PART II-1:FEASIBILITY STUDY FOR TULCEA WWTP PROJECT

CHAPTER 1 EXISTING CONDITIONS

1.1 STUDY AREA

Tulcea City is situated in the southeastern part of Romania, bordered by the Danube River to the north, and hilly lands to the south and west. The City has administration area of approximately 1,650 ha, comprising residential districts of 514 hectares and agricultural lands of 50 ha. Ground elevations in the central districts close to the river bank vary from 5 to 10 m above the mean water level of the Black Sea (MWL), which gradually rise toward the south and west hilly areas. The City's general map is illustrated in *Figure II.1.1*.

1.2 NATURAL CONDITIONS

1.2.1 TEMPERATURE

The Black Sea and the abundance of water and wet lands existing in the area influence the climate in the area. The average annual temperatures is 11℃, with the highest temperature of 24℃ in July, 21℃ in September. The highest temperature ever recorded is 38.7℃ in September 1945, and the lowest temperature is -26.8℃ in January 1948. The solar radiation is over 125 Kcal/cm^2.

1.2.2 PRECIPITATION

The average annual precipitation in the City is about 400 mm which is among the groups of lowest precipitation in Romania. The average monthly precipitation in January is about 30 mm and in July from 30 to 45 mm. Annually average 25 days have the precipitation of more than 10 mm, and average 15 days have snow with depth of 7 cm or less. Humidity in summer is relatively low ranging at 10 to 20 %, but in winter it goes up to 45 to 50 %.

1.2.3 WIND

The prevailing wind directions are northeast to southwest. The wind from north to northeast is cold and is the most important and influential wind in the area from the viewpoints of intensity and duration. The recorded winds in the last five years are as shown in the following table:

Table II.1.1 Winds in the Last Five Years (1990 to 1994)

Wind direction	N	NE	E	SE	S	SW	W	NW	Calm
Frequency (%)	9.6	6.0	4.3	5.6	10.9	6.2	14.4	19.9	23.1
Average velocity m/s)	4.0	3.7	3.0	3.2	4.8	4.0	2.8	3.6	

Source: Tulcea City

1.2.4 HYDROLOGY IN THE AREA

The groundwater elevations are more or less constant throughout the area but at the different depths depending on the location. In the low-lying areas, the groundwater elevations are generally high ranging from 0.5 to 4.0 m deep, varying with ground elevations and influenced by the Danube River water levels. In the hilly areas, the hydrostatic levels are found at the bottom of the dry loess layer or completely disappear. These exist at the depth as low as 55 m in certain unintercepted area. It should be noted that sulfuric compounds, contained in the groundwater with delta type alluvial deposits or with peat contained, are aggressive against concrete.

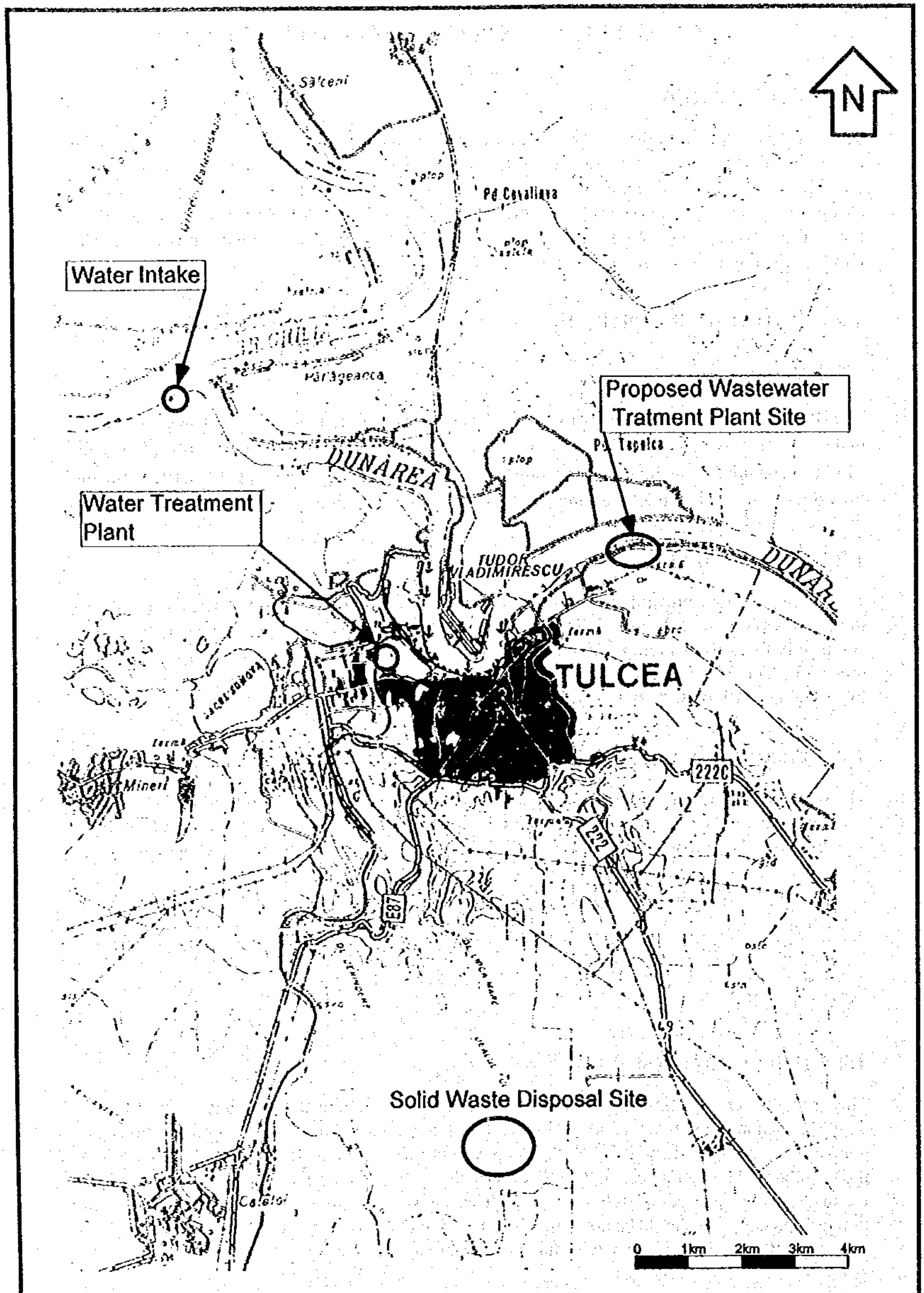

Figure II.1.1	General Map of Tulcea City

1.2.5 HYDROLOGICAL NETWORKS IN DANUBE DELTA

The main watercourse in the Danube Delta consists of four arms; namely i) Chilia, ii) Tulcea, iii) Sulina, and iv) Sfantu Gheorghe, through which the River flows down into the Black Sea. The City's major urban and industrial districts are located at the right bank of the Bratul Tulcea (Tulcea Branch), an arm running between the stretches of land Chilia and Sf. Gheorghe. The Tulcea branch stretches about 19 km with the maximum width of about 300 m, the deepest portion being 39 m. The branch carries about 40 % of the total river water flow.

The secondary hydrological networks of the Danube Delta consist of four components; i) creeks, former arms of the Danube, which are getting clogged, ii) backwaters, smaller creeks, iii) *periboinas,* littoral loopholes where water is exchanged), and iv) channels, rectified and dredged. Besides, there are also simple formations of a depression-lacustrine nature, such as marshes (0.5 to 3 m deep), estuaries (by the mouth of rivulets), lagoons (old marine gulfs), swamps (low water that may vanish), japas (pool left by high waters), as well as complex ones such as depression lakes. The Delta hydrographic basin also comprises the corresponding littoral line, the maritime zone along the coast, 10 to 15 km wide, less than 25 m deep, influenced by the flow of the sweet water.

1.3 SOCIOECONOMIC CONDITIONS

1.3.1 POPULATION

As given in the table below, the City has a total population of 96,278 (as of 1998). In the last several years, the City's population have remained almost unchanged, and the population in 2010 is estimated to be 100,000. The number of houses is estimated at 30,277 in 1997, the number of persons per house being calculated at 3.2. In addition, the City has about 10,000 daytime visitors and about 25,000 to 30,000 tourists during the tourism seasons, from May through October.

Table II.1.2 Past Trend and Projection of Populations

Year	1930	1948	1956	1966	1977	1992	1995	1998	2010
Population	20,403	21,642	24,639	35,561	61,729	98,727	97,214	96,278	100,000

Source: Tulcea City

1.3.2 INDUSTRIES

The number of employees totaled 46,307 in 1995. Out of it, the primary, secondary and tertiary sectors accounted for 6.7%, 51.2% and 42.2% respectively. The predominance of the secondary sector is to be noted. Especially, the number of workers in the manufacturing industry reached 18,644, occupying 40.3% of the entire workforce.

Table II.1.3 Number of Employees by Type of Industrial Activities (1995)

Item	Employees	%
Primary Industry	3,083	6.7
Secondary Industry	23,699	51.2
Manufacturing Industry	18,644	40.3
Production & Distribution of Electricity, Gas and Water	904	2.0
Construction	4,151	9.0
Tertiary Industry	19,525	42.2
Total	46,307	100.0

Source: Tulcea City

In the western part of the City, large shipbuilding and steel mill factories are located, whereas in the east industrial zone, major industries are food processing, machinery and chemical factories. Most of the major industries in the area are discharging wastewaters directly to the Danube River or other watercourses generally after treating them with their own treatment systems. Some of the medium- and small-scale industries are discharging wastewaters to the public sewers after treatment. Most major industries are using groundwater for the process water.

Features of the major industries located in the City are given in the following table:

Table II.1.4 Products, Employees and Wastewater Discharge of Major Industries

Name of Industries	Products	Number of Employees	Wastewater Discharge Points
SC BBG Alum SA;	Chemical	1,464	Sewers & Lake Somova
SC FEROM SA	Metallurgy	1,799	Sewers & Danube River
SC TREMAG SA	Metallurgy	590	Sewers & Danube River
Santierul Naval	Shipbuilding	2,555	Danube River
Transport Calatori	Public transport services	140	Sewers
SC Compref SA	Construction	77	Sewers
SC Delta Plan SA	Food industry	650	Sewers
SC Confectia SA	Cloth industry	1,743	Sewers
SC Marmura SA	Construction materials	314	Danube River
SC TULCO SA	Food industry	583	Danube River
SC Legume-Fructe SA	Vegetable-Fruit processing	30	Sewers
SC Dallco-Dunarea SA	Food industry	256	Danube River
SC Delta-Lact SA	Food industry	133	Sewers
SC TABCO SA	Food industry	372	Danube River
SC BERE-DELTA SA	Food industry	244	Danube River

Source: Tulcea City.

Agricultural productions are of cereal, grains, fruits, vegetables, canned products, meat and fish, and brewery.

1.3.3 Urban Development/Landuse Plan

The City's present land use plan covers urban districts of 1,650 ha, of which a 110-ha area belongs to Tudor Vladimirescu village.

The whole city area is designated into the following seven different zones:

- Agricultural area;	50 ha
- Forest;	6 ha
- Permanently flooded fields;	23 ha
- Unproductive area;	59 ha
- Building and urban arrangement	922 ha
- Central and other areas with various purposes for public uses,	46 ha
Residential and its auxiliary facilities,	514 ha
Industrial and agricultural areas,	293 ha
Parks, recreations and tourism areas,	47 ha
Communal service areas,	22 ha
- Field for special purposes,	268 ha
- Fields under construction and blocking to house lots,	28 ha

A city development plan was approved by the Local Council Decision No. 29/25.05. 1996 together with other related studies. The whole city area is designated into five major categories, including:

- Residential area;
- Industrial area;
- Communication(traffic) area;
- Green and environmental protection area; and
- Rural area (mainly used for agricultural purposes).

1.3.4 ORGANIZATION

The organization chart of Tulcea city office is shown in *Figure II.1.2.*

Sewerage service is operated by S.C. ACET S.A. S.C ACET S.A. is a commercialized company and the local council of Tulcea is the only shareholder.

S.C. ACET S.A has 334 personnel in total and operates water supply, sewerage, and district heating services. Technical part of the company consists of following sections.

- Water production section with 73 personnel,
- Water distribution and sewerage section with 79 personnel,
- District heating section with 61 personnel, and
- Workshop with 32 personnel.

The organization chart of S.C. ACET S.A is shown in *Figure II.1.3.*

1.3.5 FINANCIAL CONDITIONS OF THE CITY

It is stipulated in the law that the expenditure budget shall be equal to the income budget.

As shown in the table below, during 7 years 1992 to 1999, the local budget of Tulcea grew 194 times from ROL 289 million to ROL 56,150 million. Its average annual growth rate is calculated at 112.3%. During the same period, prices increased at the average annual rate of 76.9%. That is to say, the local budget increased in real terms by 20.0% per year on average.

Table II.1.5 Total Amount of Budget

1992	1993	1994	1995	1996	1997	1998	1999
289,063	1,541,106	4,180,279	11,079,461	15,374,334	32,602,384	38,402,432	56,150,000

Source: Tulcea City (Unit: million ROL)

The city budget of Tulcea for 1999 totals ROL 56,150 million, which is by 46.2% greater compared with the budget for 1998, ROL 38,402 million.

Because of the new local finance law which was put into force in January, 1999, there is no subsidy from the central government any longer. Under the law, 31.5% of the tax on salaries goes directly to the local government. Also, 45% of this tax is allocated for the state income budget, of which a part is transferred to the local government through the county as the quota. This quota is different from the direct transfer from the state, but by nature is an addition to the above direct local tax on salaries. It occupies the majority of the transfer from the state income budget. That is, in principle almost all the income of the city budget now derives from its own sources. It in turn gives freedom to the local authorities to use the income in whatever way they deem proper.

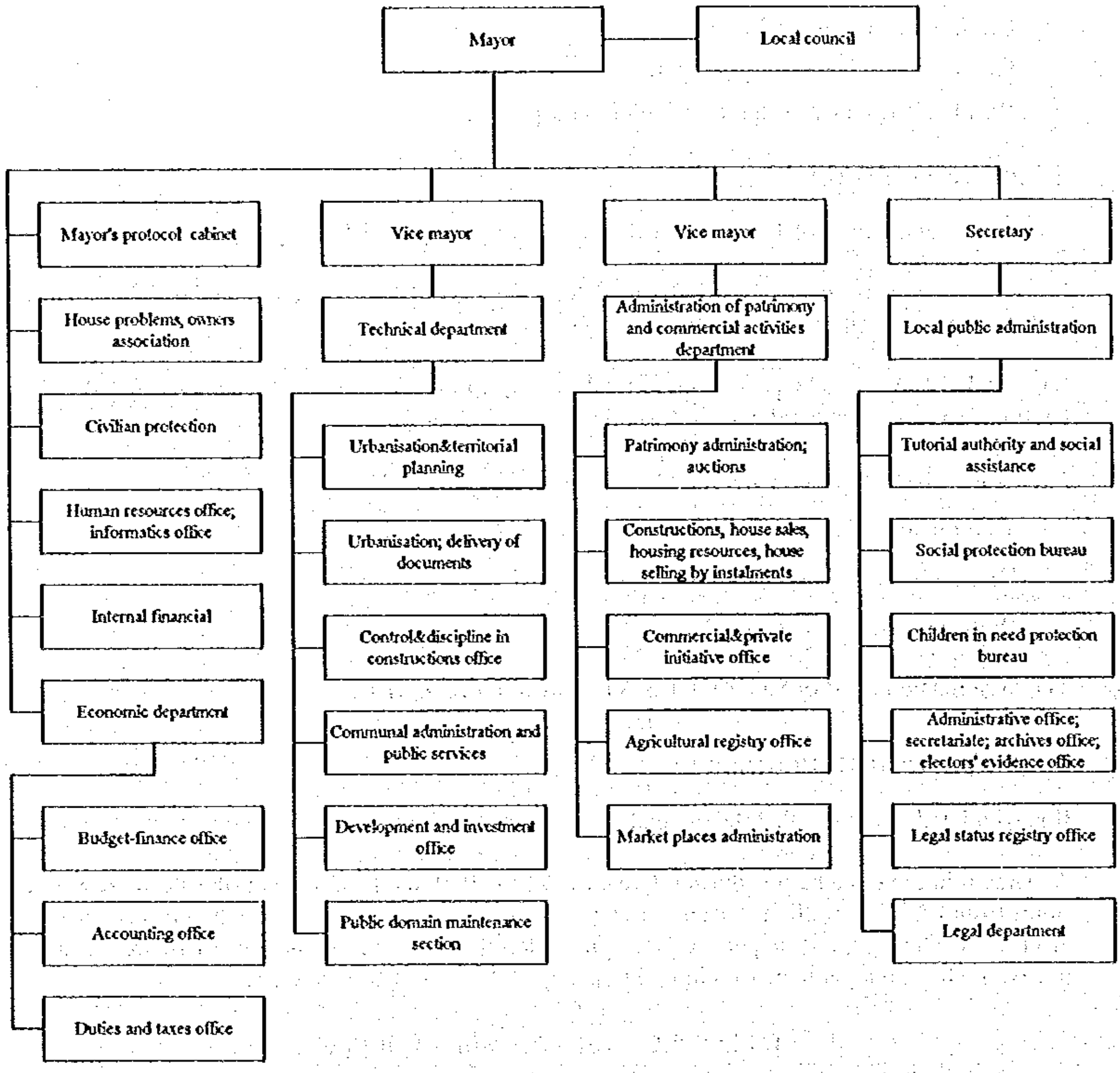

Figure II.1.2	Organization Chart of Tulcea City Office

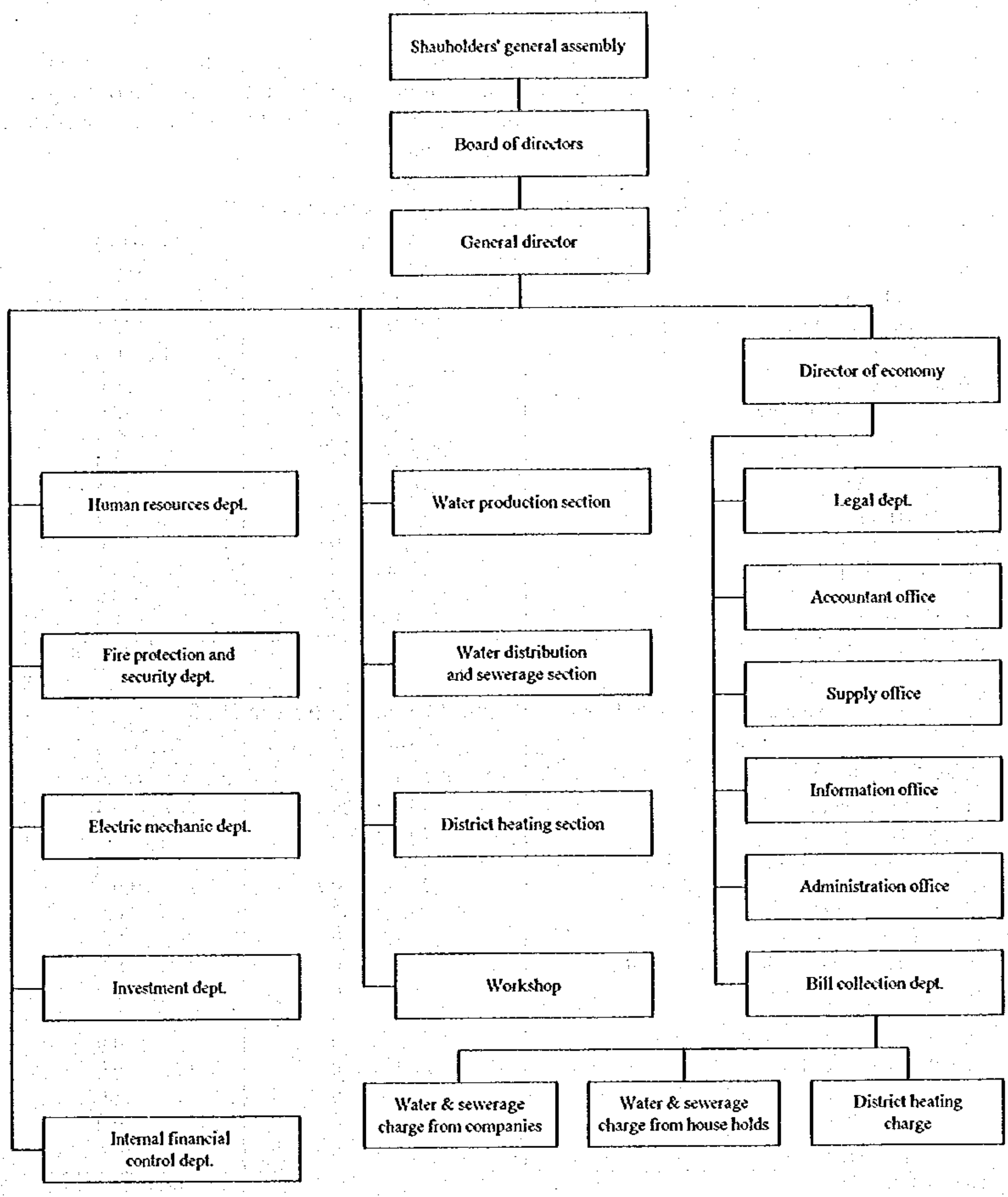

Figure II.1.3	Organization Chart of S.C. ACET S.A.

As shown in the table below, out of the city's total income budget of ROL 56,150 million in 1999, 51.9% came from its own sources and the balance of 48.1% was the transfer from the central government (most of which actually belongs to city's own resources).

Regarding the expenditure budget, capital expenditure, which is spent for the economic development of the city accounted for 20.1%. 60.1% or the majority of the expenditure budget went to "Services and Public Development, Dwellings, Environment and Water" which includes the sewerage sector. 23.3% was allocated for "Social-Cultural".

Table II.1.6 Breakdown of Local Budget for 1999

Item	Amount	Ratio (%)
Total Income	56,150,000	100.0
1. Own Income	29,150,000	51.9
2. Money from State Income Budget	27,000,000	48.1
3. Subsidy	0	0.0
Total Expenditure	56,150,000	100.0
1. Current Expenditure	44,283,200	78.9
1) Personnel	4,431,075	7.9
2) Services and Materials	20,139,752	35.9
3) Subsidies	18,100,000	32.2
4) Transfer	1,612,373	2.9
5) Interest	0	0.0
2. Capital Expenditure	11,308,000	20.1
3. Financial Operations	0	0.0
4. Reserves	558,800	1.0

Source: Tulcea City (Unit: 1,000 ROL)

Table II.1.7 Breakdown of Local Expenditure for 1999

Item	Amount	Ratio (%)
Total Expenditure	56,150,000	100.0
1. General Public Services	5,300,000	9.4
2. Social-Cultural	13,060,000	23.3
3. Services and Public Development, Dwellings, Environment and Water	33,761,000	60.1
4. Economic Activities	3,350,200	6.0
5. Other Activities	120,000	0.2
6. Guarantee and Redistribution Funds	0	0.0
7. Transfer	0	0.0
8. Loans Granted	0	0.0
9. Payment of Interest	0	0.0
10. Repayment of Loans	0	0.0
11. Reserve Funds	558,800	1.0
12. Special Destination Expenditure	0	0.0
13. Surplus/Deficit	0	0.0

Source: Tulcea City (Unit: 1,000 ROL)

1.3.6 FINANCIAL CONDITIONS OF S.C. ACET S.A.

S.C. ACET S.A. provides water supply, sewerage services and stream to the citizens of Tulcea.

(1) Water and Sewerage Charges

Since the beginning of 1998 up to now water and sewerage tariffs were revised 5 times. Sewerage tariffs are about one third compared with water tariffs.

As of June 11, 1999 the sewerage charges for domestic and industrial customers are ROL 576 and ROL 1,076 respectively.

Table II.1.8 Water and Sewerage Service Charges

Period	Water Supply		Period	Sewerage	
	Domestic	Industrial		Domestic	Industrial
Jan., 1998	1,045	2,215	Jan. 31, 1998	365	865
Feb., 1998	1,140	2,415	Mar. 31, 1998	395	940
Apr., 1998	1,240	2,630	Jun. 30, 1998	420	940
Jun., 1998	1,320	2,630	Jan. 25, 1999	448	1,003
Jan., 1999	1,510	3,010	Mar. 26, 1999	480	1,076
Jun., 1999	1,710	3,183	Jun. 11, 1999	576	1,076

Source: S.C. ACET S.A. (Unit: 1,000 ROL)

(2) Income from Water Supply and Sewerage Services

The total volume of wastewater discharged into sewerage was 6,325,000 m^3 in 1998. It occupied 57.5% of the total volume of water supply. The income from sewerage services came to ROL 3,339 million in the same year. It corresponded to 18% of the income from water supply.

Table II.1.9 Income from Water Supply and Sewerage Services for 1998

Item	1998		1st Half of 1999	
	Total Volume (1,000 m^3)	Total Income (1,000 ROL)	Total Volume (1,000 m^3)	Total Income (1,000 ROL)
Water	11,006	18,693,940	4,575	9,006,048
Sewerage	6,325	3,338,992	2,736	1,738,901

Source: S.C. ACET S.A.

The total volume of wastewater discharged into sewerage was 2,736,000 m^3 in the 1st half of 1999. The volume of sewage was 59.8% of that of water in the same period. The income from sewerage services came to ROL 1,739 million. It corresponded to 19.3% of the income from water supply.

(3) Financial Performances for Water Supply and Sewerage Services

S.C. ACET S.A. earned ROL 3,339 million, while it spent ROL 2,985 million, begetting a profit of 10.6% in sewerage services in 1998, although it lost in the preceding two years. A similar trend can be observed in water supply.

S.C. ACET S.A. earned ROL 1,739 million, while it spent ROL 1,960 million, resulting in a loss of ROL 221 million or 12.7% in sewerage services in the 1st half of 1999. Although it begot a little surplus in water supply in the same period, the combined results were negative as shown below.

Table II.1.10 Financial Performance for Water Supply and Sewerage Services

Item		1996	1997	1998	1st Half of 1999
Water Supply	Income	5,296,971	12,652,987	18,693,940	9,006,048
	Expenditure	5,686,063	14,455,676	17,262,461	8,970,565
	Profit	-389,092	-1802,689	-1431,479	35,483
	Profit Rate (%)	-7.3	-14.2	7.7	0.4
Sewerage	Income	1,113,340	2,414,705	3,338,992	1,738,901
	Expenditure	1,266,402	2,648,159	2,985,049	1,959,644
	Profit	-153,062	-233,454	353,943	-220,743
	Profit Rate (%)	-13.7	-9.7	10.6	-12.7
Total	Income	6,410,311	15,067,692	22,032,932	10,744,949
	Expenditure	6,952,465	17,103,835	20,247,510	1,093,209
	Profit	-542,154	-2,036,143	1,785,422	-185,260
	Profit Rate (%)	-8.5	-13.5	8.1	-1.7

Source: S.C. ACET S.A. (Unit: 1,000 ROL)

(4) Unit Operation and Maintenance Cost

The cost of sewage per m³ was ROL 520 in 1998. Out of it, "Personnel" and "Electricity" accounted for 35.4% and 23.3% respectively. They were followed by "Depreciation" and "Payment for Services by Other Companies" with 8.5% and 7.9% respectively. Also, "Others" accounted for 24.6%. Material cost was negligible so far as 1998 is concerned. The per m³ cost of water supply was 3 to 4 times greater than that of sewerage services. The preponderance of personnel and energy cost can also be notices in water supply.

Table II.1.11 Unit Expenditure for Water Supply and Sewerage Services

Item	1998		1st Half of 1999	
	Water Supply	Sewerage	Water Supply	Sewerage
Materials	121	0	229	6
Electricity	729	121	1,013	187
Duties and Taxes	1	2	1	2
Personnel	328	184	370	203
Payment for Services by Other Companies	118	41	167	50
Depreciation	48	44	48	44
Others	594	128	356	95
Total	2,184	520	2,184	587

Source: S.C. ACET S.A. (Unit: ROL)

The cost of sewage per m³ was ROL 587 in the 1st half of 1999. Out of it, "Personnel" and "Electricity" was ROL 203 and ROL 187 with the share of 34.6% and 31.9% respectively. They were followed by "Payment for Services by Other Companies" and "Depreciation" with ROL 50 or 8.5% and ROL 44 or 7.5% respectively. Also, "Others" with ROL 95 accounted for 16.2%. Material cost was negligible. The per m³ cost of water supply was 3.7 times greater than that of sewerage services.

(5) Income and Expenditure Budget of S.C. ACET S.A.

During the three years 1996 to 1998 the combined income budget of S.C. ACET S.A. grew 2.5 times from ROL 18,766 million to ROL 46,000 million at the average annual rate of 34.8%, as shown in *Table II.1.12*.

Table II.1.12 Planned Budget of S.C. ACET S.A.

Item	1996	1997	1998	1st Half of 199
Total Income	18,766,000	34,158,107	45,000,000	46,000,000
Total Expenditure	17,497,412	34,058,107	44,500,000	45,085,000
Materials	1,909,324	13,500,000	17,160,000	17,200,000
Energy	7,223,100	9,188,107	14,000,000	14,000,000
Depreciation	976,900	900,000	1,920,000	500,000
Services Provided by Third Companies	650,000	500,000	2,307,000	1,285,000
Salaries	4,000,000	6,835,000	6,300,000	8,000,000
Social Protection	1,300,000	2,315,000	2,226,000	3,050,000
Others	1,438,088	820,000	587,000	1,050,000
Profit	1,268,588	100,000	500,000	915,000
Profit Rate (%)	6.8	0.3	1.1	2.0

Source: S.C. ACET S.A. (Unit: 1,000 ROL)

These four years it compiled the budget in such a way that it could make a certain amount of profit each year. However, it appears that a low rate of charge collection tends to put a hurdle to its attainment. The efficiency of the collection of water and sewerage charges in recent years was 84.70% to 93.69%, as shown in *Table II.1.13*.

Table II.1.13 Collection Efficiency of Water and Sewerage Service Charges

Item	1996	1997	1998	1st Half of 1999
Collection Rate	93.7	84.7	93.7	81.4

Source: S.C. ACET S.A.

(6) Required Actions for Sustainable Financial Plan

The following things are essential to work out a sustainable financial plan on sewerage services.

- Estimation of the willingness and affordability of the households to pay sewerage charge to clarify the extent and limit of household income allocable to it.

- Incorporation of the actual collection efficiency in formulating income budget and cost analysis to realize proper level of cost per unit volume of sewage.

- Preparation of funds statement and balance sheet besides income statement in order to assure a long term profitability and solvency.

1.4 WATER SUPPLY SYSTEM

The first water supply system in Tulcea City started its services in 1906, which comprised a water purification plant, water mains and distribution networks. The water mains and distribution pipes are made of cast iron, ranging from 100 to 300 mm in diameter. The system takes its water from the Danube River through two water intakes. The power for the system operation has been supplied from its own power station since 1960.

Since the 1960's, the system has gradually been extended as the urban districts developed. Main pipelines and distribution networks, storage tanks and pumping equipment had been added in order to increase water pressure and supply more water to the peripheral housing development areas. The major portion of the present water supply facilities was built in 1982, and now almost 100 percent of the residents have access to the water supply facility. At present, the existing water supply has approximately 190-km long pipelines, and about 80 percent of the city water users are metered.

The river water is treated at the water purification plant located near the stadium in the western side of the City. The plant, constructed in 1977 and started its operation in 1984, consists of settling tanks, reaction tanks, rapid sand filters, storage tanks and pumping station. The treated water is first transmitted to two water reservoirs each having a 5,000 m^3 storage capacity. The water is then sent to an elevated reservoir of 5,000 m^3 capacity, through which the water is distributed to the water distribution networks.

The system now supplies the daily average water of 103,640 m^3/day throughout the City, of which about 95,000 m^3/day is taken from the Danube River and the remaining 8,640 m^3/day water from the ground. The total water production rates range between 800,000 and 870,000 m^3/month, with the maximum production of 1,150,000 m^3/month.

The average water production of the purification plant is 1,250 l/sec. The quantity of the water used for the plant process accounts for about 15 to 20 % of the total water production. In 1968, steel made water mains of 500 mm diameter were laid to connect the purification plant to a 3,500 m^3 capacity water storage tank built on a hill at about 70 m above SWL.

1.5 SEWERAGE SYSTEM

Tulcea's sewerage system was first constructed in 1958 as a combined system to collect both wastewater and stormwater runoffs. All the wastewater, commingled with the stormwater inflows during storms, used to be discharged directly to the Danube River through wastewater outfalls.

As the wastewater discharge to the Danube River increased, and more stringent water discharge regulations were enforced, a renovation of the old combined system became mandatory. Under the circumstances, the City planned an immediate sewerage system improvement program, so as to decrease the raw wastewater overflows with the stormwater to the Danube River by converting the old combined sewers to a separate system.

The new separate sewers were then constructed along the main streets, and the old combined sewers were converted to storm drains. At the same time, four additional stormwater pumping stations were constructed along with the protection embankments to collect and pump up the stormwater to the Danube River.

Although the existing sewerage is in principle the separate system, a small amount of stormwater inflows through some old combined sewers that have not been converted yet to a separate system. The collected domestic, commercial and industrial wastewater is being send through the 1,200 mm diameter double pressure pipelines to about 2 km downstream from the City and finally disposed of to the Danube River without receiving any treatment.

The existing sewerage system covers about 65 % of the whole city area. According to the City's estimation, the average monthly wastewater production rates vary from 700,000 and 800,000 m^3/month (23,300 to 26,700 m^3/day). The average annual wastewater production in the last five years is about 15 million m^3/year, including unavoidable stormwater inflows. The average daily per capita wastewater production is estimated to be 250 l.

The wastewaters from housing complexes, as well as individual houses, are collected through branch and lateral sewers by gravity, then flow down to the collector sub-mains and mains. The sewer pipe sizes range from 200 to 1,060 mm diameters, with a total pipe length of 90 km. All the sewers are made of either concrete or reinforced concrete pipes.

The sewers are not uniformly distributed throughout the City, some parts in the east and southeast districts of the City are without no sewer provision. At some new apartment complexes, the existing old sewer capacities are not enough to cater for the increased wastewater inflows. Hence, the wastewater is occasionally overflown and bypassed to the nearby drains.

Where the collector mains become deep, the wastewater is lifted by the lift pumping stations to the downstream collectors to further continue the gravity flow. At present, six wastewater pumping stations and five stormwater pumping stations have been in operation. Because of the topographic conditions in the area, the wastewater from hilly lands in the southeastern part of the City can flow down by gravity to the collector mains.

The locations and capacities of the existing pumping stations are as follows:

Wastewater pumping stations

- SP0 (Tabcrei station) ; q= 100 m^3/hr,
- SP1 (Ciuperca) ; q= 720 m^3/hr,
- SP2 (Casa Sindicatelor) ; q= 150 m^3/hr,
- SP3 (Hotel Delta) ; q= 1,000 m^3/hr,
- SP4 (Fabrica de mase olastice) ; q = 50m^3/hr,
- SPGradinari (Gradinari street) ; q= 10 m^3/hr,

Stormwater pumping stations

- SP1 (Ciuperca)
- SP2 (Casa Sindicatelor)
- SP3 (Hotel Delta)
- SP4 (Fabrica de mase plastice)

The stormwater runoffs from houses and streets are collected through the storm drains, and discharged to the Danube River through five stormwater outfalls. Once the river water elevation rises and the stormwater can no longer flow by gravity, the outfalls are closed and the pumping stations start their operation.

The low-lying central districts close to the River are occasionally flooded during wet seasons. The stormwater stagnates at some locations as deep as 20 to 50 cm in June and July. The stormwater drainage network has at present 7.5 km long drainage channels and conduits, but the coverage ratio is only 5.5 % of the whole city area. The hydraulic capacities of the drains are not sufficient to collect all the stormwater runoffs and safely discharge them to the River.

The industrial wastewaters from the industrial complexes in the western and eastern parts of the City are treated by their own treatment systems, generally to the permissible levels of quality by the discharge standards. The industries in the western industrial zone are now discharging the wastewater effluent to a lake, but there is a plan that the treated effluent is discharged to the public sewers within five years.

The industrial wastewaters from the major industries are discharged to the Danube River after being pretreated, but most of the small-scale factories within the City area, such as food processing, meat, beer and vegetables, do not have appropriate pre-treatment facilities.

Some of the sewer pipes are as old as 40 years, and parts of the sewers are already obsolete and damaged. Clogging and breakage of old sewers are frequent at many locations, thus causing some operational problems in the present system.

The sewer pipe length by age is:

- Pipes less than 20 years old, 17 km;
- Pipes between 20 and 30 years old, 25 km;
- Pipes between 30 and 40 years old, 38 km; and
- Pipes 40 years or older, 20 km.

The City has a sewerage improvement plan that about 80 percent of the residents will be served by the sewerage system in the near future, and 100 percent in 20 years time. The construction plan includes the possible sewer extension to the east and southeast as well as in the western district of the City. The planned WWTP site is located at the eastern part of the City about 2 km downstream from the center of the City located close to the brewery factory.

1.6 OTHER SANITATION SYSTEM

1.6.1 SEPTIC TANKS/PIT LATRINES

The wastewater networks are presently serving approximately 60 percent of the City's population. The inhabitants in unsewered districts rely on either septic tanks or pit latrines for their waste disposal. According to the City's estimation, about 4 % of the residents are served by septic tanks, 32 % by soakaways, and the rest by drain ditches.

Septic tanks and pit latrines are generally cleaned by vacuum trucks at an average frequency of once a year. About 90 to 95 % of the collected sludge is disposed of to the Danube River, the remaining sludge is being disposed of to the City solid disposal site. Presently, two (2) vacuum trucks, each owned by state and private company, are used for desludging. The City has a plan that the collected sludge will be disposed of to the public sewerage system in the future.

1.6.2 SOLID WASTES

Solid wastes are collected in special or improved containers. A state owned company manages the solid waste collection and disposal. Containers are picked up by specially designed vehicles, and are transported to the disposal site located in the southwest of the City about 8 km from the center of the City.

The housing block areas are provided with 3 to 5 m^3 containers placed on specially arranged platforms, but in the peripheral residential areas, the garbage is collected and transported to the dumping site with tractors and trailers. Most of the wastes are manually collected but only a small portion mechanically collected. Streets are manually cleaned and the collected wastes are transported with the trailers to the dumping site.

Industrial waste collection is generally made by the producers. Depending on the nature of the wastes, the wastes are collected by the special disposal services or by themselves, and are disposed of to the City's dumping site. Non of the industries in the City has its own disposal site.

CHAPTER 2 REVIEW OF EXISTING PLANS

2.1 GENERAL

Design fundamentals and criteria previously developed are reviewed and updated where necessary, taking into account the latest available data and information to establish the planning and design basis for the Tulcea wastewater management system.

The review work includes the following:

- Present and future administrative populations;
- Present and future water supply and sewerage service populations;
- Wastewater generations and wastewater flows;
- Wastewater characteristics; and
- Planning and design criteria.

The present conditions of the above factors have been reviewed in light of the latest available data and information prepared by the Tulceas City and S.C. ACET S.A., and the field surveys conducted under the present study.

2.2 POPULATIONS

The City water and wastewater service populations in 1998 numbered 96,000 and 69,000, respectively, which are expected to increase to 100,000 and 73,000 by 2010. Wastewater productions and characteristics for the wastewater system planning have then been estimated based on the population of 73,000 in 2010. The breakdown of the populations by water users category is summarized in the following:

Table II.2.1 Water and Wastewater Service Populations (1998 and 2010)

Users' Category (by Norm)	Per capita water consumption (lcd)	Present service population (as of 1998)	Service population in 2010
1	65	0	0
2	110	27,000	27,000
3 *)	170	0	0
4 *)	295	9,000	9,000
5 *)	380	60,000	64,000
Water supply		96,000	100,000
Wastewater		69,000	73,000

Note: *) Users with sewerage service

2.3 WASTEWATER FLOWS

The present and future design wastewater flows have been estimated based on the existing water supply water consumptions and wastewater generations by applying the generation factors as defined by the Romanian Standard Methods, as summarized in *Table II.2.2*.

Table II.2.2 Design Wastewater Flows

Water Use Category	Average Daily Flow (m^3/day)	Maximum Daily Flow (m^3/day)	Maximum Hourly Flow (m^3/day)
Domestic/commercial/Institutional wastewater	26,100	28,800	36,000
Industrial wastewater	8,000	10,700	14,100
Groundwater infiltration	2,600	2,600	2,600
Total	36,700	42,100	52,700
Applied Design Flow	37,000	43,000	53,000

2.4 WASTEWATER CHARACTERISTICS

The design wastewater characteristics of four major parameters, i.e. BOD_5, SS, T-N, and T-P have been determined on the basis of the City's data and the water quality survey results conducted under the present study. The results of the analysis are summarized in *Table II.2.3*.

Table II.2.3 Design Wastewater Characteristics

Wastewater Type	Design Flow (m^3/day)	Loads (kg/day)				Concentration (mg/l)			
		BOD_5	SS	T-N	T-P	BOD_5	SS	T-N	T-P
Domestic,institutional, & commercial	26,100	3,212	3,723	562	74.0	123	140	22	2.8
Industrial	8,000	1,419	1,192	208	46.9	177	149	26	6.0
Groundwater	2,600	0	0	0	0	0	0	0	0
Total	36,700	4,631	4,915	770	120.9	-	-	-	-
Average concentration						126	134	21	3.3
Applied Design Wastewater Characteristics						130	140	20	3.5

CHAPTER 3 PLANNING BASIS

3.1 SERVED POPULATION

Out of the Tulcea's 100,000 population in 2010, about 73,000 people will be served by the sewerage system. The breakdown of the service population by water user categories.

Table II.3.1 Present and Future Served Populations

Users' category by Norm	Present served population in 1998	Served population in 2010
3	0	0
4	9,000	9,000
5	60,000	64,000
Total	69,000	73,000

3.2 WASTEWATER FLOWS

The present and future design wastewater flows are summarized in *Table II.3.2*.

Table II.3.2 Design Wastewater Flows

Water Use Category	Average Daily Flow (m^3/day)	Maximum Daily Flow (m^3/day)	Maximum Hourly Flow (m^3/day)
Domestic/commercial/Institutional wastewater	26,100	28,800	36,000
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Groundwater infiltration	2,600	2,600	2,600
Total	36,700	42,100	52,700
Applied Design Flow	37,000	43,000	53,000

3.3 WASTEWATER CHARACTERISTICS

The design wastewater characteristics of four major parameters, i.e. BOD_5, SS, T-N, and T-P have been determined on the basis of the City's data and the water quality survey results conducted under the present study. The results of the analysis are summarized as follows.

BOD_5	130 mg/l
SS	140 mg/l
T-N	20 mg/l
T-P	3.5 mg/l

CHAPTER 4 INTERCEPTOR SYSTEM

4.1 EXISTING SEWERAGE SYSTEM

The sewerage system in Tulcea is in principle the separate system which collects the wastewater and stormwater separately through sanitary and stormwater sewers, although in some areas a part of the stormwater inflows to the sanitary sewers. All the collected wastewater through the sewer networks is currently discharged into the Danube River through seven (7) outfalls. The existing sewerage system in Tulcea together with the proposed wastewater treatment plant (WWTP) site is shown in *Figure II.4.1*.

The outfalls No.5 and No.6 are two major outfalls discharging the wastewater to the Danube River. The proposed WWTP site is located near those outfalls. The outfall sewers No.5 and No.6 were constructed in 1970 and 1981, respectively. These two (2) sewers, with diameter of 1,000 mm at the same invert elevation, are laid almost in parallel without interconnection, from the city center to the Danube River. The outfalls are located under the river water level and pressured. The hydraulic conditions of these outfall sewers are summarized as follows.

Table II.4.1 Hydraulic Conditions of Outfall Sewers No.5 and No.6

Items	Descriptions
Pipe type and size	Reinforced concrete, 2 x 1,000 mm dia.
Pipe length	Total 3,533 m
Pipe slope(CR5 to CR13)	0.0014
Flow velocity and rate	v = 1.25 m/sec., q = 0.9752 m^3/sec.
Remaining hydraulic head at outfall	+ 5.08 m M.W.L.
Invert elevation of pipes	+ 0.12 at the outfall gate

Source: Tulcea City

The outfall sewers No.5 and No.6 have the maximum hydraulic capacity of 0.9752 m^3/sec, which could handle the estimated peak wastewater inflow rate of 0.499 m^3/sec to the WWTP. The remaining hydraulic head of +5.08 m M.W.L. at the entrance to the WWTP could effectively be used to save energy costs for the WWTP operation. The sewer invert elevation at the outfall gate is + 0.12 m MWL.

The outfalls No.1 to No.4 discharge wastewater to the Danube River in the central part of the Tulcea City. Because the outfall No.7 discharges wastewater generated only at the water purification plant which is supposed to manage the wastewater treatment, this outfall is excluded from the Study.

4.2 PROPOSED INTERCEPTOR SYSTEM

4.2.1 OVERALL PLANNING

The outfall sewers No.5 and No.6 receive all the wastewater generated in the City and convey it to the existing outfalls No. 5 and No.6, near which the proposed WWTP is located. Therefor, it is proposed to use these two (2) outfall sewers as interceptors, by connecting other outfall sewers to them.

There is a sewer along the Street Isaccei, which is crossing four outfall sewers, i.e. No.1 to No.4. At present, this sewer collects wastewater from two areas and lead it to the outfall sewer No.5 via existing pumping station SP3. It is planned that the outfall sewers No.1 to No.4 are to be connected to this sewer to convey the wastewater to the outfall sewer No.5. *Figure II.4.2* shows proposed interceptor system of Tulcea.

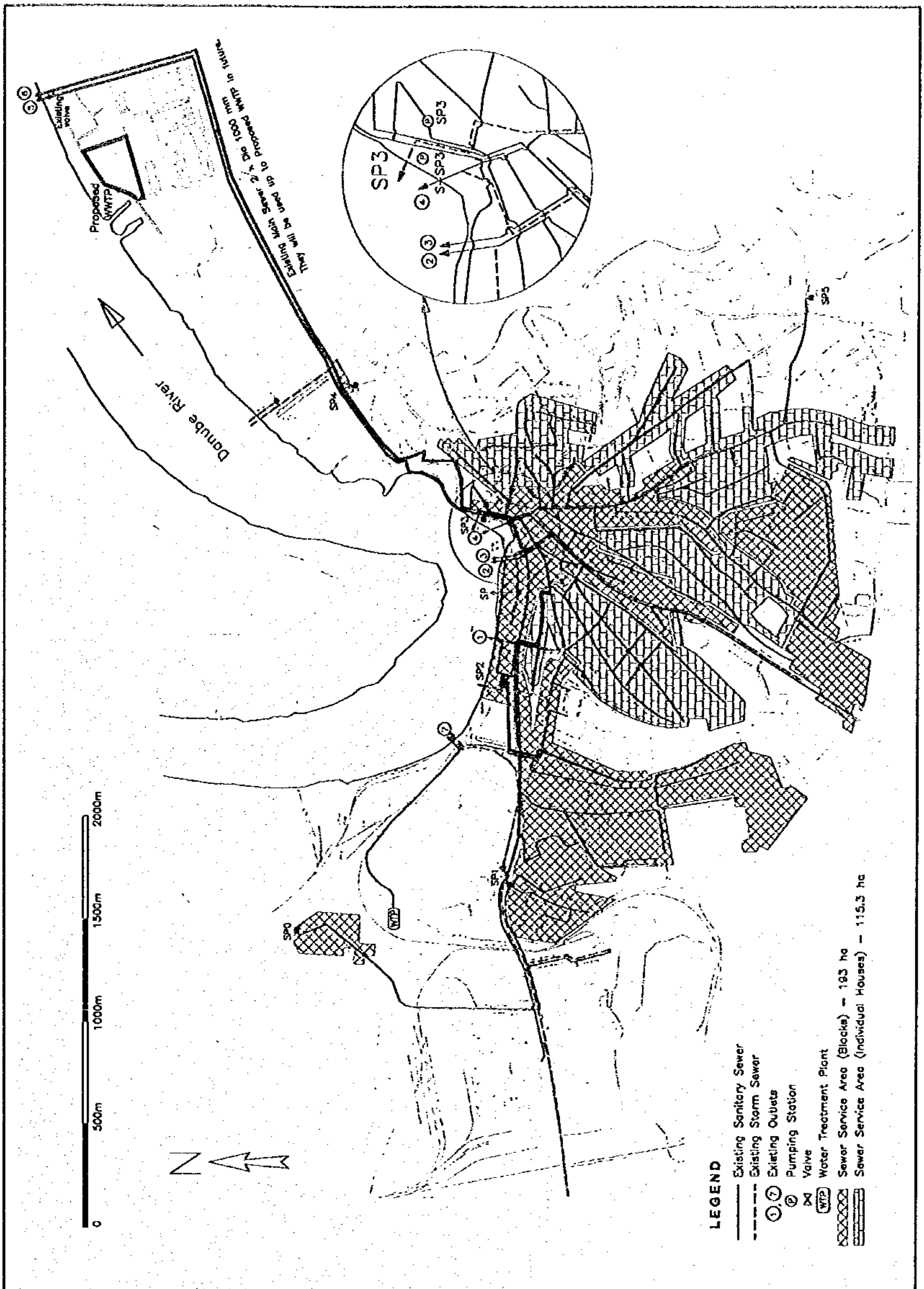

Figure II.4.1	Existing Sewerage System of Tulcea City

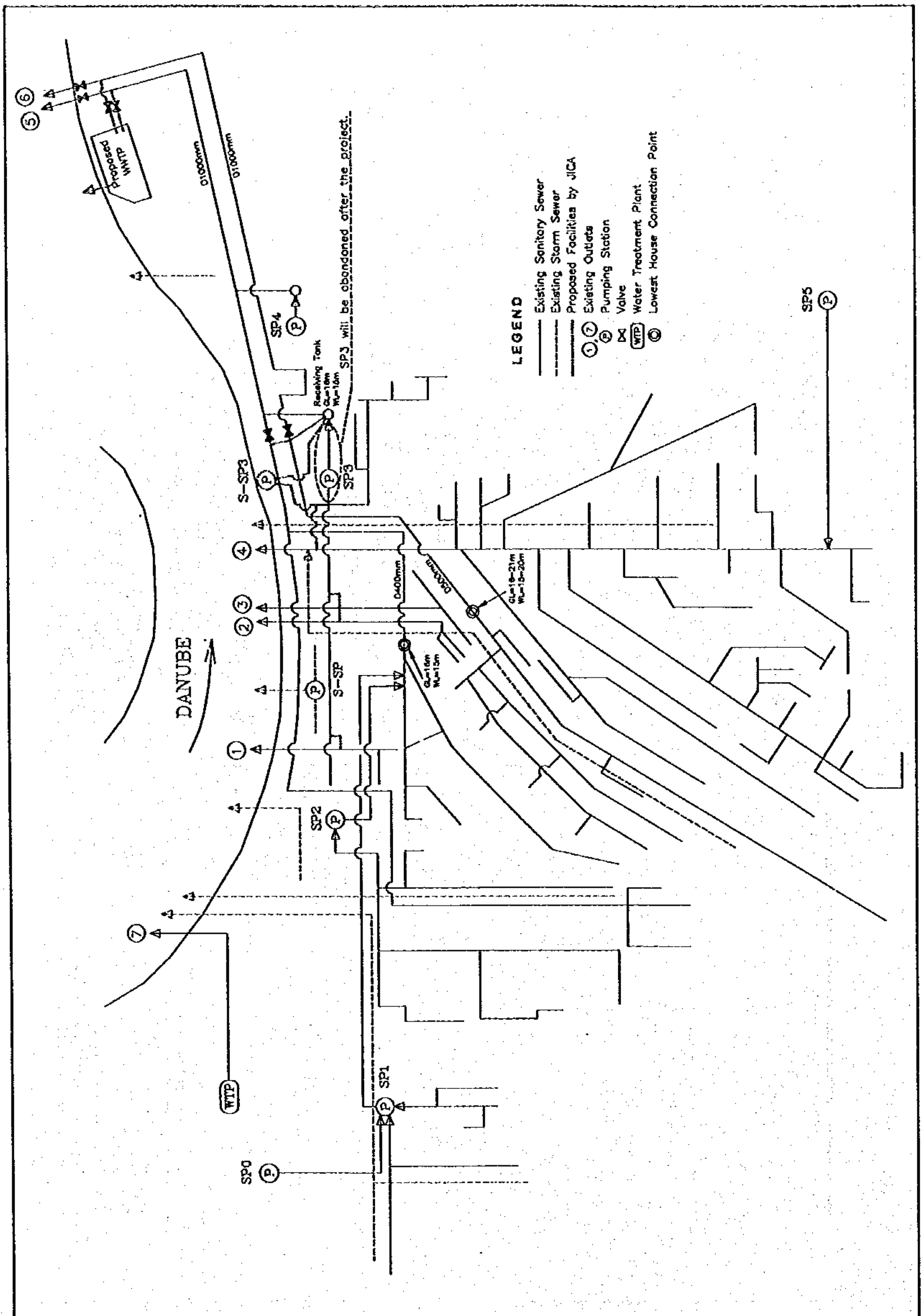

Figure II.4.2	Proposed Interceptor System of Tulcea City

4.2.2 Design Wastewater Flow

A total maximum hourly wastewater flow was given by the planning basis in the Study. A maximum hourly wastewater flow of each outfall was estimated by distributing the total flow proportionally to the estimated population in each wastewater collection area corresponding to an outfall. Estimated wastewater flow of each outfall is as follows.

Table II.4.2 Design Wastewater Flow of Each Outfall

Outfall No.	Estimated Population	Maximum Hourly Flow (m^3/s)
1	179	0.002
2	960	0.009
3	702	0.007
4	21,624	0.208
5	31,320	0.302
6	8,895	0.086
Total	63,680	0.614

4.2.3 Facilities Design

(1) Interceptor Sewer

Existing outfall sewers No.5 and No.6 are duplicated lines with a same diameter. Flow capacity of one line is estimated at 0.785 m^3/s with 1.0 m/s of velocity. The total of their flow capacity, 1.580 m^3/s, is much larger than the total design wastewater flow, 0.614 m^3/s. Therefore, these two (2) existing outfall sewers can work as the interceptor mains, which convey all the collected wastewater to the proposed WWTP.

(2) Pumping Station

It is planned to install one (1) pumping station to convey the wastewater discharged by the existing pumping station SP3 and the wastewater of the outfall sewers No.1 to No.4. The location of the pumping station was determined based on an alternative study of the following two (2) alternative cases.

Alternative-1: To convey the wastewater to the interceptors by the existing SP3.

Alternative-2: To convey the wastewater to the interceptors by new pumps to be installed in the stormwater pumping station S-SP3 which presently has no pumps.

It was found that the Alternative-1 could not applied because the elevation of an inlet sewer to the SP3 is lower than low water level of the SP3. As a result, the Alternative-2 is applied. The existing SP3 is to be abandoned after inauguration of the new pumps in the S-SP3.

At present, the wastewater discharged by the SP3 is 0.055 m^3/s and the wastewater of outfall sewers No.1 to No.4 is 0.226 m^3/s in total. Thus, the design flow of the new pumps was determined as 0.281 m^3/s.

Total pump head was determined at 30 m, considering actual head and total head losses.

4.2.4 PROPOSED FACILITIES

Planned facilities comprise connection sewers, interceptor sewers, manholes and valves, as listed in *Table II.4.3.* Major features of the facilities are as follows.

(1) Interceptor Sewer

The interceptor mains can be diverted from the existing outfall sewers No.5 and No.6, as the abovementioned. The facilities to be constructed in the proposed plan are as follows.

- Two (2) sewers, with 1,000 mm diameter, connecting the interceptor mains and the WWTP.
- An interconnection sewer between the outfall sewers No.5 and No.6, with 1,000 mm diameter, near the S-SP3.
- Replacement and additional installation of a part of existing sewer along the street Isaccei, with 600 mm diameter.
- A pressured steel pipe sewer from the S-SP3 to a receiving tank, with 400 mm diameter.
- A sewer from the receiving tank to the interceptor main (the outfall sewer No.6), with 400 mm diameter.

Generally, the sewer construction is conducted by open cut method. The earth coverage of all installed sewers ranges from 1 to 3 m.

(2) Connection sewers

Since the sewerage system in Tulcea is generally of separate system, it is supposed that sanitary sewers do not convey any stormwater. Therefore, the sanitary wastewater discharged from the outfalls No.1 to No.4 will be collected by connection sewers without combined sewer overflow (CSO) regulators.

The connection sewers are to carry the maximum hourly flow from the existing manholes to the interceptor sewer. Length of a connection sewer is in general approximately 10 m and the earth coverage is from 1 to 3 m. In total, four (4) connection sewers will be installed.

(3) Manholes

Manholes will be installed along the newly constructed interceptor sewer at intervals of about 100 m, as its diameter is less than 800 mm. They will also be installed at a sewer and road junction. In total, two (2) manholes will be installed, and one (1) receiving tank will be installed at the terminal point of the sewer from the S-SP3.

(4) Valves

Valves are to be installed for the main interceptor sewers for two areas. One is near the connection point from the receiving tank. Two (2) valves of diameter 1,000 mm will be installed there to control the flow for maintenance purpose. The other is near the proposed WWTP. One valve along a main interceptor sewer, the existing sewer No.5, has been installed near the Danube River. Hence, three (3) valves of 1,000 mm diameter will be installed to control the flows there.

In total, five (5) valves of 1,000 mm diameter will be installed.

(5) Pump Equipment

The following pump equipment with accessories will be installed at the S-SP3.

- Number of pumps: 3 (1 standby)
- Capacity: 0.15 m^3/s each
- Total pump head: 30 m

Table II.4.3 Proposed Facilities of Interceptor System of Tulcea City

1. Interceptor Sewer

Diameter (mm)	Length (m)	Earth covering (m)	Remark
400	173	1-3	From receiving tank to interceptor main.
600	87	1-3	Replacement and newly installation.
1000	590	1-3	Diversion of interceptor mains to WWTP.
1000	10	1-3	Interconnection of 2 interceptor mains.

2. Connection Sewer

Diameter (mm)	Length (m)	Earth covering (m)	Remark
200	30	1-3	Connection sewer for outfall sewers No.1 to No.3.
400	20	1-3	Connection sewer for outfall sewer No.4.

3. Pressure Sewer

Diameter (mm)	Length (m)	Earth covering (m)	Remark
400	285	1-3	Steel made. From S-SP3 to receiving tank.

4. Manhole and Receiving Tank

Diameter (mm)	Quantity	Earth covering (m)	Remark
500	1	1-3	At outfall sewer No.4 to interceptor.
600	1	1-3	At junction outfall sewer No.4.
3000	1	1-3	Receiving tank from S-SP3

5. Valve

Diameter (mm)	Quantity	Earth covering (m)	Remark
1000	5	1-3	2 valves at junction from receiving tank and 3 valves near WWTP.

6. Pump

Capacity (m^3/s)	Total pump head (m)	Quantity	Remark
0.15	30	3	Installed at the S-SP3. One pump is standby.

CHAPTER 5 WWTP FACILITY PLANNING

5.1 PLANNING PRINCIPLE

5.1.1 HYDRAULIC / ORGANIC LOADING ON FACILITIES

In determining the hydraulic and organic capacities of the WWTP component facility, the maximum daily wastewater flow of 43,000 m^3/day or 0.498 m^3/sec is employed. Each component facility is further checked both for the average daily flow and maximum hourly flow conditions.

All piping and channels are designed to carry the maximum hourly flow rate. For the design purpose, the inflowing wastewater through the existing pressure sewer pipes (2 x 1,000 mm in diameter) is considered to enter the influent chamber ahead of the WWTP.

5.1.2 FACILITY PLANNING BASES

Plant Bypass: The plant design calls for accepting the peak flow of 0.614 m^3/sec. Flows in excess of this rate may be bypassed to the nearby waterways or the Danube River. The plant bypass should be constructed at the location ahead of the WWTP.

Plant Site: The City-owned WWTP site of about 5.1 hectares land is located at the right bank of the Danube River. The land is relatively flat and low-lying with the ground surface elevations ranging from the highest point of +3.5m to the lowest point of +2.5 m M.W.L.

In the vicinity of the plant site are agricultural and industrial areas, which conditions may remain unchanged in the foreseeable future. There exists several industrial buildings within a distance of 300 m from the boundary of the site, but to the east, there is a wide Government-owned vacant land that could be used for the future plant expansion.

Ground Preparation: The treatment plant structures and all related equipment shall be protected from physical damage preferably by the 100-year flood. According to the Danube River hydrological data recorded at a location near the WWTP site over the last 28 years (1970 to 1998), the highest water elevation was 4.35 m above M.W.L. that occurred on 25th May, 1970. The 100-year flood elevation of the River is calculated to be + 4.70 m M.W.L. by using the available hydrological data.

At the WWTP effluent outfall location, the river bank top elevation is +5.84 m M.W.L. whereas the land surface elevation ranges from +2.5m to +3.5m M.W.L. On account of the conditions, the finished ground surface elevation of the site is determined to be at least + 4.7 m M.W.L. or higher.

Site Access: Access to the site can be made through a major road, running from west to east along the Danube River. From the major road, an existing unpaved public road of 6 m wide can be used as the access road to the site.

Unit Bypasses: A minimum of two units in the liquid treatment process train is to be provided for all unit processes and operations in the plant. The bypass design will facilitate plant operation during unit maintenance and emergency repair so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode.

Flow Division Control: The plant facility design provides for flow division control facilities to insure organic and hydraulic loading control to various process units. Convenient, easy and safe access, change, observation, and maintenance are considered in the design of such facilities.

Pipe Cleaning and Maintenance: Fittings, valves, and other appurtenances should be provided for pipes subject to clogging, to facilitate proper cleaning through mechanical cleaning or flushing. Pipes subject to clogging, such as pipes carrying sludge, are to be lined with a material, which creates a smooth and non-adhering surface.

Grading and Landscaping: The plant site should be graded and landscaped upon completion of the plant. Concrete or asphalt paved walkways should be provided for access to all units. Steep slopes should be avoided to prevent erosion.

Emergency Power Facilities: The WWTP shall have an alternate source of electric or mechanical power to allow continuity of operation during power failures, including provision of at least two independent sources of power, such as feeders, grid, etc., to the plant, or power generators. Auxiliary power for minimum aeration of the activated sludge is required to protect downstream uses.

Plant Sanitary System: An adequate supply of potable water under pressure shall be provided for use in the laboratory and for general cleanliness around the plant. Potable water from a municipal or separate supply will be used directly at points above grade for hot and cold supplies in lavatory, water closet, laboratory sink (with vacuum breaker), shower, drinking fountain, eye wash fountain, and safety shower; unless local authorities require a positive break at the property line. Toilet, shower, lavatory, and locker facilities shall be provided in convenient locations to serve the expected staffing level at the plant.

Flow Measurements: Appropriate flow measuring equipment should be provided after the preliminary treatment facility to continuously indicate, totalize and record the volume of the wastewater entering the plant in a unit time. Other flow measurement equipment are to be attached to the major component facilities to measure liquid and sludge.

Laboratory: The WWTP should include a laboratory for making the necessary analytical determinations and operating control tests. The laboratory size, bench space, equipment and supplies shall be such that it can perform analytical work for all self-monitoring parameters required by discharge permits, and the process control necessary for good management of each treatment process included in the design.

5.2 PROCESS DESIGN

5.2.1 PRELIMINARY TREATMENT

(1) Influent Gates

At the entrance to the plant, manually controlled influent gates are to be provided to control or bypass the influent flows. The design data of the gates are as follows:

Number of gates	2 units
Type	cast-iron made, sluice gate
Gate size	1.2 m x 1.2 m

(2) Screens

Coarse Screens: Manually-cleaned coarse bar screens are to be provided ahead of the fine screens. The criteria for the coarse screens are as follows:

Number of screens	2 units
Channel width	1.6 m
Clear bar spacing	100 mm
Slope from vertical	60 degrees

Fine Screens: The fine screens are mechanically cleaned type. The criteria for the fine screens are as follows:

Number of screens	2 units
Channel width	1.6 m
Clear bar spacing	20 mm
Slope from vertical	75 degrees

Screenings Disposal: As a minimum, screenings must be disposed of daily. All collected screenings will be dumped to one common belt conveyor and sent to a hopper for storage and hauling it to sanitary landfill.

(3) Aerated Grit Removal

Grit Chamber: Grit settled at the bottom of the grit chambers is removed by a grit lifting pump with trolley to a grit separation channel. The grit in the sand separation channels will be sent by a screw conveyor to grit hopper for storage and final disposal.

Configuration: The wastewater grit removal will be accomplished in two grit chambers. The geometry of chambers is as follows:

Number of units	2 chambers
Width	3 m (including oil separator)
Length	16 m
Depth	2.35 (side depth) to 3.05 m
Blowers	3 units (one-standby) 80 mm dia. x 5 m^3/min.
Influent gates	2 units, 800mm x 800 mm
Effluent gates	2 units, 600mm x 600 mm
Grit lifting device	2 units of trolley with grit removing pump
Grit lift pumps	2 sets of sand pumps
Screw conveyor	1 unit
Grit hopper	1 unit

Air Supply: For the total tank length of 16 m, air supply requirement is 10 m^3/min. Three units (one-standby) of turbo blowers will be provided.

Grit Removal: A trolley with grit lifting device and sand pump removes grit from each chamber. The grit water pumps lift the grit mixed with water to the grit separator for grit separation.. The separated grit will be conveyed to the hopper for storage and final hauling to sanitary landfill.

(4) Flow Measurement

A Parshal flume (7 feet) will be installed for the measurement of wastewater flows after passing through the grit chambers.

5.2.2 PRIMARY TREATMENT

The primary treatment system consists of gravity liquid/solid separation in circular clarifiers. The clarifier system will consist of clarifier modules of 4 units.

(1) Flow Distribution

After the Parshall flume, the wastewater flows down through conduits to the distribution chamber located at the center of the cluster of 4 primary clarifiers, from where the flow will be distributed to each individual clarifier. The flow split is proportional to the tank surface area.

(2) Primary Clarifiers

Hydraulic Loading and Area Requirements: The hydraulic loading rate for the clarifiers is 35 m^3/m^2/day at the maximum daily flow of 0.498 m^3/sec. Four primary clarifirs are required. The primary clarifier design criteria are summarized as follows:

Surface loading (at maximum daily flow)	35 m^3/m^2/day
Design flow rate	43,000 m^3/day
Surface area of each clarifier	423 m^2
Clarifier diameter	35m
Effective water depth	2.0 m
Number of clarifiers	4 basins
Number of clarifier cluster	1 cluster

Primary Sludge Production: The primary and excess sludge production (when excess sludge is returned to the primary tanks) for the daily average flow rate is 402 m^3/day or 0.28 m^3/min. at an average solids concentration of 2 %. The quantity of sludge, primary plus excess sludge, is as follows:

Sludge volume	402 m^3/day
TSS	8,040 kg/day

Scum Management: Scum is removed from the clarifier surface by a rotating scum removal mechanism to a scum pit located near the clarifiers and is pumped from there to a scum drum screen for scum removal.

Controls: The clarifier operation will be manually controlled, but scum and sludge pumps will be operated both automatically or manually. The automatic operation ofscum pumps and sludge pumps should be controlled by the water elevations in the scum pit by timer settling, respectively. The sludge is sent to the sludge drum screen and then to the sludge thickeners.

5.2.3 BIOLOGICAL TREATMENT

Biological treatment consists of aeration tanks and final clarifers.

(1) Aeration Tanks

The design parameters for the process component are established as follows:

Design inflow rate	43,000 m^3/day or 0.498 m^3/sec
Average inflow BOD_5	concentration 170 mg/l
Total BOD_5	5,117 kg/day
F/M	0.3 kg BOD_5/kg MLVSS/day
MLSS	1,667 mg/l
Hydraulic detention time	6.3 hours at the maximum daily flow

Recycle capability	50 % of maximum daily flow.
Liquid depth	5.5 m
Aeration system	Fine bubble diffusers
BOD removal efficiency	89.5 % (combined with clarifiers)

The contact reactor geometry is as follows:

Tank width	5.5 m
Liquid depth	5.5 m
Tank length	49 m
Number of tanks	8 units
Effective tank volume	11,368 m^3

The air requirement for the reactor tanks was calculated on the basis of 0.0779 × Q (kg O_2/day). The air delivery system consists of distribution pipelines and air diffusers, with the capability of maintaining mixed liquor dissolved oxygen concentration of 1.5 mg/l.

(2) Final Clarifiers

The hydraulic loading rate for the clarifiers is 17 m^3/m^2/day at the maximum daily flow rate of 0.498 m^3/sec. Thus, the required total surface area is calculated to be 2,464 m^2. The final clarifier geometry is summarized as follows:

Surface loading (at Q max.)	17 m^3/m^2/day
Design inflow rate	0.498 m^3/sec
Tank surface area	616 m^2 (Romanian standards)
Clarifier diameter	30 m
Effective water depth	3.5 m
Number of clarifiers	4 units

The secondary excess sludge will be sent either directly or through the primary clarifiers to the sludge thickeners. The excess sludge alone or settled with the primary sludge is then pumped to the sludge thickeners.

Return Sludge Pumps: The pump capacity will finally be determined based on the maximum 100 % sludge return to the reactor tank inflows. The design parameters are as follows:

No.1 pumps

Pump type	Centrifugal screw pump
Pump diameter	150 mm
Capacity	2.3 m^3/min.
Total dynamic head (TDH)	10 m
Number of pumps	4 sets
Motor output	7.5 kW

No.2 Pumps

Pump type	Centrifugal screw pump
Pump diameter	150 mm
Capacity	3.0 m^3/min.
TDH	10 m
Number of pumps	2 sets
Motor output	11 kW

No.3 Pumps

Pump type	Centrifugal screw pump
Pump diameter	250 mm
Capacity	8.0 m^3/min.
TDH	10 m
Number of pumps	2 sets
Motor output	30 kW

Excess Sludge Pumps: The excess sludge of 1,023 m^3/day will be sent either directly or through the primary clarifiers to the sludge thickeners. The criteria for the pump equipment are as follows:

Pump type	Centrifugal screw pump
Pump diameter	100 mm
Capacity	1.0 m^3/min.
TDH	10 m
Number of pumps	2 sets (including 1-standby)
Motor output	3.7 kW

Controls: Clarifiers will be operated by manual control. The sludge pumping from the secondary clarifiers is made on manual measuring of sludge blanket height.

(3) Chlorine Contact Tanks

Disinfection system: The chlorinator capacity shall be sufficient to produce an effluent that will meet the coliform bacteria limits specified by the standards at all time (*e.g.* total coliform bacteria and fecal coliform bacteria numbers are 1 million and 10,000 MPN/100 ml, respectively). The solution chlorine disinfection system consists of contact tank, chlorination equipment, housing and storage, and ancillary services. The design parameters for the chlorine contact tank are as follows:

Hydraulic maximum flow rate	43,000 m^3/day
Contact time	15 minutes at the design rate of flow
Capacity of chlorine feed system	3 mg/l at the maximum flow rate
Hypochlorite storage capacity	12.4 m^3 (8 days)

Tank Geometry: The chlorine contact tank will be of reinforced concrete longitudinal baffled basin, which will have a large effective length-to-width ratio. The contact tank geometry is summarized below:

Number of tank units	1 basin
Channel width	4 m
Channel depth	4 m
Channel length	38 m
Tank effective volume	448 m^3
Effective water depth	3 m

Equipment: The installed capacity of a chlorine feed system will be sufficient to provide a dosage of 3 milligrams per liter at the maximum design rate of flow.

The feed equipment will consist of the following:

Solution storage tank

Type	FRP cylinder type
Internal diameter	1,800 mm

Height	2,900 mm
Tank capacity	6 m^3
Number of tanks	2 units

Feed pumps

Type	Diaphragm pump
Discharge capacity	0.5 L/min.
Motor output	0.4 kW
Number of pumps	3 units (including one standby)

Forced, mechanical ventilation is to be installed which will provide one complete air change per minute when the room is occupied. Adequate provisions will be made to insure that one complete air change per minute is provided when the room is occupied.

(4) Effluent Pumping Station

In the pumping station provision shall be made to facilitate easy removing of pumps, motors and other auxiliary equipment. Suitable safe means of access should be designed to the dry well of the pumping station, including stairways, handrails and gratings where necessary.

For the pump room floor below the ground surface, mechanical ventilation is provided, so arranged as to independently ventilate the dry well.

Pump Equipment and Operation Control: Totally 4 units of pump are planned, including one-standby. The pumps are designed to have the same capacity and size, with the sufficient capacity for handling the flow in excess of the estimated maximum inflow. The pump sizes, numbers and capacities of the wastewater pumps are as follows:

Type of pumps	Vertical centrifugal mixed flow pump
Pump diameter	400 mm
Pump discharge capacity	15 m^3/min
TDH	5.5 m
Number of pump	4 units (one standby)
Motor output	21 kW

Piping and Valves: Suction, discharge and header piping in the station are sized to handle the flows adequately. Valves are to be provided on the suction and discharge side of each pump to allow proper maintenance of the unit. To the discharge pipeline, electric motor-operated butterfly valves and the check valves should be installed to ensure the operation of each pump.

Hoisting Equipment: An overhead bridge traveling crane should be provided in the motor room for handling of equipment and materials which cannot be lifted readily or removed from the station by manual labor.

5.2.4 Sludge Management

(1) Gravity Sludge Thickeners

Design Basis: Equipment and piping are to be designed to deliver sufficient dilution water to gravity thickeners. Hydraulic loading to produce overflow rates of 16~33 m^3/m^2/day will be maintained to prevent septicity. Loading rates and resulting solids concentration for gravity thickening are as follows:

Average sludge production volume	1,169 m^3/day
Sludge withdrawal rate	184 m^3/day
Input sludge solids	8.04 t/day
SS loads	60 kg/m^2/day

Tank Geometry: Thickener tanks geometry is summarized as follows:

Tank shape	Circular
Number of tanks	2 units
Internal diameter	9.5 m
Effective water depth	4 m
Effective tank surface area	142 m^2
Thickening mechanism	Rotating type scraper supported by center column with Tickets

Equipment Features: Heavy-duty scrapers capable of withstanding extra heavy torque loads should be provided. The thickener mechanism may be provided with pickets to help facilitate the release of water from the sludge. The drive mechanisms will be attached with a skimmer. The collected scum will be discharged into a central scum pit located near the thickeners.

Sludge Pumps: The pump capacity is so determined that the pumps can send the thickened sludge within 8 hours. Specifications of the equipment are as follows:

Type	Sludge pump with suction screw
Number of pumps	2 sets (one standby)
Diameter	100 mm
Discharge capacity	1.2 m^3/min.
TDH	20 m
Motor output	15 kW

Drum Screen: Prior to the pumping of the primary sludge or secondary excess sludge to the sludge thickeners, the sludge will be screened by a revolving drum screen for the removal of coarse materials. The specifications of the drum screen are as follows:

Type	Rotary drum screen
Number of screen	1 set
Screen openings	4mm
Screening capacity	2 m^3/min.
Motor output	0.4 kW

Operation: Tank operation will be manually controlled, but sludge pump operation will be controlled either automatically or manually. Pickets will be provided with torque limit control and an alarm system..

(2) Anaerobic Digestion Tanks

Digestion Process: Active digestion, concentration and storage will undergo in a single-stage anaerobic digestion tank. Mechanical mixing system, heating and gas collection systems should be installed in each tank.

The concentrated sludge will be pumped to the digestion tanks after passing through a drum screen. The digested sludge is withdrawn by gravity to the storage tanks in the sludge dewatering building. The produced gas will be led to gasholders after passing through gas scrubbers for the use of boilers.

Design Basis: The total digestion tank capacity is determined by the calculations based upon the following factors:

Input sludge solids	6.43 t/day
Sludge input	184 m^3/day
Sludge output	139 m^3/day
Temperature to be maintained in the digesters	35 ℃
Solid detention time	20 days
The degree and extent of mixing in the digesters	Moderate mixing
Required total tank capacity(2 tanks)	4,030 m^3

Tank Geometry: The tank shape will be of high vertical cylinder with conical floors. The total number of anaerobic digestion tanks required is 2 tanks in two clusters, with the same capacity and configuration, having the following tank dimensions:

Tank shape	Single stage, high vertical cylinder with conical floors
Tank capacity	2,015 m^3
Tank diameter	12.5 m
Tank effective water depth	21 m

Tank Operation: Sludge mixing system should be mechanical circulation type. Sludge withdrawal to dewatering system and disposal shall be from the bottom of the tank. Sampling hatches shall be provided in all tank covers with water seal tubes extending to beneath the liquid surface.

(3) Sludge Gas System

Gas Collection, Piping and Appurtenances: All portions of the gas system, including the space above the tank liquor, storage facilities and piping, are so designed that under normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure. All safety equipment shall be provided where gas is produced. Pressure and vacuum relief valves, flame traps, gas detectors, and automatic safety shut off valves, shall be provided.

Gas Utilization Equipment: Gas-fired boilers for heating digesters will be located in a separate room not directly connected to the digester gallery. Gas lines to these units shall be provided with flame traps. Gas piping shall be of adequate diameter for gas flow rate and will slope to condensate traps at low points.

Any underground enclosures connecting with digesters or containing sludge or gas piping or equipment should be forced ventilated. The piping gallery for digesters should not be connected to other passages.

Waste Gas: Waste gas burners should be located at least 8 meters away from any plant structure if placed at ground level, or they may be located on the roof of the control building at a height of not less than 0.9 m from the top of the roof.

Digester Heating: Sludge will be heated by circulating the sludge through external heaters. Piping may be designed to provide for the preheating of feed sludge before introduction to the digesters. Provisions should be made in the layout of the piping and valving to facilitate cleaning of these lines.

The boilers should be provided with suitable automatic controls to maintain the boiler temperature at a fixed rate, to minimize corrosion, and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, or excessive temperatures.

Safety: Local, state and federal safety requirements must be reviewed and complied with. Those requirements take precedence over the requirements stated herein, if more stringent, and should be incorporated in the design.

(4) Gasholder

The digestion gas is led to gasholder via gas scrubbers, whereby the gas will be de-sulfarized and used for the boilers. The total daily gas production is estimated to be 1,913 m^3. The gasholder will have the minimum gas storage capacity of 8-hour gas production. The geometry of the gasholder is as follows:

Type	dry seal gasholder (membrane seal type)
Number of unit	1 tank
Diameter	11.6 m
Height	9.2 m
Capacity	638 m^3

(5) Belt Filter Press Sludge Dewatering

The digested sludge is drawn by gravity into the storage tanks located in the dewatering building. The digested sludge production rate and the required dewatering equipment are as summarized in the following:

Total digested sludge production	139 m^3/day
Total sludge solids	4.18 t/day
Dewatering equipment	belt filter press
Yields per unit length	130 kg/m/hr.
Filter width	2 m
Daily operation time	6 hours
Working days per week	5 days
Solids load per hour	975 kg
Required filter press equipment	4 units

The sludge from the storage tank is pumped to the coagulation tank of the dewatering equipment (belt filter press) by sludge feed pumps. Polymer solution is mixed and then pumped into the coagulation tank of the belt filter press. The dewatered sludge (sludge cake) is conveyed to the cake yard by the trough belt conveyors. The filtrate, together with the belt filter cleansing wastewater is returned to the process wastewater by process wastes return pumps. Two units of electrically operated overhead crane will be provided in the building for dismantling and repairing the dewatering equipment.

(6) Process Wastewater Return Pump Facilities

The process wastewater return pump system is to return the process wastes (*i.e.* building wastewater, digester supernatant, belt press filtrate and scum filtrate) to the screen inlet chamber for further treatment.

5.3 ELECTRICAL, INSTRUMENTATION AND CONTROL FACILITIES

The numbers, shapes, sizes, and brief specifications of the equipment described here are for the preliminary engineering purpose, and may be subject to minor changes at the detailed design stage.

5.3.1 GENERAL

Adequacy of the major equipment such as circuit breakers, power transformers and the motor control centers are determined largely by the continuous current requirements of the treatment plant loads and the available short-circuit capability of the power supply.

The reliability of the equipment concerns the capacity of the electrical system to deliver power when and where it is required under abnormal, as well as normal, conditions.

The electrical system should be designed with enough flexibility to permit one or more compounds to be taken out of service at any time without interrupting the operation of the plant.

The design of the wastewater treatment plant electrical system must conform with the applicable local codes and regulations.

5.3.2 ELECTRIC POWER FACILITY

(1) General

The basic power distribution system can best be described as a secondary single selective system. One electric power line shall be received at the main substation. Another separated line should be planned as a stand-by use in the future.

The received power will be stepped down by the two main transformers and connected to the 380 V bus line. Each transformer shall have a capacity for all loads in the treatment plant by the year 2010.

The 380 V will be stepped down to auxiliary power distribution voltage (lighting and receptacles, etc.) by transformers that are installed at required locations.

The protective relay system shall be considered for proper protection of the electrical equipment in adequate/proper manner. Extensive zone protection will be considered for the parallel operation of the generator with utility power.

(2) Power Requirements of the WWTP

The WWTP mechanical equipment requires the maximum electric power supply of 685 kW, excluding standby equipment.

(3) Power Generator

An emergency electric power generator of the minimum 200 kW capacity should be provided. The generator is driven by a diesel engine and will be used as the minimum plant electric power source when the power supply is suspended. In order to attain the intent of the above design concept, the generator power line should be connected to the 380 V bus line which is charged by the utility supplied power.

(4) D.C. Power Supply

Uninterruptible D.C. power is supplied to breaker control circuit and an emergency lighting facility. Consequently, uninterruptible A.C. power supply for instrumentation and PC system is converted from D.C. by means of an inverted unit.

A sealed lead-acid stationary battery set shall be selected for this purpose due to its excellent quality features. The capacity of the battery set shall be designed by the required current and 30 minutes discharge time.

Each building within the plant will have its own independent uninterruptible power source unit for better and more effective utilization of the filtered/undistorted power source.

(5) Motor Control Facility

Power feeder to the motors and wiring to the controlling equipment is accomplished through motor control center and relay cubicles. The motor control center and the relay cubicles are divided into individual facility center and relay cubicles such as one set for clarifiers and another for scum screen area.

Each motor must be operated manually from the control station to be located adjacent to the equipment. The control panel will be equipped with switches for operation status indication and meters as required. Major control sequence is to be accomplished through the relay cubicle as required for each mechanical equipment.

The sub-monitoring panel is to be provided in the room for the purpose of detailed monitoring and back-up operation.

5.3.3 INSTRUMENTATION

(1) Design Basis

Instrumentation is an important tool of the wastewater treatment plant because it insures an easy and proper operation and maintenance of such facilities.

The equipment should be selected carefully considering its purpose, reliability, locations and costs. They should meet the specific functional needs of the particular equipment with special attention directed toward operation requirements.

(2) Supervisory Control and Data Acquisition System

The system can best be described as a local, independent, process control network with supervisory, central, monitoring station consisting of hard graphic indication (MIMIC) panels and soft monitoring/control station consisting of graphic screens, keyboards, printers, etc. The basic design of the system will be classified as follows:

- Local instrumentation/control station;
- Local process control units (Programmable logic controllers);
- Hard graphic/MIMIC panel;
- Redundant data highway;
- Host computer system and real time data storage;
- Historical data retrieval
- Workstations

5.4 MAJOR PLANT BUILDINGS AND UTILITY SERVICES

5.4.1 GENERAL LAYOUT

Administrative building will consist of several main areas comprising the control room, laboratory, conference room, administrative personnel area, etc.

The workers area should include workshop, storage rooms, restrooms, and a cafeteria for workers. The workshop should be related directly to the service road of the lot to permit easy transport of materials and machinery to be repaired.

The service road will be joined through a gate to the entrance for visitors and parking area that may be open for emergency purposes.

5.4.2 ARCHITECTURAL WORKS

The uncovered preliminary facilities could be a source of odors, and as such, trees should be planted alongside the plant fence to help minimize odors. A landscape design is conceived for the whole lot. There should be trees and grasses wherever they do not disturb wastewater treatment processes.

Administrative Building: Office room may have the capacity of twenty (20) persons with air conditioning system. In addition to the space for laboratory, this area may also include restroom and storage room, with air conditioning, natural and artificial light, and necessary desks and water analysis equipment. Control and electrical equipment room may have air conditioning and ventilation system.

Workers Room: This area consists of restroom for operation and maintenance workers with showers and lockers. This room is also raised 30 cm from the ground level.

Depot/Workshop: This room will be for small and big parts of the plant equipment, roof with metallic structure, brick walls, natural light and fans for ventilation.

Generator Room: Main electrical building shall have a floor level raised 30-cm from the planned ground elevation to avoid possible flooding. Noise and vibration prevention measures shall be considered. Mechanical ventilation system shall be provided.

5.4.3 GENERAL CRITERIA FOR THE STRUCTURAL DESIGN

Foundations: The field survey results and recommendations refer to excavation systems, control of groundwater, foundation levels, inclination of slope, coefficient of lateral pressure, bearing capacity, expected settlements, and all aspects that should be considered in the design and construction of the treatment plant facilities.

The floor levels of the various component buildings of the plant will be installed at a minimum level of 30 cm above the site finished mean grade level of 4.7 m above the mean Black Sea water level (M.W.L).

Structures: The main structures of the plant are cylindrical and rectangular tanks in shape; pipes with large diameters; pumping facilities, and buildings for the administration, operation and maintenance purposes.

The basic material for the construction of the plant structures will be the conventional reinforced concrete structures. Long span beams may be applied to the structures, which may be of post-tensioned with high resistance-cables.

According to the Regulation P100/1992, the area is located in a D-degree seismic area.

Determination of seismic loads shall be in accordance with the Regulations, local codes or other accepted standards. Each type and size of structures shall be individually designed depending on its own conditions assigning the factors of security established by the standards.

The structure design shall follow the Romanian National Standards STAS 4273/83 or equivalent international standards and publications.

All materials to be considered for the structural and architectural designs shall be subject to the relevant in the Romanian Standards, or other equivalent international specifications.

5.4.4 PRINCIPAL PLANT FACILITIES

Grading and Landscaping: Grading will slope away from structures to the open channels or box culverts. Landscaping includes grass for the area around the roads, structures and buildings. Trees and shrubs will be all along the fence of the site limits. The use of small trees around roads and buildings help to give a human scale to the project because structures are usually high.

Site Security: The site must be closed with a chain link fence or other appropriate means. The entrances will have a gate with hardware locks to have them closed when necessary.

Guardrails: For walkways located in hazardous areas of the structures, guardrails must be used. Guardrails shall be painted with safety colors of yellow and black.

Lighting: There shall be exterior lighting all-over the site, along roads, near the structures and along the edge of the surrounding of fence.

5.4.5 LAYOUT OF FACILITIES

Figure II.5.1 shows the layout of facilities in the wastewater treatment plant and *Figure II.5.2* shows hydraulic profile of Tulcea WWTP. List of main facilities are shown in *Table II.5.1*.

Table II.5.1 Main Equipment of Tulcea WWTP

Item	Specification
Screen and Pump	Influent gate 1.0 m × 0.6 m × 2 units Coarse screen B 1.6 m × H 2 m Fine screen B 1.6 m × H 2 m Pumps ϕ400, Q=15 m³/min, TDH=5.5 m, Mp=21 kW, 4 pumps
Grit chamber/ Oil separator	B 3 m × L 8 m × 2 channel
Parshall flume	306 - 12,380 m³/h × 1 unit
Primary Sedimentation Tank	ϕ25 m effective depth 2.0 m × 4 tanks
Aeration Tank	B 5.5m × H 5.5 m × L 49 m × 8 tanks (For advanced treatment : B 5.5 m × H 5.5 m × L 54 m × 8 tanks)
Final Sedimentation Tank	ϕ30 m, effective depth 3.5 m × 4 tanks (For advanced treatment : ϕ30 m, effective depth=3.5 m × 4 tanks)
Chlorination Chamber	B 4.0m × H 4.0m × L 38m (Chlorination time 15 min)
Sludge Thickener	Inside diameter 9.5m × H 4m × 2 tanks
Sludge Digester	Inside diameter 12.5m × H 21m, V=2,015 m³ × 2 tanks
Gas Holder	Inside diameter 12m × H 9.5m, V = 650 m³ × 1 tank
Dewatering Equipment	130kg/m hr, B = 2 m × 4 units (building 24 m × 10 m)
Blower Equipment	Multi stage turbo blower ϕ200 / ϕ200, 55 m³/hr × 2 (building 18 m × 13 m)
Administration Building	30 m × 20 m = 600 m²

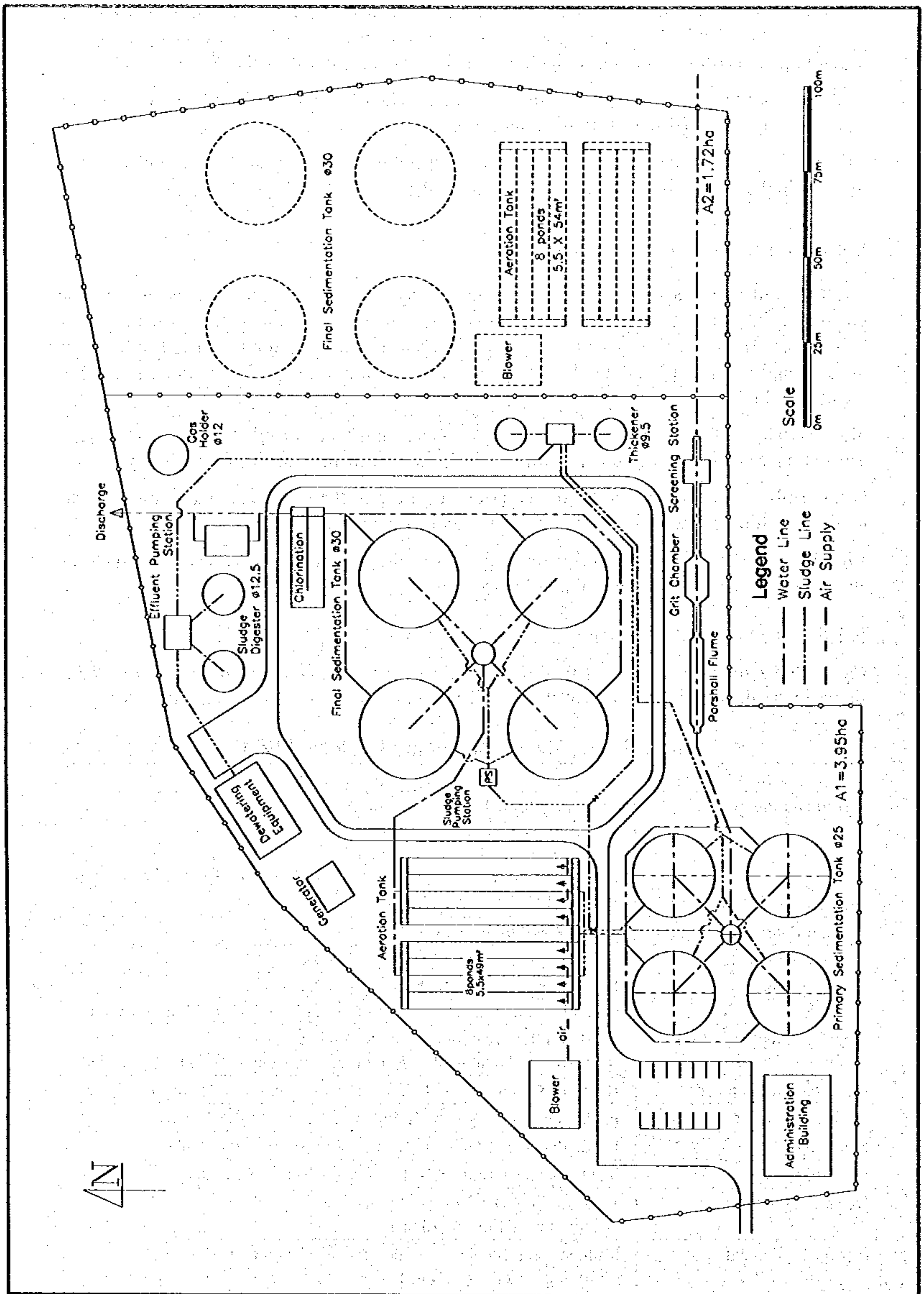

Figure II.5.1	Layout of Plan of Tulcea WWTP

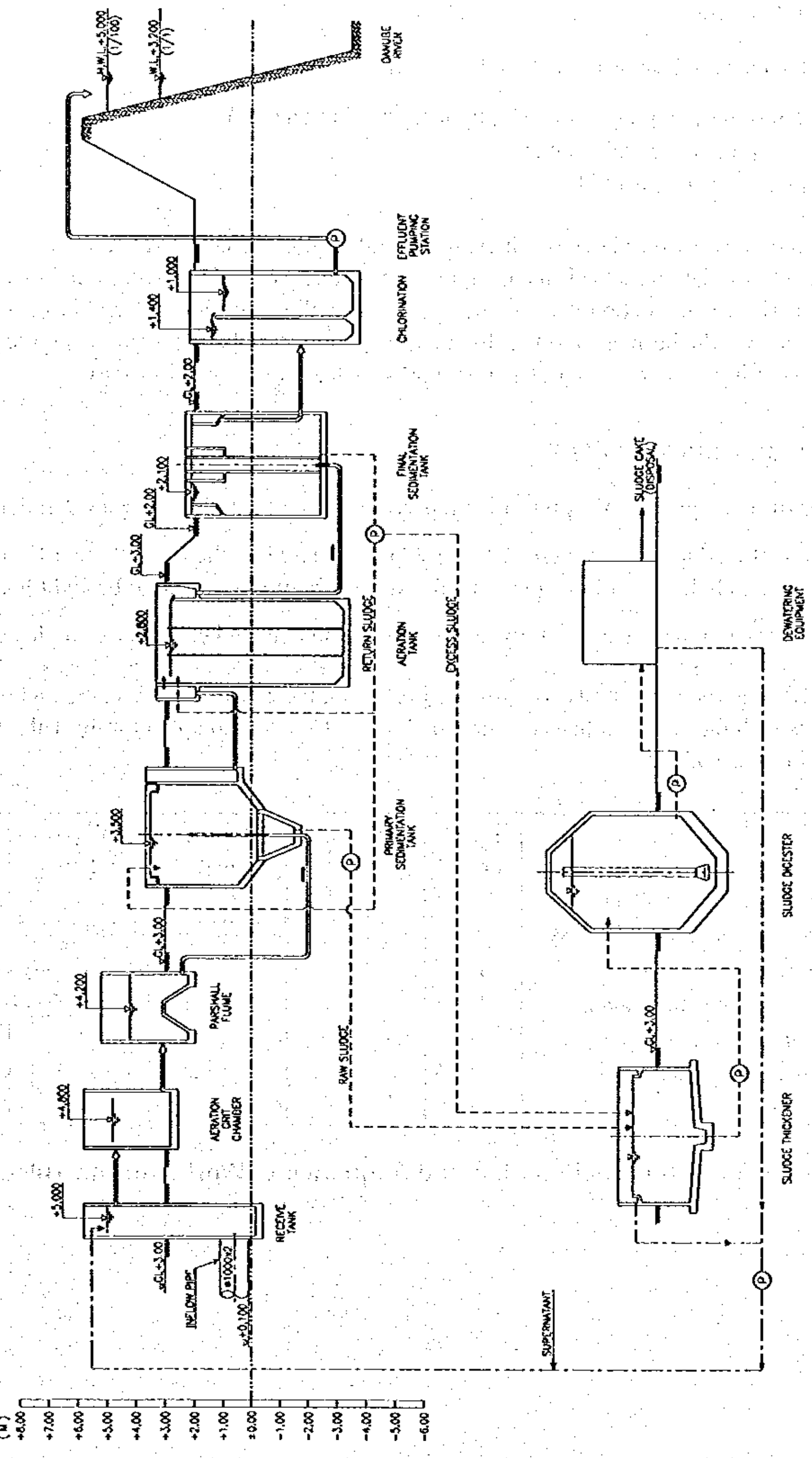

Figure II.5.2	Hydraulic Plofile of Tulcea WWTP

5.5 CONSTRUCTION PLAN

5.5.1 GENERAL

Major Facilities to be constructed the Project are as follows:

- Wastewater pumping station (Equipment installation only)
- Interceptor sewer and manhole
- Wastewater treatment plant

Construction works for above facilities, in general, will be executed by ordinary construction and equipment installation methods using equipment readily available in Tulcea and/or Romania. In addition, since construction site for the proposed facilities are located within or around Tulcea City, there would be neither difficulty to transport materials and equipment nor difficulty in obtaining utility services for construction works such as water and electricity.

5.5.2 CONSTRUCTION PLAN

The construction plan for the project is prepared based on the following considerations:

- Annual working days are estimated at 225 days based on the rainfall records in the past five years and holidays in Romania. Daily working hour is assumed to be eight hours.
- Construction machines are fully utilized for the smooth and economical implementation.

Required construction periods are estimated based on the construction volume and ordinary scale of inputs with the considerations mentioned above. Construction plan for the Tulcea project is as shown in *Figure II.5.3*.

	Period (Year)	1st year 2001	2nd year 2001	3rd year 2002	4th year 2003
Wastewater Treatment Plant					
Wastewater Treatment Process	2.5				
Sludge Treatment Process	1.5				
Discharge Pumping Station	1.5				
Power Receiving Facility	1				
Administration Building	1				
Interceptor	1				

Figure II.5.3 Construction Plan and Sequence of Works for the Tulcea Project

CHAPTER 6 OPERATION AND MAINTENANCE PLAN

6.1 DESCRIPTION OF OPERATION AND MAINTENANCE WORKS

Following figure shows necessary operation and maintenance works in WWTP.

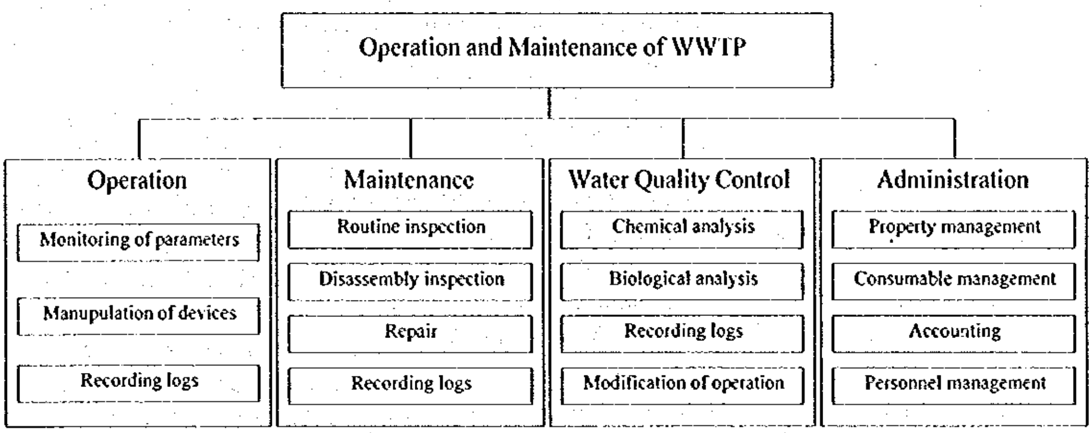

Figure II.6.1 Necessary Operation and Maintenance Work

The works are composed of operation of treatment processes for wastewater and sludge, maintenance work, water quality control, and administrative work.

6.1.1 TREATMENT PROCESS OPERATION

Process operation consists of monitoring of parameters and manipulation of devices such as gates, valves and pumps. The characteristics of these two activities are quite different. Manipulation of devices may be required only several times a day at most, on the contrary, monitoring will be required continuously. Thus, introduction of centralized automatic monitoring system greatly contributes to reduce number of operation staff. Furthermore, automatic monitoring is technically far easier and more reliable than automatic operation. These are the reasons why centralized monitoring system is applied in the proposed WWTP, though the automatic operation system is not introduced.

Tables II.6.1 to *II.6.3* show operation parameters monitored by central control system.

Table II.6.1 General Operation Parameters Monitored by Central Control System

Operation Process	Monitoring parameter
Electrical facilities (including receiving equipment)	Voltage, electric current, electric power, electric power consumption
	Power factor, frequency, temperature of transformer
Others	Atmospheric temperature, humidity, pressure, rainfall
	Direction of the wind, wind velocity, strength of rainfall

Table II.6.2 Wastewater Treatment Operation Parameters Monitored by Central Control System

Operation Process	Monitoring parameter
Grit chamber and oil separator	Inflow gates opening
	Inflow water level and volume (incoming flow), pH
	Water level of pre-screen and post screen
	Intake air flow, supplied air flow and pressure of blower
Pumping station	Water level at wet well
	Supplied water flow
	Effluent water level
	Valve opening
	Bearing temperature of pump and motor
Primary sedimentation tank	Receiving water level
	Underflow sludge volume
Aeration tank	Gate opening
	Receiving water level
	Air volume
Blower equipment	Intake air flow of blower
	Supplied air flow and pressure of blower
	Bearing temperature of blower and motor
Final sedimentation tank	Receiving water level
	Underflow sludge volume
	Excess sludge volume
	Water level of sludge sedimentation pond
Chlorine contact tank	Hypo-chlorite dosage volume
	Receiving water level
Discharge pipe	Discharge water volume
	Water level of river

Table II.6.3 Sludge Treatment Operation Parameters Monitored by Central Control System

Operation Process	Monitoring parameter
Sludge thickener	Inflow sludge volume
	Water level of tank
	Sludge-liquid interface
	Underflow sludge volume
Sludge digester	Inflow sludge volume
	Water level of tank
	Digested sludge transportation volume
	Under flow digested sludge volume
	Supernatant volume
	Outbreak sludge-digestion gas volume
	Digestion tank temperature
	pH
Dewatering equipment	Inflow sludge volume
	Sludge cake volume
Gas holder	Storage volume
	Gas holder level
	Add temperature combustion gas volume
	Excess combustion gas volume

6.1.2 MAINTENANCE WORK

Routine and disassembly inspections are essential to keep proper function of devices. *Table II.6.4* summarizes necessary maintenance work in general.

Table II.6.4 Necessary Maintenance Work

Frequency	Work content
Daily	Check appearance, unusual vibration and sound
	Check condition of lubricants
Monthly	Check gland packing wear and leakage around seals
	Check and, if necessary, replenish lubricants
	Check tension and wear of chains
Yearly	Replace lubricants and gland packing
	Tighten bolts
	Check operation of electric and mechanical devices
	Check operation of protective devices
	Dry up tanks/reservoirs and check submerged devices
Every 1 – 4 years	Overhaul, paint or greasing devices

Results of inspections and any maintenance activities should be recorded in daily or monthly logs. Maintenance staff should request necessary spare parts and consumables so that administrative staff can properly manage them.

6.1.3 WATER QUALITY CONTROL

Water quality control is one of the essential parts of WWTP operation. Operation parameters should be determined by the results of water quality analysis. Analysis items and sampling frequency of each sampling point is summarized below:

Table II.6.5 Analysis Items and Sampling Frequency of Each Sampling Point

Sampling points	Analysis items	Sampling frequency
Inflow channel	Appearance, Odor, Water temperature, Turbidity, pH	Daily or at the time of inspection
	SS, COD	Weekly
	BOD, NH_4-N	Monthly
Aeration tank	Appearance, Odor, Water temperature, Turbidity, pH	Daily or at the time of inspection
	MLSS	Weekly
	Microorganism	Monthly
Outlet of final sedimentation tank	Appearance, Turbidity, pH	Daily or at the time of inspection
	SS, COD, NH_4-N, NO_3-N	Weekly
	BOD	Monthly
Outlet of WWTP	Appearance, Turbidity, pH, Chlorine residual	Daily or at the time of inspection
	SS, COD	Weekly
	BOD, NH_4-N, NO_3-N	Monthly

Source: Japan Sewage Works Association, "Guidelines for Planning, Design and Operation and Maintenance for Small Scale Treatment Works." 1996.

6.1.4 ADMINISTRATIVE WORK

WWTP forms a self-complete organization and needs administrative staff for management of properties and consumable goods, budgeting and accounting, and personnel management. In addition, security guards, building janitors, and cleaning persons are also included in administrative staff.

6.2 EQUIPMENT FOR OPERATION AND MAINTENANCE

In addition to ordinary maintenance equipment such as welding machine or turning machine, at least the following laboratory equipment is necessary for laboratory:

- Temperature/pH/conductivity meters
- DO meters
- COD apparatus
- Turbidity meter
- Low power and high power microscopes
- Digital balances
- Drying ovens
- Incubators
- Laboratory flocculation apparatus
- TOC analyzer
- Hot plate stirrers
- Digestion apparatus
- Laboratory centrifuge
- Vacuum pumps with blower facility
- Evaporation equipment (water bathes, etc.)
- Distillation equipment and rotary film evaporator
- Fume cupboards with ventilation equipment
- Extensive range of laboratory ware
- Continuous still and deionizer units
- Miscellaneous instruments and spares

CHAPTER 7 ORGANIZATION PLAN

7.1 PRINCIPLES OF THE ORGANIZATION PLAN

The organization plan in the Study is made in line with the following principles.

- A current sewerage operating body, S.C. ACET S.A. will undertake the operation and maintenance of facilities constructed by the proposed project.
- The WWTP section will be established in S.C. ACET S.A. as a responsible body of WWTP.
- Scope of the organization plan is limited within the personnel related to the operation and maintenance of facilities constructed by the proposed project. The plan does not aim to modify current structure of S.C. ACET S.A.
- Since the administrative staff of the WWTP section will deal with most part of administrative work related to WWTP, increment of indirect division personnel out of the WWTP section is not envisaged.

7.2 REQUIRED PERSONNEL FOR THE WWTP SECTION

The wastewater treatment process runs for 24 hours continuously. Thus, the operation personnel for the process will work in three shifts. The chief of each shift should be an engineer in order to improve supervision capacity and plant operation control. The personnel for the final sludge disposal site are not included here, because neither construction nor operation and maintenance of the disposal site are within project scope. Following factors are also taken into consideration to estimate the number of required personnel.

- The WWTP should be self-sufficient from the laboratory viewpoint, for the control of treatment processes, research and development processes.
- Though the maintenance personnel will work during daytime in principle, the electric technician should stay for 24 hours continuously taking into account that failures in the electrical area are the most common in general.
- For day/night shift tasks, four persons will share one job. Each of three persons will work for either 8 hours or 12 hours a day, and the additional one will serve as replacement so that the other three may rest one day a week.

Under the section chief who is responsible for all the activities relating to operation and maintenance of WWTP, the following management personnel is deployed:

- Operation supervisor
- Maintenance chief responsible for all maintenance staff
- Laboratory chief responsible for water quality control, especially for sampling and analysis
- Administrative chief responsible

The number of required personnel is shown in *Table II.7.1*.

Table II.7.1 Personnel Requirements for the WWTP Section

Position	Total number	Day shift	Day/night shift
0. Section chief	1	1	-
Subtotal of Item 0	1	1	-
1. Operation			
Chief	1	1	-
Operator (engineer)	1	1	-
Equipment operator	4	-	4
Auxiliary staff	4	-	4
Subtotal of Item 1	10	2	8
2. Maintenance			
Chief	1	1	-
Supervisor	1	1	-
Auxiliary staff (mechanical)	1	1	-
Turner	1	1	-
Auxiliary shop staff	1	1	-
Instrumentation technician	1	1	-
Electrician (senior)	4	-	4
Auxiliary staff (electrical)	1	1	-
General concrete works	1	1	-
Subtotal of Item 2	13	9	4
3. Water Quality Control			
Chief	1	1	-
Chemist	1	1	-
Microbiologist	1	1	-
Sampling auxiliary staff	1	1	-
Subtotal of Item 3	4	4	-
4. Administration			
Chief	1	1	-
Administration assistant	1	1	-
Secretary	1	1	-
Driver	1	1	-
Janitor / cleaning staff	1	1	-
Security guard	4	-	4
Subtotal of Item 4	9	5	4
Total	36	20	16

7.3 OTHER PERSONNEL INCREMENT

The proposed facilities in the Tulcea feasibility study in addition to the WWTP are as follows:

- 3 pumping stations
- 910 m of gravitational sewer pipes with 2 manholes
- 285 m of pressure pipes

To cope with an increase of work volume due to the above facilities, additional four (4) maintenance persons, or one (1) shift, in the water distribution and sewerage section, is proposed for operation and maintenance of those facilities.