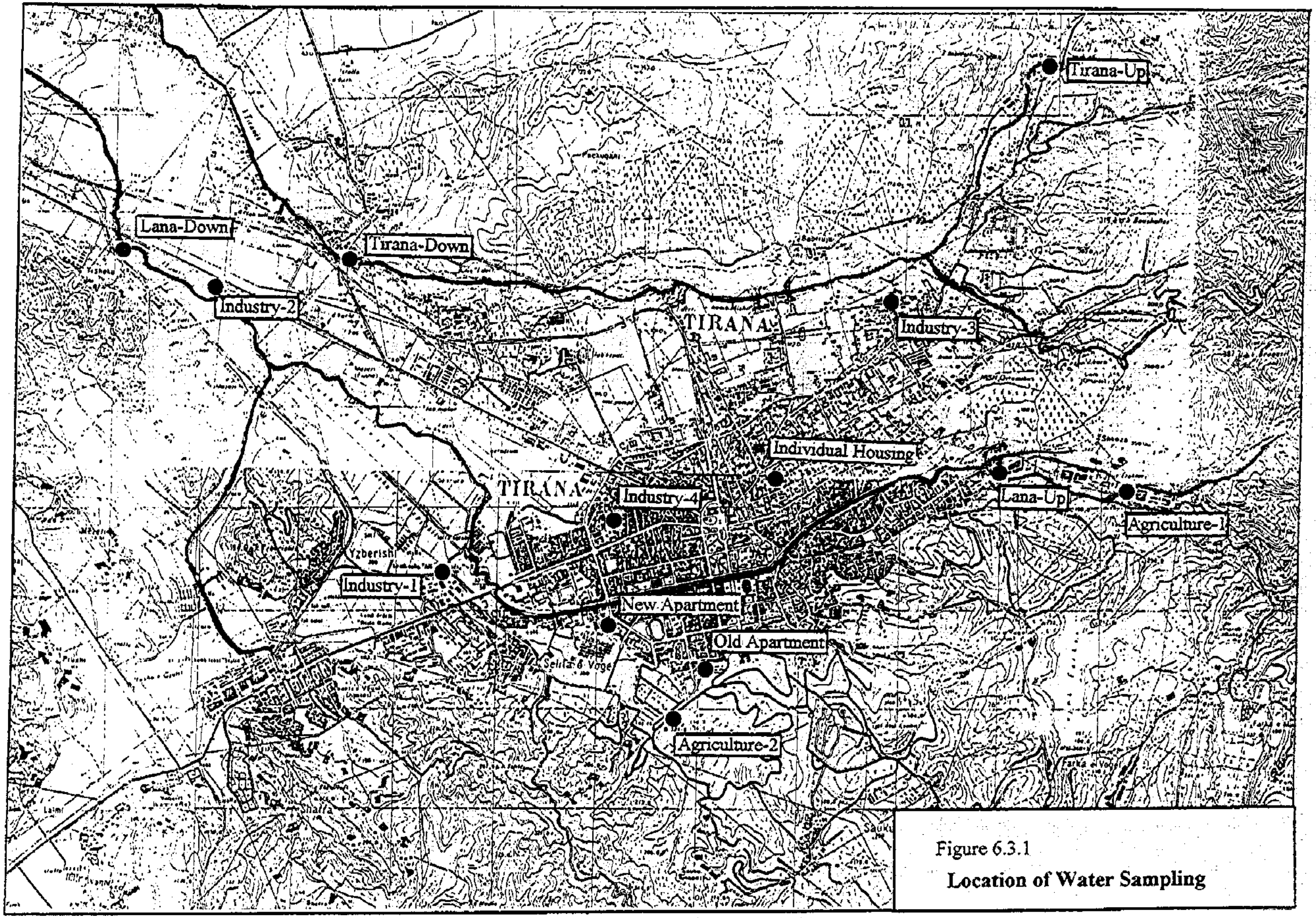


Figure 6.3.1
Location of Water Sampling

6.3.2 Examination Results

The water quality analysis results of dry season conducted during September to October in 1996 were submitted by the Institute of Public Health. These results were carefully reviewed and evaluated to clarify the current water pollution conditions and characteristics of wastewater discharged from different pollution sources. While the results for rainy season conducted during January to February, 1997 were submitted by the same institute in February prior to departure of the Study Team from Tirana.

Detailed water quality examination results and field observation results are contained in Supporting Report 6.3.1 and 6.3.2, respectively.

It should be noted that slight rainfall was observed on two days before sampling date of Batch 1 (September 26, 1996) in dry season, while no rainfall was observed throughout the sampling period in rainy season (January to February, 1997). Thus, these analysys results shall be considered to represent water quality in sunny days.

6.3.3 Current Water Pollution Conditions

(1) River water

A simultaneous sampling at upstream and downstream of the Tirana River and the Lana River was carried out. The same manner of sampling was also applied to the Lana river and domestic sewage to wit relationship between pollution sources and receiving water body.

BOD and COD at these sampling points are summarized in Table 6.3.3.

In the Tirana River, BOD of composite sample at upstream was only 2 mg/l, while that of downstream was about 20 to 23 m/l. COD analysis results also indicate the same tendency; 3 to 4 mg/l at upstream and 29 to 34 mg/l at downstream.

With regard to the Lana river, average BOD and COD at upstream were 23 to 36 mg/l and 33 to 45 mg/l, respectively. In the downstream, these water quality indices were 42 to 73 mg/l and 57 to 90 mg/l, respectively. In general, water quality in rainy season was approximately 50 % higher than that in dry season.

Table 6.3.3 Water Quality in the Tirana River and the Lana River

Unit: mg/l

River	Season	Upstream		Downstream		Discharge Point of Treated Effluent	
		BOD	COD	BOD	COD	BOD	COD
Tirana River	Dry	2	4	20	29	-	-
	Rainy	2	3	23	34	31 & 24 Ave. 28	42 & 35 Ave. 39
Lana River	Dry	22 & 23 Ave. 23	32 & 33 Ave. 33	34 & 49 Ave. 42	44 & 70 Ave. 57	-	-
	Rainy	29 & 43 Ave. 36	39 & 51 Ave. 45	62 & 83 Ave. 73	80 & 100 Ave. 90	-	-

Note: Data of upstream and downstream are referred to composite samples.

As a whole, it is obvious that the absence of sewage treatment plant has been causing serious water pollution at downstream of the Tirana River and the Lana River.

The agricultural wastewater sampled at the uppermost stream of the Lana river was only 2 mg/l of BOD. This result could be considered as the natural pollution load of the Lana river and equivalent to the upstream of the Tirana River.

(2) Domestic sewage

Water sampling was carried out at three different localities, namely new apartment building area, old apartment building area and individual housing area. Sampling at new apartment building area was carried out for two times in each season.

BOD and COD examination results of composite samples are as follows:

Table 6.3.4 BOD and COD of Domestic Sewage (Composite Sample)

Unit: mg/l

Sampling Location	BOD		COD	
	Dry Season	Rainy Season	Dry Season	Rainy Season
New Apt. Bldg.	133 & 232 Ave. 183	88 & 142 Ave. 115	167 & 350 Ave. 259	105 & 170 Ave. 138
Old Apt. Bldg.	182	240	236	362
Individual Housing	267	214	440	250
Average	211	312	190	250

BOD analysis results fluctuate by type of housing and by season. However, reasons on these fluctuations are not clearly identified even through questionnaire survey to residents' awareness in respective area.

As a whole, BOD concentration of these analysis results is considered within the normal range of domestic sewage. When the current water supply conditions are improved by completion of the on-going Bovilla Water Supply Project, these BOD concentration is assumed to decrease by dilution, while the sewage volume may increase. The per capita unit pollution load is also considered to be increased through the future corresponding to the improvement of economic conditions and living standards.

Through the questionnaire survey on residents' awareness on environmental sanitation, it was confirmed that approximately 90 % of households being located within the service area of existing sewer network are directly discharging their domestic sewage into sewer lines, while the remaining households are discharging into septic holes or canals/open channels. Households utilizing septic holes periodically remove septage by means of vacuum truck. The collected septage is dumped on to open space in suburban area or ino manholes of sewer lines.

(3) Industrial wastewater

Due to drastic change of economic activities through introduction of market economy, almost all state-owned factories have lost competitive position and been closed or bankrupted in recent years. Owing to this circumstance, discharge sources of industrial wastewater are now quite limited to several major factories in the Study Area. The largest factory at present is a food processing industrial complex located at southwest part of Tirana City and discharging its wastewater into brook which is finally flowing into the Lana River.

The rest of factories are mostly small scale, such as meet processing factory to produce sausage and ham being located at the central part of Tirana City.

A total of four samples was obtained from different factories in each season. Their analysis results are summarized below:

Table 6.3.5 Analysis Results of Industrial Wastewater

Site Number	Type of Factory	pH (-)	Turb. (mg/l)	SS (mg/l)	BOD (mg/l)	COD (mg/l)
1	Food Processing Complex	5.80	119	133	485	959
		6.80	79	85	327	613
2	Liquor Manufacturing	6.85	34	58	288	477
		7.02	35	40	154	273
3	Industrial Complex (Milk & Soap)	7.18	50	69	110	237
		7.40	130	132	282	487
4	Meat Processing	6.68	163	234	304	615
		7.01	200	205	533	1,277

Note: Upper - Dry season, Lower - Rainy season

Water sample from Industrial Complex (Site No.3) was obtained at manhole of sewer lines wherein certain amount of domestic sewage seems to be mixed due to recent housing developments.

In view of discharged pollution load, the Food Processing Complex (Site No.1) and Meat Processing Factory (Site No.4) are considered major pollution sources.

CHAPTER 7

APPROACH TO SEWERAGE SYSTEM PLANNING

CHAPTER 7 APPROACH TO SEWERAGE SYSTEM PLANNING

7.1 General

Establishment of planning fundamentals and design criteria is requisite prior to proceed framework of the sewerage system planning as well as the feasibility study of the priority project. Planning fundamentals and design criteria adopted for the Study were concluded with the MOPWT and other Albanian authorities concerned through discussions with the Study Team.

Adopted figures are subject to modification and update corresponding to the future changes of socio-economic conditions, urban development plans as well as financial and institutional development of the country and Tirana City in the water supply and sanitation sectors.

7.2 Fundamentals for Sewerage Planning

7.2.1 Target Year of The Study

The target year for the Study on the Sewerage System in Metropolitan Tirana is 2010.

7.2.2 Study Area and Population

The study area is Metropolitan Tirana with surface area of approximately 12,000 ha, and its population in 2010 is estimated as follows:

Tirana City	540,000
Outside of Tirana City	192,000
Study Area Total	732,000

7.2.3 Fundamentals for Sewerage Planning

(1) Principal objectives of implementing sewerage project

Prior to establish the planning fundamentals for the sewerage project, the principal objectives to be achieved by the proposed project are redefined as follows:

1) Improvement of public hygiene and living environment in Metropolitan Tirana through development of sewerage system

2) Improvement of water quality in the Tirana River and the Lana River aiming at the wastewater discharge standard level set by the national regulations by the following countermeasures:
   - Minimize direct discharge of raw sewage into the rivers, and
   - Treat collected sewage at the sewage treatment plant to meet the requirements of national regulation (BOD 25 mg/l)

(2) Selection basis for sewerage planning area

Criteria to determine the target area of sewerage planning are established taking into account the above mentioned principal objectives and the present service area of the existing sewerage system, as follows:

1) Expansion area shall adjoin to the service area of the existing sewerage system
2) Expansion area shall, in principle, have topographic feature to drain collected sewage into the existing sewer lines by gravity flow
3) Expansion area shall have reasonable population density to attain economic efficiency
4) Expansion area shall be of legally developed or legally planned area, such as Type-1 or Type-5 specified in the Land Use Plan.

The expansion area of sewerage system with an area of 565 ha is selected from a total of 12 zones based on the above criteria and indicated in Figure 7.2.1. The overall target area for sewerage planing is 1,810 ha consisting of:

- 1,245 ha of the service area of the existing sewerage system, and
- 565 ha for expansion area.

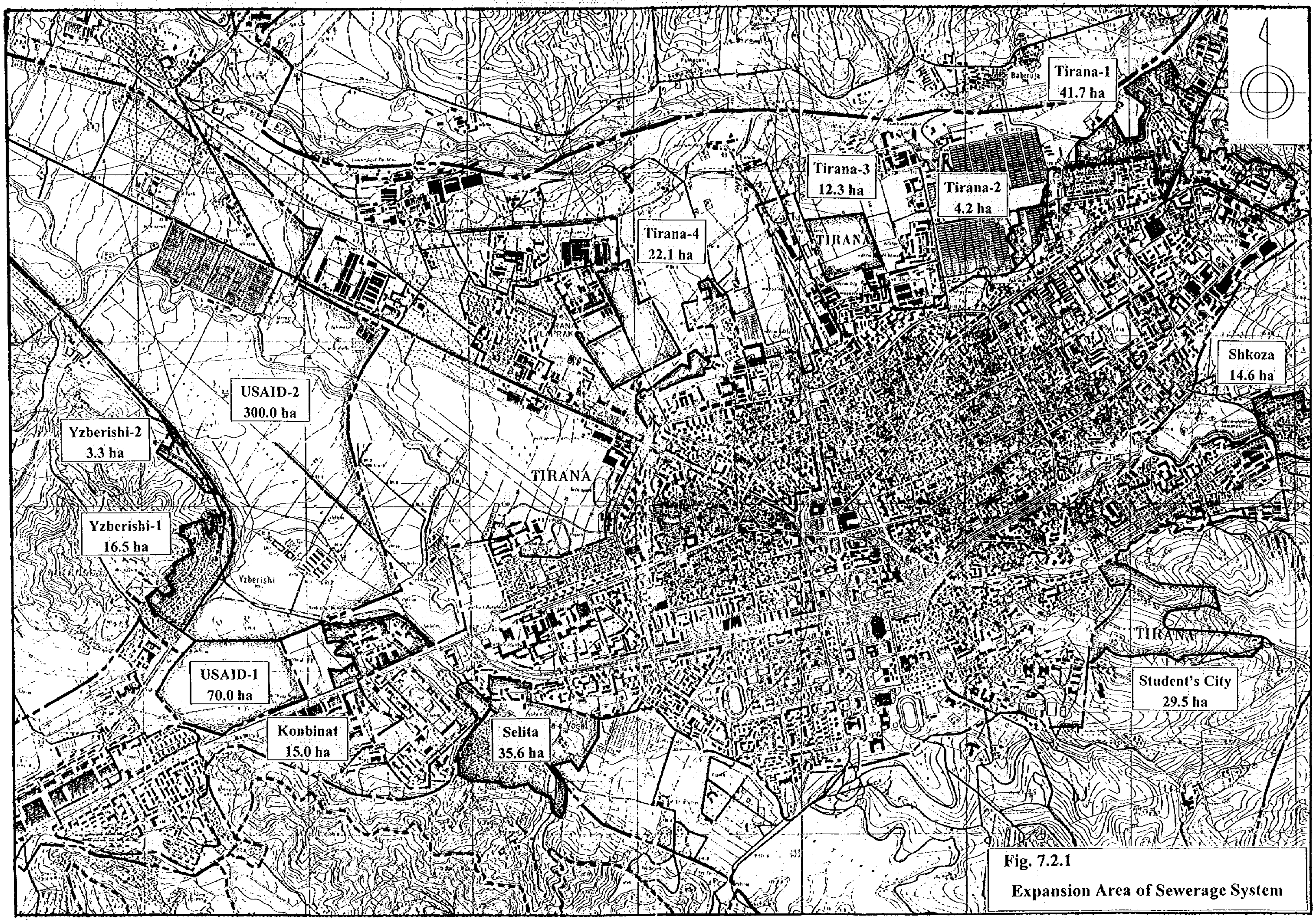


Fig. 7.2.1

Expansion Area of Sewerage System

7.2.4 Sewerage Planning Area and Population

The entirely sewerage planning area and their population (present/projected) are shown in Table 7.2.1.

Table 7.2.1 Sewerage Planning Area and Population

Zone			Area (ha)	Population (person)			Remarks
				1996	2001	2010	
Existing Service Area	Tirana River		213.6	47,914	51,000	56,600	
	Center		183.2	46,497	49,500	54,900	
	Lana-North		396.4	117,262	124,900	138,600	
	Lana-South		380.6	108,070	115,100	127,700	
	Kombinat		71.0	17,640	18,800	20,800	
	Total		1,244.8	337,383	359,300	398,600	
Expansion Service Area	Lana-South	Shkoza	7.0	2,730	2,800	3,200	Z1-T5-1
			7.6	2,976	3,100	3,400	Z1-T5-6
		Selita	13.1	2,620	2,600	2,600	Z5-T2-13
			22.5	5,251	5,500	6,000	Z99-T5-23
		Kombinat	15.0	-	-	-	Z6-T0-0
		Sub Total	65.2	13,577	14,000	15,200	
		Student's City	2.8	84	100	100	Z2-T1-7
			26.7	5,340	5,300	5,300	Z2-T2-5
		Sub-Total	94.7	19,001	19,400	20,600	
	USAID	USAID-1	70.0	0	5,000	14,000	Z6-T2-1
		USAID-2	300.0	1,674	22,500	60,000	Z99-T1-4/71
		Yzberishi-1	16.5	3,840	4,000	4,400	Z99-T5-60
		Yzberishi-2	3.3	758	800	900	Z99-T5-61
		Sub-Total	389.8	6,272	32,300	79,300	
	Tirana	Tirana-1	41.7	16,263	16,900	18,700	Z4-T5-72
		Tirana-2	3.1	620	600	600	Z4-T2-10
			1.1	429	400	500	Z4-T5-7
		Tirana-3	12.3	2,460	2,500	2,500	Z8-T2-19
		Tirana-4	10.5	2,100	2,100	2,100	Z9-T2-20
			4.5	0	300	900	Z9-T4-3
			7.1	0	500	1,400	Z11-T4-4
		Sub-Total	80.3	21,872	23,300	26,700	
	Total		564.8	47,145	75,000	126,600	
Grand Total			1,809.6	384,528	434,300	525,200	

Note: Z1-T5-1 refers to Zone-1, Type-5, Area-1. This coding for area categorization is used for civil registration by Tirana City.

*1 -Existing service area is measured on the maps by the Study Team.

*2 -Present population and expansion service area are referred to "Housing Typology of Existing Land Use" (MOPWT); details are referred to Tables 7.2.2 and 7.2.3 in Appendix 7.2.1.

*3 -Future population is projected by the Study Team.

Table 7.2.2 shows a breakdown of planning area and population by sewerage served zone.

Table 7.2.2 Breakdown of Planning Fundamentals by Sewerage Service Zone

Zone	Area (ha)			Population (person)		
	Existing	Expansion	Total	Existing	Expansion	Total
Tirana River	213.6	80.3	293.9	56,600	26,700	83,300
Center	183.2		183.2	54,900		54,900
Lana-North	396.4		396.4	138,600		138,600
Lana-South	380.6	159.9	540.5	127,700	20,600	148,300
Kombinat	71.0		71.0	20,800		20,800
USAID		389.8	389.8		79,300	79,300
Total	1,244.8	630.0	1,874.8	398,600	126,600	525,200

7.2.5 Planned Sewage Flow

(1) Unit per capita sewage quantity

Unit per capita sewage quantity is calculated as follows:

Unit Quantity = $q - q_{\text{-Leakage}} + q_{\text{-Infiltration}}$

where, q : Unit water consumption (l/cap/day)

$q_{\text{-leakage}}$: Sewage leakage from sewer pipe

$q_{\text{-Infiltration}}$: Groundwater infiltration to sewer pipe

1) Unit per capita water consumption

a. Daily average

Based on the discussion in Chapter 3, the planned daily average per capita unit water consumption ($q_{\text{Daily Ave}}$) is assumed as shown below:

$q_{\text{Daily Ave.}} = 170 / (1 - 0.3) = 243$ l/cap day

where, 170 l/cap/day : Unit domestic water consumption

0.3 : Non-domestic use ratio

(70 % of water consumption is for domestic use.)

b. Daily maximum

As discussed in Chapter 3, the present water supply conditions will be remarkably improved upon completion of Bovilla water treatment plant by the year 1999 and the water supply system will be able to cope with the increase of water demand for the mean time. However, further increase of water demand by the target year of 2010 will not be managed by the existing water sources. Future water sources are not identified yet.

In due consideration of the above mentioned situation of water supply through the future, seasonal fluctuation of sewage volume to be discharged in the sewerage planning area will not be foreseen owing to the restrictive conditions of water supply capacity, even if water demand varies seasonably. Therefore, the planned daily maximum per capita unit water consumption $q_{Daily\ Max}$ is not considered in this Study.

For reference, the daily maximum unit water consumption is estimated below:

$q_{Daily\ Max.}$ = (170 / (1 - 0.3)) / 0.75 = 324 l/capita/day

where, 0.75 : Loading factor (=75%=daily average/daily maximum)

c. Hourly maximum

Hourly maximum unit water consumption ($q_{Hourly\ Max.}$) is a key in hydraulic calculation of sewer network. However, due to absence of technical data on peak factor to establish the hourly maximum consumption, the following assumption is taken up in this Study.

When the daily average water consumption is referred to as the base figure, the hourly peak factor tends to become larger one owing to restrictive water supply conditions. In this regard, peak factor if assumed to be two (2) times over the daily average consumption, which is equivalent to the current Albanian standard. Hourly maximum unit water consumption is likewise calculated as follows:

$q_{Hourly\ Max.}$ = 243 x 2.0 = 486 l/capita/day

where, 243 l/capita/day: Daily average per capita unit water consumption

On the other hand, when the daily maximum consumption is referred to, the hourly fluctuation of water consumption tends to become smaller as it stands on the stable water supply conditions. In this case, 1.5 times (150%) of peak factor against the daily maximum consumption is considered appropriate. Hourly maximum per capita unit water consumption is computed as follows:

$q_{Hourly\ Max.}$ = 324 x 1.5 = 486 l/capita/day

where, 324 l/capita/day: Daily maximum per capita unit water consumption

Resultant from the above two assumptions, the same figure of the hourly maximum unit water consumption is obtained.

2) Leakage of sewage from sewer network

Leakage of sewage occurs not only from broken/damaged sewer pipes, but also loosened pipe connection and connection pit of service pipe and sewers. This leakage was reported to be approximately 40 % by a sewage leakage investigation executed by Tirana City in 1985. Considering an improvement of the pipe in the future, 35 % is employed as an appropriate sewage technical leakage ratio in this Study.

Sewage leakage from sewer network is calculated as follow:

$q_{\text{-Leakage}}$ = 243 x 0.35 = 85 l/capita/day

where, 243 l/capita/day: Daily average unit water consumption

3) Groundwater infiltration to sewer pipe

The rate and quantity of the groundwater infiltration are related to the length and diameter of the sewers, the age and condition of the materials, and the soil and topographic features of the catchment area. The groundwater infiltration ratio for the sewer in Tirana is not available. While the above ratio is usually used 10 to 20 % of the base flow (daily maximum flow) in Japan. Fifteen (15) % of the daily average sewage flow is assumed in this Study.

Groundwater infiltration to sewer pipe is calculated as follow:

$q_{\text{-Infiltration}}$ = 243 x 0.15 = 36 l/capita/day

where, 243 l/capita/day: Daily average unit water consumption

4) Planned unit sewage quantity

a. Daily average

Unit quantity = q_1 +

243 - 85 + 36 = 194 l/capita/day

say, 200 l/capita/day

b. Hourly maximum

Unit quantity = 486 - 85 + 36 = 437 l/capita/day

say, 440 l/capita/day

(2) Planned sewage flow

1) Planned sewage flow at treatment plant

Table 7.2.3 shows planned sewage flow at treatment plant calculated on the daily average basis.

Table 7.2.3 Planned Sewage Flow for STP

Zone	Population (person)			Planned Sewage Flow (m^3/day)	Remarks
	Existing	Expansion	Total		
Tirana River	56,600	26,700	83,300	16,660	
Center	54,900		54,900	10,980	
Lana-North	138,600		138,600	27,720	
Lana-South	127,700	20,600	148,300	29,660	
Kombinat	20,800		20,800	4,160	
USAID		79,300	79,300	15,860	
Total	398,600	126,600	525,200	105,040	

Note: Planned sewage flow as daily average

2) Planned sewage flow in sewer network

The planned sewage flow in sewer network on the hourly maximum basis is calculated as shown in Table 7.2.4.

Table 7.2.4 Planned Sewage Flow for Sewer Pipe

Existing Area		Expansion Area		Population	Planned Sewage Flow		
Name	Population	Name	Population	Total	(m^3/day)	(m^3/sec)	3Q(m^3/sec)
Tirana River	56,600	Tirana-1	18,700	83,300	36,652	0.424	1.273
		Tirana-2	1,100				
		Tirana-3	2,500				
		Tirana-4	4,400				
		Sub Total	26,700				
Center	54,900	-	-	54,900	24,156	0.280	0.839
Lana-North	138,600	-	-	138,600	60,984	0.706	2.118
Lana-South	127,700	Shkoza	6,600	148,300	65,252	0.755	2.266
		Student's City	5,400				
		Selita	8,600				
		Kombinat	-				
		Sub Total	20,600				
Kombinat	20,800	-	-	20,800	9,152	0.106	0.318
USAID	-	USAID-1	14,000	79,300	34,892	0.404	0.404
		USAID-2	60,000				
		Yzberishi-1	4,400				
		Yzberishi-2	900				
		Sub Total	79,300				
Total	398,600		126,600	525,200	231,088	2.675	7.216

Note : Planned sewage flow as hourly maximum in 2010

7.2.6 Planned Sewage Quality

Among others, BOD (Biochemical Oxygen Demand) and SS (Suspended Solids) are most important parameters in planning and designing the sewage treatment plant. BOD, in particular, plays a role of key parameter to determine capacity of the plant.

There are two method to determine BOD of sewage. The first method is estimation by using unit BOD pollution load per capita per day and sewage quantity. The second method is, of course, estimation based on the result of water analysis of actual sewage sampling from the existing sewerage system. A series of water sampling and examination was repeatedly carried out during the field work of this Study and their results were referred to in establishing planned sewage quality.

(1) Sewage quality estimation

BOD estimation in other countries where the many existing data are available, will be done using such data and reviewed referring to the values obtained by actual water analysis in the field.

1) Domestic sewage

There are some reports on the study of unit BOD pollution load of domestic sewage stemming from field investigations and the followings are the findings and study results.

a. Japan (in 1990) Unit: g/capita/day

	Nightsoil	Other Wastewater	Total
BOD	18	39	57
COD-Mn	10	18	28
SS	20	23	43
T-N	9	3	12
T-P	0.9	0.3	1.2

b. United States Unit: g/capita/day

	Nightsoil	Other Wastewater	Total
BOD	23	55	78

c. Tropical countries Unit: g/capita/day

	Nightsoil	Other Wastewater	Total
BOD	22	18	40

d. Other countries Unit: g/capita/day

	BOD - Total
United Kingdom	50 to 59
France (rural area)	23 to 34
Brazil	44

Source: "Urban drainage and sewage treatment in developing countries" by the Ministry of Construction of Japan

As observed in above, there is wide range of variation reflecting differences of living standard, life style, etc. WHO, however, recommends to apply 45 g/capita/day where there is no available data.

Using 45 g/capita/day, BOD pollution load is calculated as follows.

BOD load: 45 g/capita/day x (1 - 0.35) = 29.25 g/capita/day

Discharged sewage volume: 170 l/capita/day x (1 - 0.35 + 0.2) = 136 l/capita/day

where, leakage from water distribution pipe and sewer pipe: 35 %

infiltration to sewer pipe: 20 %

BOD = 29.25 g-BOD/capita/day / 136 l/capita/day = 215 mg/l

2) Commercial and institutional sewage

In this Study, water demand is categorized into two, domestic use and non-domestic use. The non-domestic use may be deviled into commercial use, institutional use and industrial use. Among them, commercial and institutional uses, which are water use at offices, restaurants, hotels, etc., are expected to have the similar characteristics with domestic use, but less BOD load. Therefore, 30 g/capita/day will be applied in this Study.

BOD load of commercial and institutional sewage is calculated as follows.

BOD 215 mg/l x (30 / 45) = 143 mg/l

3) Industrial wastewater

According to some reports on industrial wastewater, typical characteristics of wastewater by industry group are as follows. There are very wide differences of BOD by industry and food processing shows the largest, and some industries show very small values. Therefore, average value of BOD, 300 mg/l to 400 mg/l will be applied for all industrial wastewater, in general.

Industry Group	Average BOD (mg/l)
Food Processing	1,374
Min./Cement/Ceramics	372
Light Processing	463
Mechanical/Electrical	151
Others	500

(2) Results of water quality examination

Water sampling was carried out at three different localities for domestic sewage and four different factories, whereas discharge sources of industrial wastewater are now quite limited to several major factories in the Study Area due to drastic change of economic activities through introduction of market economy.

1) Domestic sewage

Sampling Location	BOD (mg/l)	
	Dry Season	Rainy Season
New Apartment Bldg.	133 and 232 Ave. 183	88 & 142 Ave. 115
Old Apartment Bldg.	182	240
Individual Housing	267	214
Average	211	190

BOD concentration of these samples is lower than the value estimated in the preceding discussion, it is, however, within the normal range of domestic sewage.

2) Industrial wastewater

Three out of four samples are obtained from food processing which usually discharge higher BOD concentration than the other industries. In this study, average BOD concentration of industrial wastewater is assumed 300 mg/l.

Type of Factory	BOD (mg/l)	
	Dry Season	Rainy Season
Food Processing Complex	485	327
Liquor Manufacturing	288	154
Industrial Complex (Milk & Soap)	110	282
Meet Processing	304	533
Average	297	324

(3) Planned sewage quality

There is only small difference of BOD concentration of domestic sewage between estimation and results of actual water analysis, and estimation will be applied for this calculation. While, results of actual water analysis will be applied for industrial wastewater.

Using values set in the above, BOD load is calculated as follows.

a. Domestic sewage (assuming 70 % of total water use)

BOD 215 mg/l

b. Commercial and institutional sewage (assuming 23 % of total water use)

BOD 215 mg/l x (2 / 3) = 143 mg/l

c. Industrial wastewater (assuming 7 % of total water use)

BOD 300 mg/l

d. Mixed sewage

BOD = 215 x 0.7 + 143 x 0.23 + 300 x 0.07 = 204 mg/l say, 200 mg/l

When the current water supply conditions are improved to continuous supply, BOD concentration will be decreased by dilution, while the sewage volume may increase. Therefore, the BOD concentration of 200 mg/l obtained from above calculation considering results of water quality examination.

7.2.7 Planned Storm Water Flow

(1) Run-off formula

The rational run-off formula is widely used for computing storm water quantity. Whereas some of the factors are shown below;

$$Q = C\,I\,A$$

where, Q : Storm water quantity; m^3/sec

C : Run-off coefficient

I : Rain fall intensity; mm/h

A : Catchment area; ha

(2) Rainfall intensity formula

The Talbot's formula is broadly adopted in all over the world as an effective and simple method of calculation of rainfall quantity. The Talbot's formula is given below.

$$I,\ \text{mm/hr} = \frac{a}{t + b}$$

where : t : Concentration time

a and b : Coefficients

The rainfall characteristics was examined based on the rainfall data for past 41 years (1950 - 1990) measured at Tirana Airport. The rainfall intensity for 10 to 60 minutes was calculated with the use of Talbot's formula as shown in Table 7.2.5.

Table 7.2.5 Calculation of Rainfall Intensity Using Talbot Formula

Return Period	Coefficient		Rainfall Intensity (mm/hr)					
	a	b	10 min	20 min	30 min	40 min	50 min	60 min
2.5Year	2520	17	93.3	68.1	53.6	44.2	37.6	32.7
4 Year	2750	17	101.9	74.3	58.5	48.2	41.0	35.7
5 Year	2870	16	110.4	79.7	62.4	51.3	43.5	37.8
7 Year	3060	16	117.7	85.0	66.5	54.6	46.4	40.3
10 Year	3270	16	125.8	90.8	71.1	58.4	49.5	43.0

Table 7.2.6 shows a comparison of calculated rainfall intensity between Gumbel's and Talbot's. Return period of rainfall intensity was set forth as 4 years for main sewer and 2.5 years for lateral sewers, in accordance with commonly adopted Albanian method.

Table 7.2.6 Comparison of Rainfall Intensity

Return Period	Name of Formula	Rainfall Intensity (mm) 10 min	20 min	30 min	40 min	50 min	60 min
2.5 Year	Gumbel	92.5	60.5	47.0	38.5	33.6	30.4
	Talbot	93.3	68.1	53.6	44.2	37.6	32.7
4 Year	Gumbel	106.6	68.3	52.8	43.3	37.9	34.4
	Talbot	101.9	74.3	58.5	48.2	41.0	35.7

As shown in Table 7.2.6, there are no significant difference on rainfall intensity between two formula. However, the Talbot's formula gives rather safety figure than Gumbel's one.

(3) Run-off coefficient

Run-off coefficient is used to estimate percentage of rainwater which run out from respective type of land uses. The commonly used run-off coefficient is shown in Table 7.2.7.

Table 7.2.7 Run-off Coefficient Standard

Land Use Condition	Run-off Coefficient
Commercial and residential built-up area wherein open space is quite limited.	0.80
Residential area with garden and industrial area with certain open space	0.65
Medium stories apartments and individual housing area	0.50
Residential area having sufficient garden space and suburban area with sufficient green space	0.35

When the existing and future land use as well as roads and housing conditions are taken into account, 0.5 of the run-off coefficient shall be uniformly applied for the whole of the sewerage planning area in this Study. However, larger figure of run-off coefficient (0.6 to 0.7) may be considered in the future when infiltration area (open space) is decreased corresponding to the progress of urbanization.

(4) Concentration time

Concentration time is defined as a sum of the inlet time required for rainwater to reach storm sewer inlets and the time of flow for collected storm water to reach sewage treatment plant, as shown in the following formula:

$$t = t_1 + t_2$$

where, t: Concentration time
t_1: Inlet time
t_2: Time of flow (=L/V; V m/sec-Assumed average velocity)

Based on the Albanian method of hydrology, the following factors are adopted in calculation of the concentration time:

- Inlet time; 5 minutes, and
- Time of flow using assumed average velocity of 1.5 m/sec.

7.3 Design Criteria to be Used for the Study

7.3.1 Sewage Collection System

(1) Intercepting capacity

In general, intercepting capacity is determined to be 3 - 5 times that of peak dry weather flow. In consideration of economic and water pollution control aspects, three (3) times that of said flow is used as intercepting capacity.

In order that the function is most effective, appropriate overflow chambers must be installed at respective overflow points to separate combined wastewater from existing sewer pipes and collect the design flow into the interceptor.

(2) Hydraulic calculation

The Manning's formula is usually used for flow velocity calculation in all over the world. The Manning's formula is given below.

$$Q = A \times V, \qquad V = 1/n \times R^{2/3} \times I^{1/2}$$

where, V: velocity of flow (m/sec)
n: roughness coefficient
R: hydraulic radius (m)
I: gradient in decimal
A: section area (m^2)

Standard roughness coefficients to be used for the type of material are as follows:

Table 7.3.1 Roughness Coefficients in Manning's Formula

Type of Pipe	Roughness Coefficient
Asbestos Cement Pipe	0.013
Vitrified Clay Pipe	0.013
Plastic Pipe	0.010
Concrete Pipe/Conduit	0.013
Coated Steel Pipe	0.008

(3) Flow velocity

1) Minimum velocity

Sewers must be designed to convey peak flows. Meanwhile, the gradient of the sewer should be determined to ensure minimum flow velocity by pipe diameter in order to obtain the self-cleansing velocity in full flow. The minimum velocities to be used in this Study are as follows:

For combined sewer	:	0.8 m/sec (full section flow)
For separate system storm sewer	:	0.8 m/sec (same)
For separate system sanitary sewer	:	0.6 m/sec (same)

2) Maximum velocity

A velocity of sewer shall not exceed 3.0 m/sec to protect against sewer erosion. On the contrary to the above, the velocity in partly existing sewer exceed the limited velocity, since existing pipes are installed corresponding to steep surface slope.

3) Sewer capacity

The flow capacity of pipes are calculated to convey sewage with full section in the pipe for combined sewer and storm sewer of separate system.

In the case of separate system sanitary sewer, the sewer capacity must be selected on condition that is shown follows:

Diameter is 600mm or less : Capacity / Flow is at least 200%

Diameter is more than 600mm : Capacity / Flow is at least 175%

7.3.2 Sewage Treatment Plant

The following fundamentals and criteria are applied for the study of sewage treatment plant.

(1) Planned design flow

Planned design flow of sewage treatment plant is established as shown below taking into consideration of treatment capacity in each series and number of series:

Daily Average	106,000 m^3/day	
Daily Maximum	106,000 m^3/day	
Hourly Maximum (Dry)	9,670 m^3/hour	(= 232,000 m^3/day)
Hourly Maximum (Rain)	26,000 m^3/hour	(= 624,000 m^3/day)

(2) Planned water quality

Influent:	BOD_5	200 mg/l	
	SS	200 mg/l	
Effluent:	BOD_5	25 mg/l	
	SS	35 mg/l	(150 mg/l)

Note:

a. Water quality of influent is tentative, and it will be determined referring results of the second water quality examination.

b. Water quality of effluent shall aim at the European Communities' "Council Directive of 21 May 1991 concerning urban waste water treatment - Table 1."

c. The Council Directive states that "Analysis concerning discharges from lagooning shall be carried out on filtered samples; however, the concentration of TSS in unfiltered water samples shall not exceed 150 mg/l."

(3) Phased construction

Phase 1	(in 2001)	53,000 m^3/day	(26,500 x 2 units)
Phase 2	(in 2010)	53,000 m^3/day	(26,500 x 2 units)
Total		106,000 m^3/day	(26,500 x 4 units)

7.4 Improvement of Sewage Collection System

7.4.1 Introduction

As mentioned in the proceeding section in this report, the existing sewage collection system, especially trunk sewer was designed under a different calculation method from the present employed design criteria in Albania which is widely used the storm return period of 4 years for main sewer and 2.5 years for branch sewer.

The computerized functional assessments for the sewer network were executed by the Study Team in order to grasp the existing condition of the sewage collection system. Based on the assessment result, the following are observed in the current situation.

1) 81 % out of total length of the main sewer pipe has an insufficient capacity to accommodate sanitary sewage and storm water as for the combined system at Albanian design criteria, return period is 4 years for trunk sewers and 2.5 years for branch sewers.

2) 57 % out of total length of the main sewer pipe has an insufficient capacity to convey the combined sewage at a trial condition in term of the return period of 0.5 years for both trunk sewers and branch sewers.

3) While, 78 % out of total length of the main sewer pipe has an insufficient capacity to run off only storm water, which has the same return periods as 1), as for the assumed separate system.

4) On the contrary to the above, all the main sewer pipe has a sufficient capacity to run off the sanitary sewage generated the houses and the public facilities, but not including any rain water.

The matters mentioned in the above show that the existing sewage collection system was constructed by apparently different design policy, and it causes the frequent inundation and submergence everywhere on the road when there is medium or strong rain.

7.4.2 Discussion on Improvement of Collection System

The main objective of this particular study is to look into the solution to cope with the most serious problem of the existing sewer network that more than 80% of existing sewer pipes have insufficient flow capacity.

In other word, fundamental and drastic countermeasure shall be developed to improve existing sewer network in which more than 60% of sewer pipes have less than 50% of the required flow capacity to meet with the planned sewage flow.

(1) Principal approach to the study

Two directions are considered for principal approach to the study:

1) Approach to increase flow capacity of the sewer network

This option is to identify solution to increase flow capacity of existing sewers by following two methods:

a. Method to increase flow capacity of the existing combined system
b. Conversion of the existing combined system to the separate system to collect sanitary sewage and storm water to respective sanitary sewer and storm sewer.

2) Approach to reduce the planned sewage flow

This option is to restrict inflow of storm water into the existing combined sewer network, since the volume of storm water run-off is extremely predominant in the total sewage flow. Possible options are:

a. Rejection of storm water from the sewer network (in other word, dependence to surface run-off or other drainage measure)

b. Dependence to rivers for considerable volume of storm water run-off (in other word, massive installation of overflow chamber or storm water outlet)

c. Direct reduction of storm water run-off and inlet to sewer network (introduction of infiltration system and retention basin)

The above option "a." is, however, excluded from further study due to absence of other drainage facility in the sewerage planning area. Within the option "b.", the roadside gutter is worth to consider as a measure to drain surface run-off, although it is not used at present. The option "c" shall be taken up for consideration in the future, since it requires development of relevant infrastructures.

This study will be focused onto the target area (936.9 ha) of priority project, namely Lana-North (396.4 ha) and Lana-South (540.5 ha), wherein subject sewer lines will be all the sewer pipes having diameter of 400 mm or larger and their lateral sewers (200 mm or larger) as described in Chapter 4.

(2) Alternative plan for improvement of sewage collection system

Applicability of alternative measures and required activities for new installation, replacement and supplemental installation.

1) Improvement of the existing combined system

Following two measures will be studied to improve flow capacity of existing sewer lines:

Case-1 Replacement with new pipe having required flow capacity
(hereinafter referred to as "New combined sewer")

Case-2 Supplemental installation to compensate insufficiency of existing pipes
(hereinafter referred to as "Supplemental combined sewer")

2) Introduction of separate system

Following two measures will be studied to convert the existing combined system to the separate system:

Case-1 Utilization of the existing combined sewers as sanitary sewer and construction of new storm sewer.
(hereinafter referred to as "New storm sewer")

Case-2 Utilization of the existing combined sewers as storm sewer together with construction of supplemental storm sewer to compensate lack of flow capacity, and construct new sanitary sewer.
(hereinafter referred to as "New sanitary sewer + Supplemental storm sewer")

The above alternatives are summarized in Table 7.4.1 from the view point of new construction and supplemental construction.

Table 7.4.1 Alternative Plan for Improvement of Sewage Collection System

Sewer Pipe	Combined System		Separate System	
	Case-1	Case-2	Case-1	Case-2
Combined Sewer	Existing + Partly New	Existing + Partly Supplemental	-	-
Sanitary Sewer	-	-	Existing	New
Storm Sewer	-	-	New	Existing + Partly Supplemental
House Connection	As it is	As it is	As it is	As it is

(3) Sharing of storm water disposal by rivers and sewer system

In the combined system, storm water occupy majority of the total sewage flow, so called 10 to 500 times of sanitary sewage. Therefore, the improvement of the existing combined sewers shall be focused on how to handle the storm water. This study approach is also useful for the storm sewer of the separate system.

In other word, it pertains to whether storm water in the subject area is shouldered by rivers or sewer system. Where topographic conditions are favorable, diameter of sewer pipes can be minimized by sub-dividing the subject drainage area and installation of storm overflow chamber.

In the target area of this particular study, only nine (9) storm overflow chambers exist, although there are Lana River and many brooks. In other word, the existing sewer network was designed to discharge storm water of larger size of drainage area through the sewer network. This situation has caused the major reason of insufficient flow capacity of existing interceptors along Lana River. On the other hand, it has been confirmed during the course of this Study that Lana River has sufficient flow capacity to accept storm water throughout its water course in the sewerage planning area, as shown in Appendix 7.4.2. Therefore, it is advantageous to fully utilize Lana River for seeking the solution on the insufficient flow capacity of the existing sewers.

(4) Study subjects

1) House connection

In general, when the existing sewers are to be converted as storm sewer and new sanitary sewer is to be installed, it is considered that existing house connections shall also be reconnected. However, the actual practice of this arrangement is being implemented by reconnection of service pipe at junction pit of lateral sewer and house connection itself is not changed. Resultant from this fact, all of the above mentioned alternative measures will not incur any private expenditures to be shouldered by consumers.

2) Utilization of street gutter

Street gutter, which is often used as substitute for small storm sewer in the separate system, is very rare in the existing combined system in Tirana City. On the other hand, street gutter has an economic advantage that construction cost of gutters at both sides of street is about half of the installation of storm sewer pipe with same flow capacity.

Therefore, street gutters are considered to drain storm water where the diameter of storm sewer is less than 600 mm. This technical option will be applied for storm sewers in Case-1 and Case-2 alternatives of the separate system.

3) Structure and location of storm overflow chamber in the combined system

The most critical deficiencies on the design of existing combined system are:

- Insufficient number of storm overflow chambers in interceptor
- Inappropriate structural design of storm overflow chamber that existing chambers are not designed to divert planned intercepting sewage flow into interceptor.

To reduce quantitative load to interceptor, a total of 33 storm overflow chamber is considered for this plan and 24 out of 33 chambers are to be newly constructed.

To cope with the above structural deficiency, there are two options to insert new storm overflow chamber in the existing interceptor:

a. Insert the storm overflow chamber at junction point of sewer pipe and interceptor.
b. Insert the storm overflow chamber along the interceptor route.

The above option "b." is further subdivided into two sub-options:

b-1.Reconstruction of existing manhole (insert the storm overflow chamber at junction of sewer pipe and interceptor)

b-2.Insert storm overflow chamber just downstream side of interceptor

Conceptual design of these technical options and respective advantages and disadvantages are exhibited in Figure 7.4.1. In due consideration of prevailing conditions in the sewerage planning area, the option "b-2." is considered most appropriate measure.

7.4.3 Study on Improvement of Collection System

The overall evaluation of existing sewer network has been performed in the previous section, 4.1.3 "Evaluation of Existing Sewage Collection System."

In this subsection, more precise evaluation is intended for Lana-North and Lana-South area based on the planning fundamentals (expansion area of sewerage system, planned population, planned sewage flow and planned storm water flow, etc. as described in subsection 7.2 and 7.3). The evaluation result of existing sewer network in the subject area is shown in Table 7.4.2.

This evaluation result clearly indicates that both Lana-North and Lana-South have similar characteristics of insufficiency on flow capacity, such as:

- Out of the total 65.7 km of sewer pipes in the subject area, 53.1 km or the 80 % of the total length have insufficient flow capacity against the planned sewage flow. It is further broken down to that 46.5 km or 82 % of the 56.4 km sewer network and 2.8 km or 30 % of the 9.3 km interceptor have insufficient flow capacity, respectively.

- Sewer pipe of ϕ 400 mm with a total length of 20.0 km has 17.2 km of insufficient flow capacity which is equivalent to 32 % of the total insufficient sewer pipes as the largest part among different sizes of sewer pipes.

- In small sewer pipes (ϕ 200 mm and ϕ 300 mm) being used as major lines in some area, almost 100 % of their total length (8 km) have insufficient flow capacity.

- As a whole, smaller size of sewer pipes have tendency to show larger percentage and longer length of insufficient flow capacity.

Table 7.4.2 Existing Sewer Capacity of Combined System

Unit : m

Zone	Dia.	Network			Interceptor			Total		
	(mm)	F/C≦100	F/C>100	Total	F/C≦100	F/C>100	Total	F/C≦100	F/C>100	Total
Lana North	200		134	134					134	134
	300	342	4,146	4,488				342	4,146	4,488
	400	1,867	7,997	9,864				1,867	7,997	9,864
	500	1,496	4,774	6,270				1,496	4,774	6,270
	600	1,958	7,263	9,221				1,958	7,263	9,221
	800	723	1,342	2,065	912	2,167	3,079	1,635	3,509	5,144
	1,000		996	996	421	1,400	1,821	421	2,396	2,817
	Total	6,386	26,652	33,038	1,333	3,567	4,900	7,719	30,219	37,938
Lana South	200		390	390					390	390
	300	290	2,739	3,029				290	2,739	3,029
	400	957	9,211	10,168				957	9,211	10,168
	500	593	4,322	4,915				593	4,322	4,915
	600	386	1,689	2,075				386	1,689	2,075
	800	1,307	1,253	2,560	1,433	1,634	3,067	2,740	2,887	5,627
	1000		242	242		1,359	1,359		1,601	1,601
	Total	3,533	19,846	23,379	1,433	2,993	4,426	4,966	22,839	27,805
Total	200		524	524					524	524
	300	632	6,885	7,517				632	6,885	7,517
	400	2,824	17,208	20,032				2,824	17,208	20,032
	500	2,089	9,096	11,185				2,089	9,096	11,185
	600	2,344	8,952	11,296				2,344	8,952	11,296
	800	2,030	2,595	4,625	2,345	3,801	6,146	4,375	6,396	10,771
	1,000		1,238	1,238	421	2,759	3,180	421	3,997	4,418
	Total	9,919	46,498	56,417	2,766	6,560	9,326	12,685	53,058	65,743

To improve the above mentioned deficiency, simulation and analysis are conducted for alternative plan shown in Table 7.4.1 and rough cost estimates of respective alternatives are also prepared as shown in Table 7.4.3. Relative cost comparison is also indicated as percentage to Case-2 of separate system.

Table 7.4.3 Estimation Result of Sewage Collection System Improvement

Items		Combined System		Separate System	
		Case-1	Case-2	Case-1	Case-2
Combined Sewer		Existing + Mostly New	Existing + Mostly Supplemental	-	-
Sanitary Sewer		-	-	Existing	New
Storm Sewer		-	-	New	Existing + Mostly Supplemental
Lana-North	Pipe Length m	85,859	85,859	98,024	181,258
	Cost 10^3US$	23,680	20,384	19,960	24,032
	Cost %	99	85	83	100
Lana-South	Pipe Length m	63,516	63,516	72,252	132,239
	Cost 10^3US$	15,227	13,374	11,513	15,502
	Cost %	98	86	74	100
Total	Pipe Length m	149,375	149,375	170,276	313,497
	Cost 10^3US$	38,907	33,758	31,473	39,534
	Cost %	98	85	80	100

Table 7.4.4 Comparison of the Alternative Plan

Evaluation Items	Importance	Combined System		Separate System	
		Case-1	Case-2	Case-1	Case-2
Max. No. of Sewer Lines in One Route	C	One	Double	Double	Triple
Contribution to Improvement of River Water Quality	A	Relatively Poor	Relatively Poor	Good	Good
Countermeasure to Deteriorated Sewers and Improvement of Leakage from Sewers	A	Mostly Improved (84 %)	Partially Improved (46 %)	No Improvement (0 %)	Total Improvement (100 %)
Improvement of Inundation	B	Improved	Improved	Improved	Improved
Flexibility of Implementation	B	Low	High	Fair	Relatively High
Difficulty of construction	C	Good	Difficult	Fair	Difficult
Difficulty of Reconnection	C	Difficult	Easy	Easy	Easy
Construction Cost	A	98%	85%	80%	100%

In addition to the above economic comparison, a comprehensive evaluation of these alternatives is prepared and summarized in Table 7.4.4.

Among the evaluation items for comparison shown in Table 7.4.4, important items as classified "A" are further discussed below.

- The contribution to improvement of river water quality is one of priority item and the separate system is superior than the combined system on this subject.

- Aging of sewer pipes is another potential problem on the existing sewerage system, since most of these pipes are more than 35 years in service since their installation in early 1960s. Generally, service life of sewer pipes is known to about 50 years. In this respect, the existing sewer pipes will become the age of replacement by the target year of 2010.

  In view of reported cases on leakage of sewage from sewer pipes by breakage and damage, the above mentioned aging problem shall be paid due attention in planning and design of sanitary sewer in separate system and of combined system.

The comprehensive technical evaluation shows that Case-2 of separate system seems the most favorable measure from the following view points:

- Fundamental countermeasure to solve problems contained in the existing sewerage system in Tirana City,
- Provision of stability and safety of the sewerage system as one of urban infrastructures through the future.

The final selection of the best countermeasure shall involves economic evaluation. However, the rough cost estimate indicates that no significant difference on the construction cost among alternatives. Therefore, it is considered that the technical evaluation result cannot be overturned by other options.

Resultant from the above, it is recommended that the existing sewer network shall be converted and improved to be the separate system through utilization of existing sewers as the storm sewer and construction of new sanitary sewer (Case-2 separate system). The second choice would be Case-1 of combined system in which mostly new sewer pipes will be installed.

It shall be noted, however, that thorough implementation of the recommended optimum plan for improvement of the existing sewer network requires huge investment and long term implementation and is subject to further study under the master planning basis for the whole city. In this regard, an exclusion of such overall improvement of the existing sewer network is agreed to be excluded from the scope of preliminary design of this Study between the MOPWT and the Study Team.

7.5 Study of Sewage Treatment and Disposal

7.5.1 General

All the existing sewerage systems in Albania have only sewer networks and there is no provision of sewage treatment plant. In this respect, it is indispensable for designing sewerage system to take into account technical level of personnel to be placed in operation and maintenance of the sewerage system as well as capability of operating organization.

In some countries, it is often observed that effluent from the treatment plant is same as raw sewage, owing to several reasons which are lack of knowledge and experience of personnel, lack of spare parts and budgetary constraints, etc.

Design of sewage treatment plant is therefore intended to attain sustainability not only from view points of both technical design and manpower capability, but also from the view point of less cost for operation and maintenance.

7.5.2 Preliminary Selection of Sewage Treatment Method

There are many well-developed and popular sewage treatment methods, such as:

- Conventional Activated Sludge,
- Extended Aeration,
- High Rate Trickling Filter,
- Rotating Bio-Reactor,
- Oxidation Ditch,
- Aerated Lagoon, and
- Stabilization Pond.

The following criteria are applied in this Study to select the most appropriate treatment method:

- Less cost for construction and O & M (operation and maintenance), and
- Less power consumption.
- Easy operation,
- Easy maintenance,

Table 7.5.1 exhibits the general comparison of the above mentioned treatment methods.

Table 7.5.1 Comparison of Sewage Treatment Methods

Treatment Method	Operation	Maintenance	Cost	Power
Conventional Activated	difficult	difficult	high	large
Extended Aeration	difficult	difficult	high	large
Trickling Filter	fair	fair	high	fair
Rotating Bio-Reactor	fair	difficult	fair	fair
Oxidation Ditch	fair	fair	fair	fair
Aerated Lagoon	easy	fair	low	less
Stabilization Pond	easy	easy	low	none

As highlighted in the above table, oxidation ditch, aerated lagoon and stabilization pond methods are firstly selected as applicable ones and subject to further study.

7.5.3 Comparative Study of Sewage Treatment Method

(1) Treatment methods to be studied

Following three treatment methods are further evaluated to select the most optimum method:

- Oxidation Ditch
- Aerated Lagoon
- Stabilization Pond

(2) Treatment process

Sewage treatment of the said three methods consists of three processes. At first, sand/ grit in sewage is settled at grit chamber and floating substances are caught by screens.

Secondly, sewage is divided and daily average flow or flow at dry season is led to biological treatment process, such as oxidation ditch, aerated lagoon or stabilization pond, and in this process, organic substance is removed by activities of aerobic and anaerobic bacteria and algae. In some processes, it is required to settle these bacteria or sludge at sedimentation tanks.

Then, exceeded quantity, which is considered as storm water, flows into storm water settling tank to remove further suspended materials by sedimentation.

Thirdly, disinfection by chlorination or sun light will be done to reduce bacteria, such as coliform.

Flow diagrams of these three methods are shown in Figure 7.5.1.

(3) Design calculation

Design calculation was carried out and their results are summarized in Table 7.5.2.

1) Power consumption

Among three methods, stabilization pond does not require any electric power for treatment, however, aerated lagoon method needs power for aerators in lagoon and chlorination in disinfection tank, and oxidation ditch method for aerators in ditch, sludge collectors, sludge pumps and chlorinators.

Estimation of power consumption (excluding power for offices and in-plant lighting) are:

-	Stabilization Pond	approx.	0 kW
-	Aerated Lagoon	approx.	1,370 kW
-	Oxidation Ditch	approx.	1,540 kW

Stabilization pond does not require any power owing to absence of mechanical equipment. Oxidation ditch consumes 12 % larger power than aerated lagoon.

2) Area requirement

Since stabilization pond uses natural activity of bacteria, the treatment efficiency is relatively low and large area is required, while, aerated lagoon and oxidation ditch require less area because aerators are used to accelerate the activity of aerobic bacteria.

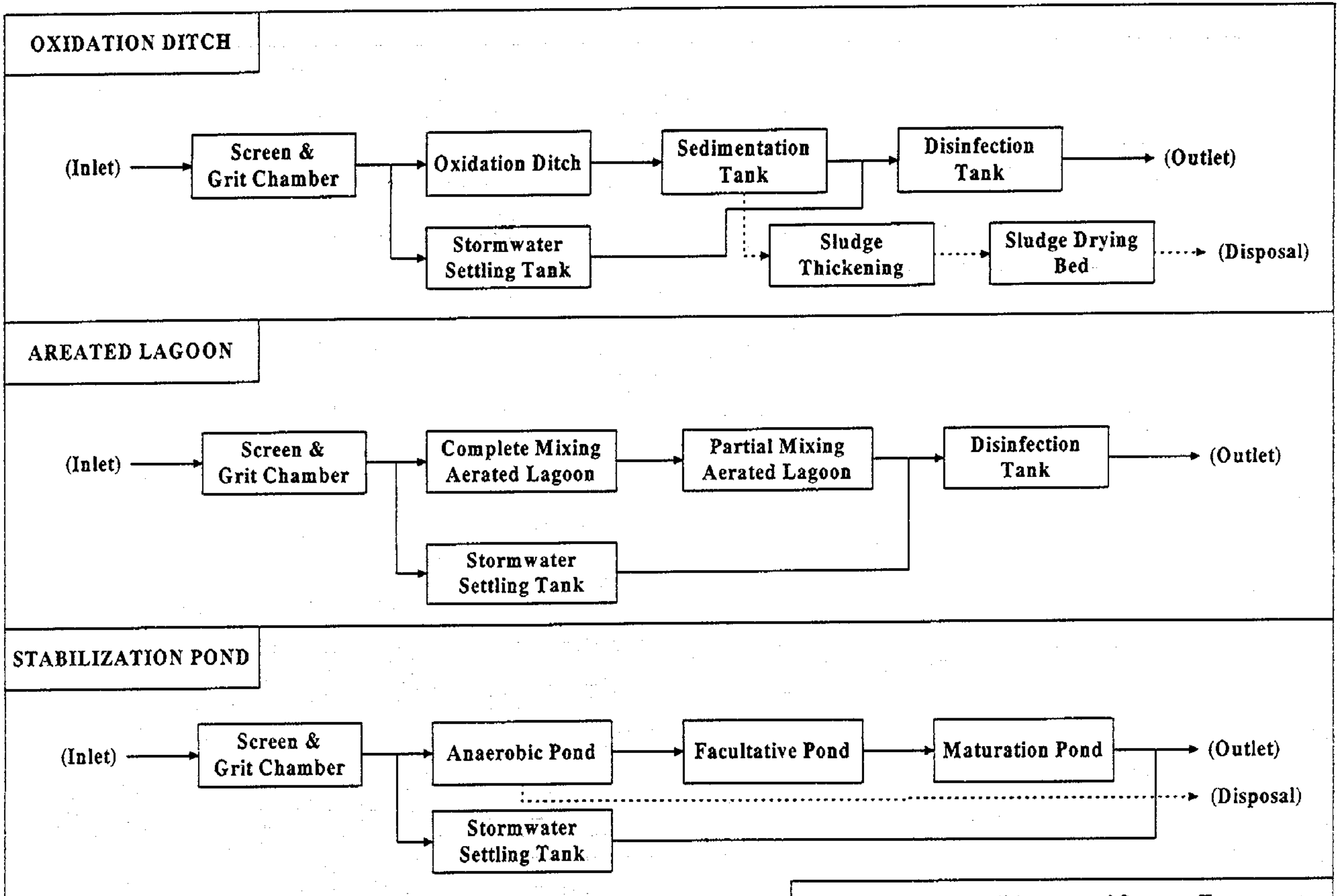


Figure 7.5.1 Flow Diagram of Sewage Treatment

Table 7.5.2 Design Calculation for Wastewater Treatment Plant

Treatment Method	Stabilization Pond	Aerated Lagoon (Dual Power)	Oxidation Ditch
1 Design Criteria	Flow Design Flow Daily Average 106,000 m^3/day Daily Maximum 106,000 m^3/day Hourly Maximum 232,000 m^3/day(Dry) Hourly Maximum 624,000 m^3/day(Rain) Load Influent - BOD_5 Load 21,200 kg-BOD_5/day Influent - SS Load 21,200 kg-SS/day	Water Quality - Influent BOD_5 200 mg/l SS 200 mg/l Removal Rate BOD_5 88 % SS 83 % Water Quality - Effluent BOD_5 25 mg/l SS 35 mg/l	
2 Flow Diagram	(Inlet) ↓ Screen & Grit Chamber ↓ Anaerobic Pond ↓ Facultative Pond ↓ Maturation Pond ↓ Storm Water Settling Tank ↓ (Outlet)	(Inlet) ↓ Screen & Grit Chamber ↓ Complete Mixing Lagoon ↓ Partial Mixing Lagoon ↓ Storm Water Settling Tank ↓ Disaffection Tank ↓ (Outlet)	(Inlet) ↓ Screen & Grit Chamber ↓ Oxidation Ditch ↓ Sedimentation Tank ↓ Storm Water Settling Tank ↓ Disinfection Tank ↓ (Outlet) Sludge Thickening Tank Sludge Drying Bed
3 Outline of Major Facilities	1) Grit Chamber Type: Plug Flow, Rectangular Dimension L = 22.0 m W = 3.0 m D = 1.5 m Number (2-standby) 8 units Surface Area 528 m^2 Surface Load 1,576 m^3/m^2/day	1) Grit Chamber Type: Plug Flow, Rectangular Dimension L = 22.0 m W = 3.0 m D = 1.5 m Number (2-standby) 8 units Surface Area 528 m^2 Surface Load 1,576 m^3/m^2/day	1) Grit Chamber Type: Plug Flow, Rectangular Dimension L = 22.0 m W = 3.0 m D = 1.5 m Number (2-standby) 8 units Surface Area 528 m^2 Surface Load 1,576 m^3/m^2/day
	2) Anaerobic Pond Type: Rectangular BOD-Volumetric Load (at 9 oC) = 100.00 kg-BOD/m^3/day BOD Removal 50 % BOD - Effluent 100.0 mg/l Dimension L = 85.0 m W = 130.0 m D = 4.0 m Number (1-standby) 8 units Surface Area A = 88,400 m^2 Volume V = 353,600 m^3 Retention Time T = 2.50 days	2) Complete Mixing Aerated Lagoon Type: Rectangular Dimension L = 104.0 m W = 75.0 m D = 3.0 m Number 8 units Surface Area A = 62,400 m^2 Capacity V = 187,200 m^3 Retention Time 0.00 days Aerator Power 1120.0 kW - Oxygen Supply 696.3 kW - Agitation 1113.0 kW	2) Oxidation Ditch Type: Circular Channel Dimension L = 340.0 m W = 6.0 m D = 3.0 m Number 20 units Surface Area A = 40,800 m^2 Volume V = 122,400 m^3 Retention Time T = 27.7 hours Oxygen Supply 1,767 kg-O2/hr Aerator Power 930 kW Sludge Age 20.1 day

Treatment Method	Stabilization Pond	Aerated Lagoon (Dual Power)	Oxidation Ditch
3 Outline of Major Facilities	3) Facultative Pond Type Rectangular Req'd Surface Area 60.3*1.0993^T = 749,795 m^2 where, T = 9 °C Dimension L = 470.0 m W = 200.0 m D = 1.5 m Number 8 units Surface Area A = 752,000 m^2 Volume V = 1,128,000 m^3 Retention Time T = 10.6 days	3) Partial Mixing Aerated Lagoon Type Rectangular Dimension L = 47.0 m W = 72.0 m D = 4.0 m Number-Basin 8 units -Cell/Basin 3 units -Cell (stand-by) 2 units Surface Area A = 81,216 m^2 Volume V = 324,864 m^3 Retention Time T = 3.00 days Aerator Power 220.0 kW - Agitation 212.0 kW	3) Final Sedimentation Tank Type Circular Tank Dimension L = 26.0 m dia. D = 3.0 m Number 20 units Surface Area A = 10,613 m^2 Surface Load 10.5 $m^3/m^2/day$ Volume V = 30,248 m^3 Retention Time T = 6.8 hours
	4) Maturation Pond Type Rectangular Retention Time 9 days Dimension L = 380.0 m W = 70.0 m D = 1.5 m Number-Series 8 units -Basin 3 Surface Area A = 638,400 m^2 Volume V = 957,600 m^3 Retention Time T = 9.0 days	4) Storm Water Settling Tank Type Rectangular Dimension L = 8.0 m W = 70.0 m D = 3.0 m Number (2-standby) 8 units Surface Area A = 4,480 m^2 Volume V = 13,440 m^3 Surface Load 116.7 $m^3/m^2/day$ Retention Time T = 0.62 hour	4) Storm Water Settling Tank Type Rectangular Tank Dimension L = 9.0 m W = 20.0 m D = 3.0 m Number(2-standby) 20 units Surface Area A = 3,600 m^2 Surface Load 121.0 $m^3/m^2/day$ Volume V = 10,800 m^3 Retention Time T = 0.60 hours
	5) Storm Water Settling Tank Type Rectangular Dimension L = 27.0 m W = 20.0 m D = 3.0 m Number (2-standby) 8 units Surface Area A = 4,320 m^2 Surface Load 120.99 $m^3/m^2/day$ Volume V = 12,960 m^3 Retention Time T = 0.60 hours	5) Disinfection Tank Type Rectangular Dimension L = 121.0 m W = 9.0 m D = 3.0 m Number 2 units Surface Area A = 2,178 m^2 Volume V = 6,534 m^3 Retention Time T = 15.1 min.	5) Disinfection Tank Type Rectangular Dimension L = 240.0 m W = 5.0 m D = 3.0 m Number 2 units Surface Area A = 2,400 m^2 Volume V = 7,200 m^3 Retention Time T = 16.6 min.

Treatment Method	Stabilization Pond	Aerated Lagoon (Dual Power)	Oxidation Ditch
3 Outline of Major Facilities			6) Sludge Thickening Tank Type: Circular Tank Dimension L = 13.0 m dia. D = 4.0 m Number: 2 unit Surface Area A = 265 m^2 Solid Matter Load: 65.9 $kg/m^2/day$ Volume V = 1,061 m^3
			7) Sludge Drying Bed Type: Drying Bed Thick'd Sludge: 349.8 m^3/day Dimension L = 60.0 m W = 20.0 m D = 0.3 m Number: 30 units Surface Area A = 36,000 m^2 Volume V = 10,800 m^3 Retention Time T = 30.9 days
4 Power Consumption excluding: - office - lighting	Approx. 0 kW	Aerator Complete Mixing: 1120 kW Partial Mixing: 220 kW Disinfection: 30 kW Total: 1,370 kW Approx. 1,370 kW	Aerator Oxidation Ditch: 930 kW Sludge Collector Sedimentation Tank: 30 kW Sludge Thickener: 3 kW Sludge Pump Return: 440 kW Surplus: 110 kW Disinfection: 30 kW Total: 1,543 kW Approx. 1,540 kW
5 Area Requirement	Grit Chamber: 528 m^2 Anaerobic Pond: 88,400 m^2 Facultative Pond: 752,000 m^2 Maturation Pond: 638,400 m^2 Storm Water Settling Tank: 4,320 m^2 Total: 1,483,648 m^2 Approx. 297 ha	Grit Chamber: 528 m^2 Complete Mixing Lagoon: 62,400 m^2 Partial Mixing Lagoon: 81,216 m^2 Storm Water Settling Tank: 4,480 m^2 Disinfection Tank: 2,178 m^2 Total: 150,802 m^2 Approx. 30 ha	Grit Chamber: 528 m^2 Oxidation Ditch: 40,800 m^2 Sedimentation Tank: 10,613 m^2 Storm Water Settling Tank: 3,600 m^2 Disinfection Tank: 2,400 m^2 Sludge Thickening Tank: 265 m^2 Sludge Drying Bed: 36,000 m^2 Total: 94,207 m^2 Approx. 19 ha

Area requirement of three methods are:

- Stabilization Pond approx. 297 ha
- Aerated Lagoon approx. 30 ha
- Oxidation Ditch approx. 19 ha

Area required for stabilization pond is approx. 297 ha, or about 1.5 km long and 2 km wide, and the area is so large. In this respect, stabilization pond is not suitable to construct in the surrounding area of Tirana City and excluded from the further study.

3) Construction Cost

Rough construction cost is estimated as shown below:

Unit: Thousand US$

Item	Aerated Lagoon		Oxidation Ditch
Construction Cost			
Civil Work	7,572		9,410
Mechanical/Electrical Work	6,021		15,960
Sub-Total	13,593		25,370
Land Acquisition Cost (30 ha)	3,000	(19 ha)	1,900
Total	16,593		27,270

In this cost estimate, land acquisition cost is assumed at 10 million Lek per ha, or 1,000 Lek (10 US dollar) per square meter.

Through the cost comparison, it becomes apparent that that the aerated lagoon method is far economical than the oxidation ditch method, even land acquisition cost is included.

4) Operation and maintenance cost

Annual operation and maintenance cost is estimated as follows.

Unit: US$

Item	Aerated Lagoon		Oxidation Ditch	
Electricity Cost	(1,370 kW)	360,036	(1,540 kW)	404,714
Personnel Expenses	(25 persons)	90,000	(30 persons)	108,000
Spare Parts for M/E facilities	(1 %)	6,021	(1 %)	15,960
Total		456,057		528,674

Since oxidation ditch requires sludge treatment, more personnel is necessary. In this estimate, annual cost of spare parts for mechanical/electrical facilities is minimized and estimated at 1 % of construction cost. In addition to this annual expenses, mized and estimated at 1 % of construction cost. In addition to this annual expenses, 5 % of construction cost of mechanical/electrical facilities is, however, required for overhaul taking into account that service life of mechanical/electrical facilities is evaluated approximately 15 years and most of facilities shall be replaced after 15 years of operation.

5) Reliability of treatment

The oxidation ditch method is flexible to the fluctuation of sewage flow and quality by its long retention time in reactor tank (approximately 35 hours or 1.45 days). While, the aerated lagoon method is much flexible due to longer retention time in complete and partial mixing lagoons (approximately 90 hours or 3.75 days).

As for stability in sewage temperature fluctuation, the oxidation ditch method is good, while, BOD removal in aerated lagoon is affected by sewage temperature. The size of lagoons, however, is considered the coldest condition in Tirana. Then, both method are considered stable in sewage temperature fluctuation.

The aerated lagoon equipped with aerators has less mechanical/electrical equipment than the oxidation ditch which has aerators, sludge collectors, sludge pumps. In case of defects on equipment, sewage treatment in the oxidation ditch will be affected seriously than the aerated lagoon.

6) Difficulty of operation and maintenance

The oxidation ditch method is inferior to the aerated lagoon method in terms of operation and maintenance due to the following reasons:

a. Oxidation ditch method requires more mechanical/electrical equipment which also necessitate much maintenance for proper operation.
b. Oxidation ditch method has sludge treatment in daily operation, which consists of sludge removal, thickening and drying and requires additional manpower to the sewage treatment.

7) Conclusion

Aerated lagoon method is recommended for this particular project in view of its superiority in power consumption, construction and operation/maintenance cost, as well as ease of operation and maintenance. While oxidation ditch has an advantage on area requirement, but the difference is not such as to impact construction cost.

7.6 Study of On-Site Treatment

7.6.1 Objectives of the Study

On-site wastewater treatment/disposal is an important mean, not only for small rural communities, but also for urban household/s unserved by the public sewerage system. The study of on-site treatment/disposal was hereby taken up as an intermediate countermeasure for those unserved households in the Study Area until the proposed sewerage system be serviceable. This study results indicate several technical options for application of the on-site treatment/disposal methods as well as recommendations on associated problems to help maintain public hygiene and living environment at desirable level.

Reference is made to the lAppropriate Technology for Treatment of Wastewaters for Small Rural Communitiesl (Lyon, 1982, EURO Reports and Studies, WHO Regional Office for Europe).

7.6.2 Septic Tank with Infiltration as Typical Method

Systems with septic tanks are the most commonly applied method. After certain treatment in a septic tank, the effluent is usually disposed into the soil by several means. However, the design and size of the infiltration units/facilities play an important role to attain the satisfactory performance of this technical option.

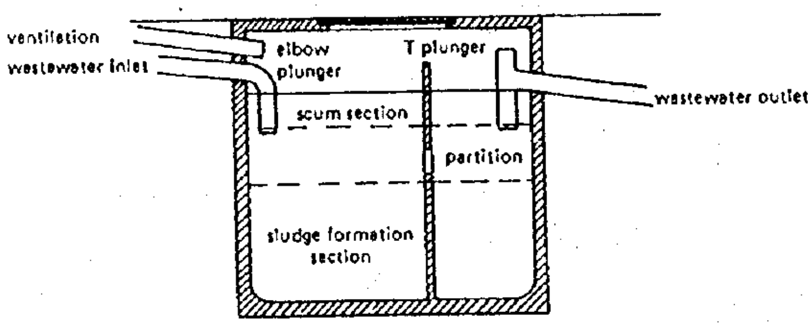
This method is practically suitable for treatment of domestic wastewater of single household, institution and small communities (or apartment type housing accommodating more than 5 households).

(1) Design of septic tank

Septic tank shall be constructed with the use of watertight materials and composed of two compartments as shown in Figure 7.6.1.

Domestic wastewater (both sullage and fecal wastewater) is carried into the first compartment of the septic tank. In this compartment, solid wastes is settled to form a sludge layer and processed under anaerobic digestion. Further sedimentation as well as sedimentation of sludge that has been re-suspended by peak flow takes place in the second compartment, which is generally half the size of the first compartment.

Figure 7.6.1 Typical Design of Septic Tank



Source: L'assainissement individuel - principes et techniques actuelles. Paris. Ministère de l'Environnement et de Cadre de Vie et Agence de Bassin Loire-Bretagne. 1980.

The treatment performance largely depends on climatic conditions (particularly temperature). BOD may be reduced by 30-50%, while the total suspended solids (TSS) by 50-70%. Physico-chemical characteristics of treated effluent generally restrict direct disposal to surface water body or an aquifer (cesspool, fissured subsoil, etc.).

The required size of septic tank depends on the following design conditions:

1) Influent wastewater flow

   Attention shall be paid to reduce water consumption for economical sizing of septic tank; such as replacement of conventional flush toilets by water-saving designs (pour flush, etc.).

2) Retention time required for effective sedimentation of solid wastes

   The required retention time for solid sedimentation depends on the number of users.

3) Sludge accumulation rate

   The sludge accumulation rate varies considerably depending on climatic conditions, ranging from 30 liters/person/year in southern Europe to 70 liters/person/year in the north.

4) Frequency of desludging

   The frequency of desludging depends on the rate of sludge accumulation and the cost of its removal. In different European countries, the desludging frequency varies from twice a year to once every four years, although yearly or twice-yearly intervals are usually recommended.

(2) Disposal of treated effluent

There are several technical options for disposal of treated effluent, such as soak pit, sub-surface irrigation system, and sand filters. Selection of these technical options largely depends on land availability and volume of treated effluent. However, septic tank with irrigation system is becoming popular for both individual household and community sanitation (for up to 1,000 people in some European countries).

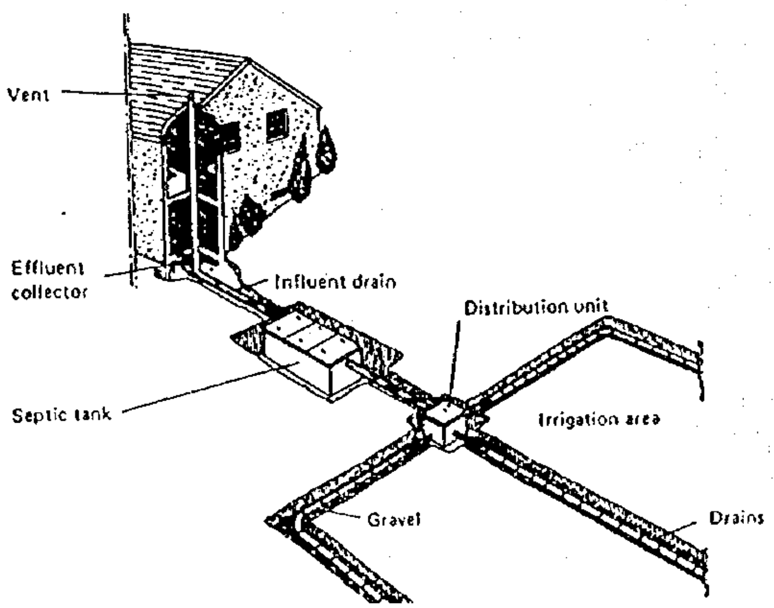
1) Subsurface irrigation system

This system disposes the treated effluent of septic tank by means of infiltrating into the soil through drains embedded in a filtering media. Principal design of this system is exhibited in Figure 7.6.2.

Additional options to this system are to include:

- Pre-filter upstream of the distribution unit to serve as a precaution against silting of the drains since it is an indicator of the functioning of the septic tank.
- Flushing cistern to ensure better distribution of the wastewater in the treatment unit.

Figure 7.6.2 Principal Design of Shallow Subsurface Irrigation System



Source: L'assainissement individuel-principles et techniques actuelles. Paris, Ministère de l'Environnement et du Cadre de Vie et Agence de Bassin Loire-Bretagne. 1980

Subsurface filtration system consists of a series of narrow (0.5 to 1 m) leaching trenches or one or more sand filters. The choice between trenches or filters depends on the nature of the soil and the land immediately surrounding the system, as shown in Figure 7.6.3.

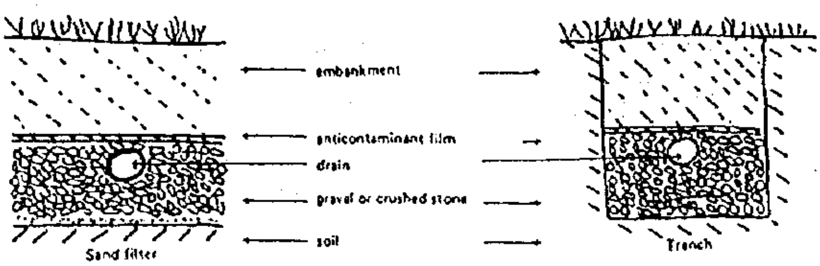
a. Trenches

Trenches are suitable for the locality where the soil is not permeable enough and is difficult to work on. Trenches can accommodate certain storage of the effluent, since the walls of trenches play a useful role in the infiltration process.

b. Sand filters

Sand filters are more compact and are particularly suitable when the soil is permeable, and when the site does not present any topographical problems or difficulties due to the presence of impermeable strata.

Figure 7.6.3 Subsurface Filtration System (Trench & Sand Filter)



Source: L'èpandage des eaux usèes domestiques. Tude prèalable de l'aptitude des sols et règles de dimensionnement des installations. Paris, CTGRF. Etude No. 50, 1980.

2) Alternative measures of subsurface filtration

More costly alternative measures are available for subsurface filtration, when the environmental conditions restrict the application of the above mentioned methods, particularly:

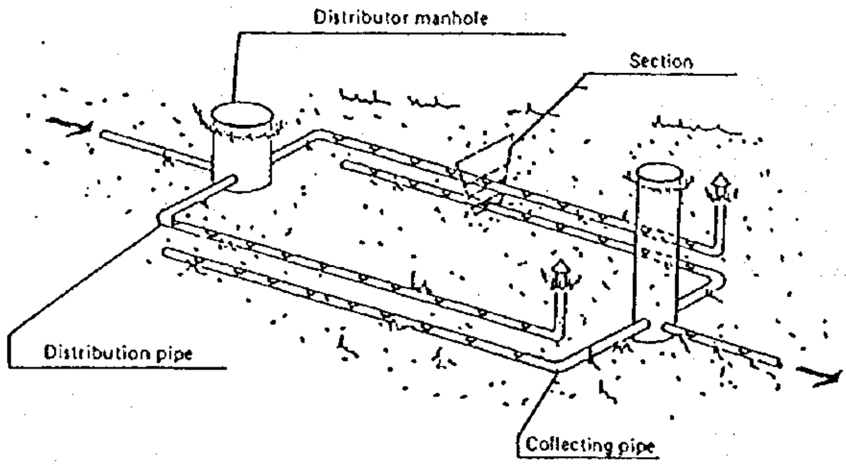
- when unprotected groundwater is located near the surface; and
- when the soil stratum is not sufficiently thick.

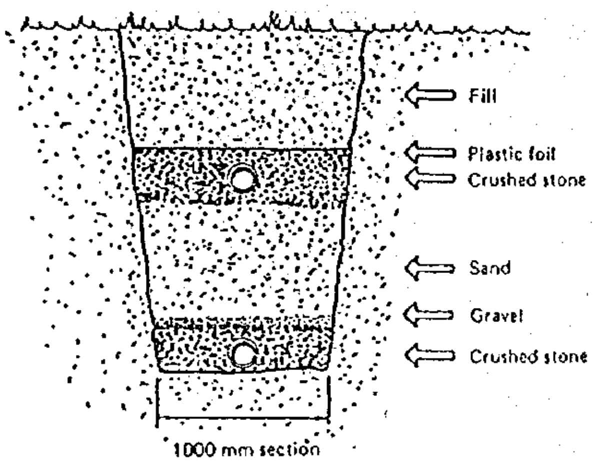
Three alternative measures are considered as follows:

a. Drained sand filter

This method is useful when the permeability of soil is too poor or when groundwater table is too shallow (0.5 to 1 m). this method shall be used only in case where the effluent can be discharged into surface environment, as shown in Figure 7.6.4.

Figure 7.6.4 Drained Sand Filter for a Single Household

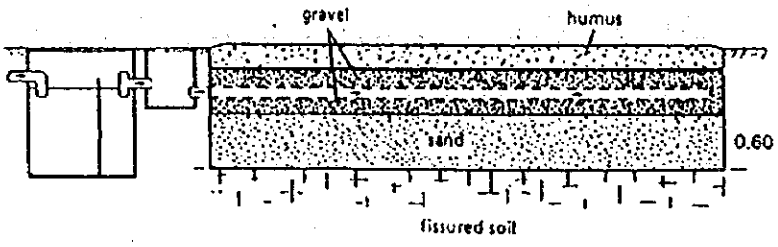




b. Undrained sand filter

This is a modified method of the above mentioned drained sand filter and applicable when the soil stratum is not sufficiently hick, but does allow infiltration of effluent after treatment (fissured substratum), as shown in Figure 7.6.5.

Figure 7.6.5 Undrained Sand Filter

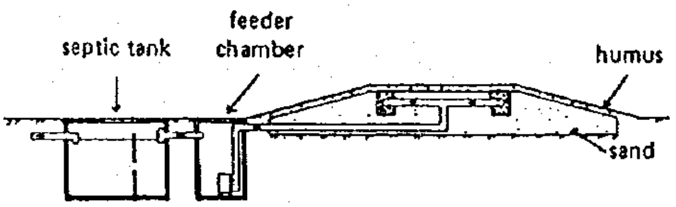


Source: *L'assainissement individuel-principles et techniques actuelles.* Paris, Ministère de l'Environnement et du Cadre de Vie et Agence de Bassin Loire-Bretagne. 1980

c. Raised sand filter

This sand filter is installed in a mound (approximately 1 m) of sand placed on the natural ground surface after leveling. This method is applicable if an aquifer is close to the surface (0.5 to 1 m depth) and if the effluent cannot be discharged into the environment. In application of this method, the soil must be sufficiently permeable, as shown in Figure 7.6.6.

Figure 7.6.6 Raised Sand Filter



Source: *L'assainissement individuel-principles et techniques actuelles.* Paris, Ministère de l'Environnement et du Cadre de Vie et Agence de Bassin Loire-Bretagne. 1980

7.6.3 Compact Aerobic Domestic Sewage Treatment Module

Septic tank associated with infiltration system has several limitations on its application that:

- it is applicable to rural and suburban areas where necessary open space is available to construct infiltration system.
- it is applicable to the area where soil conditions are favorable for infiltrating effluent from septic tank.

In other word, when the sufficient area is densely populated and open space to construct infiltration system is not available, and/or soil conditions are impermeable, the said treatment/disposal method of domestic sewage is no suitable.

To meet with the above mentioned restrictions on locality, there is an technical option among the on-site treatment/disposal methods which is so called the compact aerobic domestic sewage treatment module.

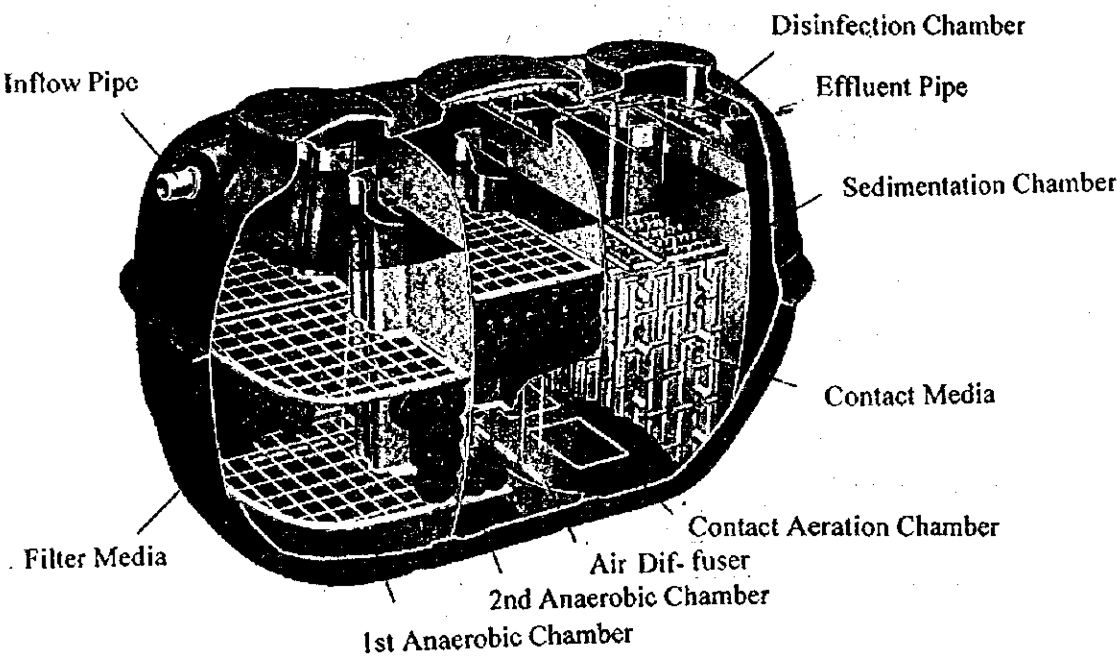
This compact treatment module employs a biological contact treatment method with diffuser of compressed air. It enables reduction of required space to more or less equivalent to septic tank by increased treatment efficiency and does not require infiltration system.

This compact treatment module has two different types in its application; one for only nightsoil treatment and the other for both nightsoil and other domestic sewage. Generally, this compact module achieves treatment efficiency of at least 30 m/l of BOD in its treated effluent. It requires, however, removal of excess sludge to be accumulated in the module at an interval of twice a year.

Different treatment capacity is available corresponding to sizes of households or apartment. A typical design of compact aerobic domestic sewage treatment module is shown in Figure 7.6.7.

When the future urban development in the Study Area is taken into account, this compact treatment module shall be considered for those apartment type housing to be constructed in the suburban area where the public sewerage system is not planned.

Figure 7.6.7 Typical Design of Compact Aerobic Domestic Sewage Treatment Module



7.6.4 Standardization of On-Site Treatment and its Application

In application of on-site treatment method, certain standardization will be indispensable not only from the view point of technical design, but also from the view point of legislative arrangement for massive application to the public. In addition, septage from septic tank shall be removed periodically to keep performance of septic tank. This pertains to provision of facility for final treatment and disposal.

(1) Technical standardization

Standardized design of septic tank is available at the Institute of Study and Design of Water Supply and Construction of the MOPWT.

Application of respective locality, such as urban area, suburban area, rural area is not clearly regulated. Furthermore, the standardized design is prepared only for septic tank without any infiltration system. In this regard, further research and development on this particular field is necessary.

In some locality, the septic tank with infiltration system may not be applicable and alternative measures, such as compact aerobic domestic sewage treatment module, need to be identified.

(1) Legislative arrangement of domestic sewage treatment/disposal

Although the public sewerage system will be implemented by responsible implementation agency in each locality, considerable number of households will be left behind from direct benefit of the public sewerage system and be forced to have individual treatment/disposal facilities of their domestic sewage.

For smooth introduction and application of appropriate treatment/disposal method, an legislative arrangement will be required:

- Building permission shall be approved upon submission of appropriate installation plan of septic tank or equivalent facility and plumbing schedule for disposal of effluent.
- Type and required efficiency of domestic sewage treatment facility shall be stipulated in the pertinent regulation.
- Penalty clause shall be provided in the pertinent regulation to restrict building without appropriate domestic sewage treatment facility and plumbing schedule (water supply to such building may be terminated until such illegal condition is rectified).
- Financial incentives, such as soft loan facility to individual households, shall be considered to be rendered by the local government for smooth implementation of appropriate domestic sewage treatment facility.
- Health and hygiene education to the public shall be initiated to enhance an importance of public hygiene practice and community participation.

CHAPTER 8
OVERALL PLAN AND PRELIMINARY DESIGN OF SEWERAGE SYSTEM

CHAPTER 8 OVERALL PLAN AND PRELIMINARY DESIGN OF SEWERAGE SYSTEM

8.1 Sewage Collection System

(1) Sewage collection method

Although the separate sewer system is selected as the most optimum sewage collection method in improving the existing sewer network, it is excluded from the scope of preliminary design since it shall be dealt with under the master planning basis of the whole city.

Therefore, the scope of preliminary design for improvement of existing sewers is focused on interceptor mains with associated storm overflow chambers and storm discharge outlets for the existing combined sewer system. The method of improvement is to replace existing sewers having insufficient flow capacity with new pipes to meet with the planned sewage flow.

(2) Improvement of existing sewer system

The scope of preliminary design for improvement of existing sewers is focused on interceptor mains with associated storm overflow chambers and storm discharge outlets.

The method of improvement is to replace existing sewers having insufficient flow capacity with new pipes to meet with the planned sewage flow which is secondary recommended measures as Case-1 in preceding subsection 7.3.

The target sewers for improvement are listed below by their drainage zone:

- Tirana River Zone	:	Dia. - 700 mm to 1,800 mm, 1,751 m
		Storm overflow chamber - 4 units
- Center Zone	:	Dia. - 1,300 mm to 1,900 mm, 2,259 m
		Storm overflow chamber - 3 units
- Lana-North Zone	:	Dia. - 900 mm to 1,400 mm, 3,567 m
		Storm overflow chamber - 14 units
- Lana-South Zone	:	Dia. - 900 mm to 1,500 mm, 2,993 m
		Storm overflow chamber - 19 units

Figure 8.1.1 shows the location with improvement part of interceptor mains and storm overflow chambers.

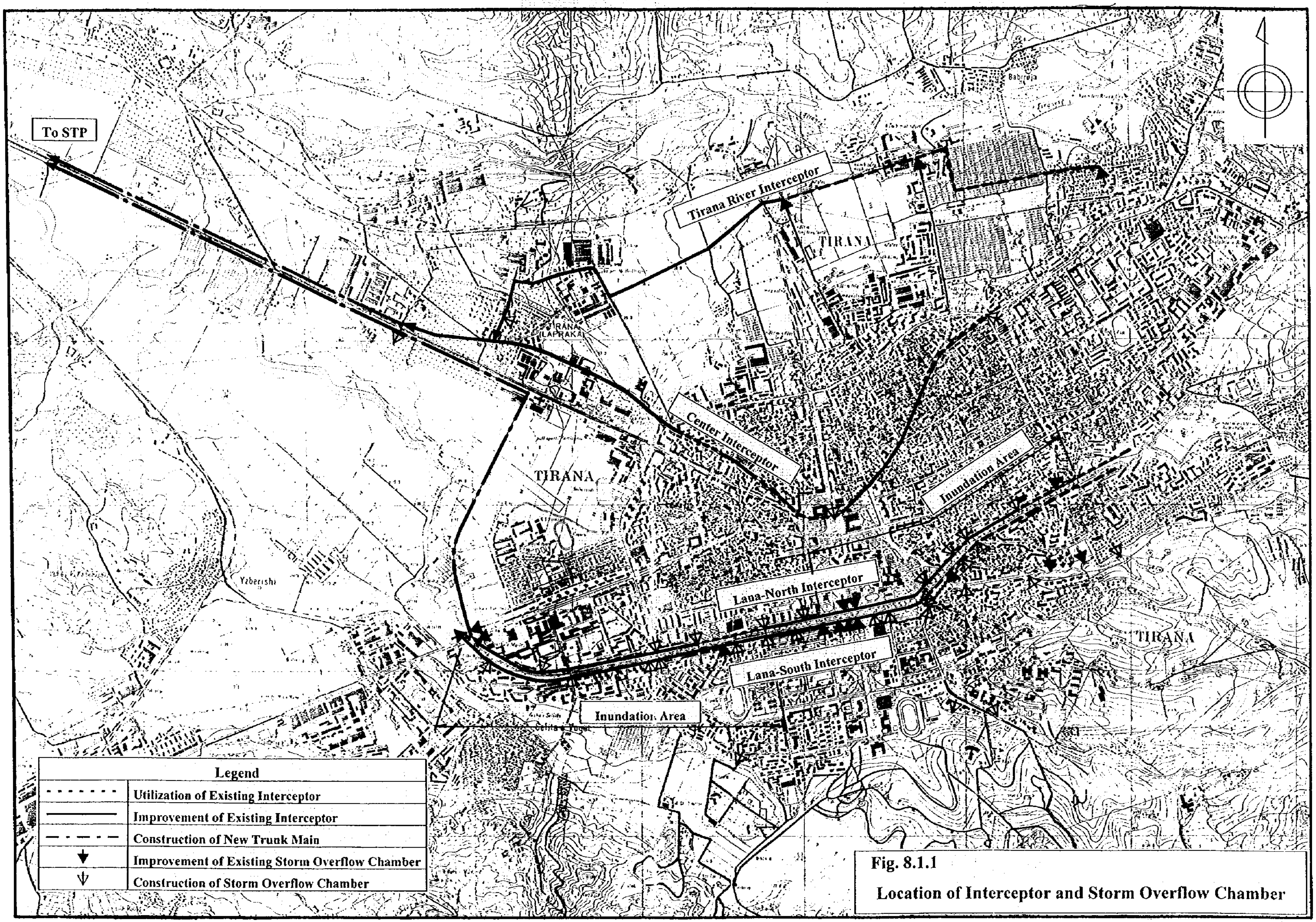


Fig. 8.1.1

Location of Interceptor and Storm Overflow Chamber

(3) Extension of trunk main

The proposed route of trunk main which convey sewage collected by interceptor mains to the proposed sewage treatment plant is presented in Figures 8.1.2.

There are two alternative plans for trunk main from junction point of Tirana interceptor main and Lana interceptor main at the end of the sewerage planning area, up to the sewage treatment plant. These alternatives are single line plan and dual (parallel) line plan for the length of about 11 km. Comparative study is made for these alternatives as follows:

Table 8.1.1 Alternative Plan for Trunk Main

<table>
<tr><th rowspan="2">Alternative</th><th rowspan="2">Trunk Main</th><th rowspan="2">Zone</th><th colspan="2">Planned Sewage Flow</th><th colspan="5">Specification of Planned Sewer Pipe</th></tr>
<tr><th>Q (m³/sec)</th><th>3Q (m³/sec)</th><th>Range</th><th>Dia. (mm)</th><th>I (‰)</th><th>V (m/sec)</th><th>Q (m³/sec)</th></tr>
<tr><td rowspan="8">Dual</td><td rowspan="3">Lana River Trunk Main</td><td>Lana-North</td><td>0.706</td><td>2.117</td><td>Min.</td><td>1,400</td><td>6.0</td><td>2.96</td><td>4.557</td></tr>
<tr><td>Lana-South</td><td>0.755</td><td>2.266</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sub Total</td><td>1.461</td><td>4.383</td><td>Max.</td><td>2,000</td><td>1.0</td><td>1.53</td><td>4.807</td></tr>
<tr><td rowspan="5">Tirana River Trunk Main</td><td>Tirana River</td><td>0.424</td><td>1.273</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Center</td><td>0.280</td><td>0.838</td><td>Min.</td><td>1,300</td><td>6.0</td><td>2.82</td><td>3.743</td></tr>
<tr><td>Kombinat</td><td>0.106</td><td>0.318</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>USAID</td><td>0.404</td><td>1.211</td><td>Max.</td><td>1,800</td><td>1.0</td><td>1.43</td><td>3.639</td></tr>
<tr><td>Sub Total</td><td>1.214</td><td>3.641</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Single</td><td rowspan="2">-</td><td rowspan="2">Total</td><td rowspan="2">2.675</td><td rowspan="2">8.024</td><td>Min.</td><td>1,900</td><td>4.0</td><td>2.96</td><td>8.39</td></tr>
<tr><td>Max.</td><td>2,500</td><td>1.0</td><td>1.38</td><td>8.73</td></tr>
</table>

Note: Planned Sewage Flow as Hourly Maximum in 2010

Total construction cost of these alternatives is assumed have the difference of 100 (Single) : 135 (Dual) and the initial construction cost is approximately 100 (Single): 72 (Dual).

In addition to the above, it is determined to adopt dual trunk main plan considering the following advantages:

- Applicability and flexibility to introduce the separate sewer system in the future, and
- Reduction of initial cost requirement.

Scope of dual trunk main plan is as follows:

- Tirana River Trunk Main : Dia. 1,200 mm to Box 1,600 x 1,600 mm, 10,700 m
- Lana River Trunk Main : Dia. 1,650 mm to Box 1,700 x 1,700 mm, 13,500 m