4.2.6 Financial Performance

4.2.6.1 Overview

The Skuodas Water Company made losses both in 1996 and in 1997. Operating losses to sales, however, decreased from -6.5 percent in 1996 to -5.6 percent in 1997. Current losses to sales decreased from -11.8 percent in 1996 to -10.3 percent in 1997. Losses to sales improved a little but the ratio is still on the negative side.

Table 4.7 Outline of the P/L of the Skuodas Water Company (in litas)

Water & Sewerage	1997	1996
Income	587,593	517,068
Operating Cost	620,254	550,429
(Operating) Profits or Loss	-32,661	-33,361
Other Expenditure	27,811	27,584
(Current) Profit or Loss	-60,472	-60,945
Financial Investment Income	2,357	4,589
Profit or Loss before Tax	-58,115	-56,356
Income Tax	0	0
Net Profit or Loss	-58,115	-56,356

4.2.6.2 Income Analysis

The income of the Company increased by 13.6 percent in 1997, mainly due to the tariff increase. The tariff increased by 25 percent for water supply and 32 percent for individual users for sewage and by 9 percent for other users. However, the volume decreased by more than 12 percent because of the tariff increase. There was no increase in population and number of households, and industrial activities continued to be depressed. This is shown in the following table.

Table 4.8 Income Structure of the Skuodas Water Company

Income/Volume	1997	%	%,Increase	1996
Total Income (litas)	587,593	100	13.6	517,068
Sewerage Income (litas)	268,664	46	19.7	224,452
Water Supply Income (litas)	318,929	54	9.0	292,616
Sewage Volume (m^3)	211,196		-12.7	241,917
Water Supply Volume (m^3)	233,630		-12.8	267,984

In 1997, Skuodas increased sales by 13.6 percent, but the cost also increased by almost the same degree. So the operation continued as a loss, with only a 2.1 percent improvement in the operating loss level and 3.1 percent decrease in the net loss level.

At the operation level, while the sewage division provided 45 percent of the total sales, it also contributed 84 percent of the total loss. As such, improvement in the business of the sewerage division is of primary importance.

Table 4.9 Operating Loss (1997, litas)

Sewerage Division	
Income	268,664
Expense	296,124
Operating Profit or Loss	-27,460
Water Supply Division	
Income	318,929
Expense	324,130
Operating Profit or Loss	-5,201

4.2.6.3 *Cost Analysis*

The Skuodas Water Company divided the operating cost into two divisions: sewerage and water. The administration cost was shared by the two divisions.

Using this accounting method, the operation costs (per/m^3) were almost the same: 1.40 litas for sewage and 1.39 litas for water.

However, the tariff for sewage is cheaper than that for water. If the tariff is decided based on the operating cost, then the sewage tariff must be raised.

Table 4.10 Operating Cost of the Skuodas Water Company

Operating Cost	Sewerage Division			Water Division		
	litas	composition	litas/m^3	litas	Composition	litas/m^3
Cost of Energy Usage	19,189	6.48%	0.09	48,411	14.94%	0.21
Cost of Chemicals		0.00%	0.00	945	0.29%	0.00
Administration (4p x 0.5)	34,352	11.60%	0.16	33,497	10.33%	0.14
Engineers and Technicians (2p x 0.5)	19,563	6.61%	0.09	19,077	5.89%	0.08
Taxes	38,785	13.10%	0.81	28,068	8.66%	0.12
Nature Protection Tax	33,254	11.23%	0.16	14,395	4.44%	0.06
Property Tax	4,184	1.41%	0.02	12,078	3.73%	0.05
Road Tax	1,347	0.45%	0.01	1,595	0.49%	0.01
Wages, Social Securities (13/12P)	115,197	38.90%	0.55	104,993	32.39%	0.45
Salaries	88,803	29.99%	0.42	81,091	25.02%	0.35
Social Insurance	26,395	8.91%	0.12	23,901	7.37%	0.10
Depreciation, Fuels & Others	69,038	23.31%	0.33	89,139	27.50%	0.38
Depreciation	34,491	11.65%	0.16	46,573	14.37%	0.20
Parts, Materials	13,608	4.60%	0.06	20,429	6.30%	0.09
Fuel	10,189	3.44%	0.05	14,245	4.39%	0.06
Analysis Cost	8,943	3.02%	0.04	2,201	0.68%	0.01
Others	1,906	0.64%	0.01	5,691	1.76%	0.02
Total	296,124	100.0%	1.40	324,130	100.0%	1.39

While above operating structure is a basic method used in calculating and deciding the tariff, there are other expenses which are not permitted to be used in calculation of the tariff shown in the following table. These other costs must be paid from the revenue generated by the company or offset by the municipality.

Table 4.11 Other Expenditure (litas)

Total Other Expenditure	27,811
Insurance	945
Penalty	1,590
Pollution Penalty	14,293
Others	4,595
Bad Debt	6,388

The operating cost for sewerage is 1.25 litas/m^3. While the standard sewage tariff is 1.16 litas (for residential use) and 1.17 litas (for other uses), the effective tariff was estimated about 1.50 litas (some enterprises pay a special tariff as a penalty for pollution).

The operating cost of the water is 1.71 litas/m^3. The standard tariff is 1.24 litas for residential use and 2.15 litas for other uses.

4.2.6.4 Ratio Analysis

(1) Efficiency Analysis

The total assets require 4.83 years for turnover. The large portion of the long term assets and low sales cause the low asset turnover ratio.

Table 4.12 Efficiency Ratio

	1997	1996
Total Sales (litas)	587,593	517,068
Total Assets (litas)	2,837,534	2,875,006
Asset Turnover Ratio (Times)	0.21	0.18
Asset Turnover Period (Years)	4.83	5.56
Long Term Asset (litas)	2,668,549	2,731,444
Current Assets (litas)	168,985	143,562
Long Term Asset Turnover (Times)	0.22	0.19
Current Assets turnover (Times)	3.48	3.60
Long Term/Total Assets Ratio (%)	0.94	0.95
Current/Total Assets Ratio (%)	0.06	0.05

The company had 93,587 litas receivables (unpaid bills for water and sewage) at the end of 1997, a decrease from 99,158 litas in the previous year. The average collection period shortened to 1.91 months from 2.30 months over the same period.

Table 4.13 Collection Period for Receivables

	1997	1996
Bill Collection Period (M)	1.91	2.30

(2) Liquidity Analysis

Current Liability Ratio is 1.77 percent and the company has no outstanding loans.

The current liability consists only of short-term payables to suppliers, taxes, wages and social insurance.

The sum of the current liability was 95,457 litas at the end of 1997, a very small figure.

Equity Ratio is 96.64 percent and, as previously stated, the company has no long-term bank loans or other long-term liabilities. The equity ratio is very high.

4.3 EXISTING WATER SUPPLY SYSTEM

4.3.1 Existing Facilities

The Water Company has three deep wells inside the town proper as a source as listed in the table below:

Table 4.14 Production Well of the Water Company

Well Certificate No.	Depth (m)	Capacity (m^3/h)
1	100	30
2	110	84
3	110	80

The total capacity of the five wells is calculated at 4,656 m^3/day when operated continuously.

Groundwater taken from these wells is collected at a treatment plant located in the Water Company building for iron removal. This plant was constructed in 1984. The treatment process consists of aeration, rapid sand filtration, and disinfection using gaseous chlorine. Treated water is then pumped into the distribution pipeline network.

The filter produces wastewater from backwash process. Approximately 100 m^3 of wastewater is discharged into a drainage channel without treatment everyday.

The existing water supply network has approximately 23 km of pipeline of diameters ranging 150 to 250 mm. These are broken down as follows:

dia. 250 mm	1 km
dia. 200 mm	4 km
dia. 150 mm	5 km
dia. 100 mm	2 km
dia. 65 mm	8 km
dia. 50 mm	1.5 km
dia. 32 mm	0.5 km
dia. 25 mm	1 km

Pipe materials are cast iron for pipes of 65 mm diameter or larger, steel for pipes of 50 – 32 mm diameter, and PVC for pipes of 25 mm diameter.

4.3.2 Water Production and Sales

In 1997, the Water Company supplied 233,630 m^3 of water to consumers. Water consumption is broken down by category as follows:

Table 4.15 Water Sales

unit: m^3

Year	Residence	Industry	Hospital	Others	Total
1996	187,412 (69.9%)	9,870 (3.7%)	36,741 (13.7%)	33,961 (12.7%)	267,984
1997	155,540 (66.6%)	14,746 (6.3%)	24,816 (10.6%)	38,528 (16.5%)	233,630

As shown in the table, residential use has a high percentage. Sewage discharged from the hospital and other users (public offices, canteen, school etc.) is also regarded as domestic sewage, more than 90 percent is accounted as domestic sewage. Percentage of the industrial wastewater is about 5 percent.

4.3.3 Future Development Plan

There is no development plan for the water supply system since the existing deep wells have sufficient capacity to meet the anticipated demand increase in the near future.

The Water Company expects the service ratio will increase to 70 percentage of the total population by the year 2010.

4.4 EXISTING SEWERAGE SYSTEM

4.4.1 Existing Facilities

4.4.1.1 General

The sewerage system of Skuodas has been developed since the 1960's to collect, transfer and treat the sewage discharged in the town proper. The existing system consisting of pipelines, pump stations, and a treatment plant was completed in 1962. Currently, the existing system collects sewage totaling about 2,200 m^3/day. The layout of the existing sewerage system is presented in Figure 4.3.

4.4.1.2 Sewage Collection

The sewage collection system of Skuodas is a separate system in which only sewage is collected. Rainwater is drained into the rivers or the lake through open channels. The sewerage collection system consists of sewer pipelines and pump stations. The total length of sewers is 19,185 m with diameters ranging 100 to 500 mm broken down as follows:

100 mm	4,465 m
150 mm	2,685 m
200 mm	7,285 m
250 mm	340 m
300 mm	4,160 m (including 3,200 mm pressure line)
500 mm	250 m

Pipes are made of several types of material such as clay and concrete for gravity lines, and cast iron and ductile cast iron for pressure lines.

There are three major transfer pump stations. The details for the pump stations are shown in table below:

Table 4.16 Existing Pump Stations

No.	Pumps Installed		Discharge to
	Pump Capacity	Type of Pump	
1	12 m^3/h, 7.6 kw 1 unit	submersible pump	to No.1 existing treatment plant
2	100 m^3/h, 22 kw 2 units	horizontal centrifugal pump	to No.2 existing treatment plant
3	100 m^3/h, 22 kw 2 units	submersible pump	to No.1 existing treatment plant

The structure of the pump stations is a typical design. It has a reinforced cylindrical barrel that is vertically split into two parts: namely, a sump for receiving and storing sewage and a dry well for accommodating the pumps installed at the bottom slab level. The motor control units are installed on the ground level floor. Power receiving and transfer facilities are provided in a building outside each pump station. The typical structure of the pump stations is presented in Figure 4.4.

Pumps are switched on and off according to liquid level in the sump. An automatic on-off system using a liquid level detector operates in each pump station.

Another pump station was recently constructed in the No.1 Treatment Plant to transfer the incoming sewage to the proposed new treatment plant site while the No.1 Treatment Plant is to be abandoned. For this station, pumps were purchased by the Water Company but have not been installed. From this pump station, dual 300 mm transmission pipelines were installed to the new treatment plant site. Pipes are of ductile iron and have a length of 1.6 km.

4.4.1.3 Sewage Treatment

Existing Treatment Plant No.1

No.1 Treatment Plant is located in the center of the town and in the area called New Town. The service area of this plant is also the New Town. The 220 sewerage service connection in this area are broken down to: 86 individual houses, 63 corporate houses, 16 commercial entities, 1 factory, 1 hospital, and 53 others. Present connected population is estimated at 6,018.

The plant was constructed in 1979 with a design capacity of 75 m^3/day. It receives sewage from Pump Stations No.1 and 3. At present, the plant receives about 600 m^3/day of sewage. The plant is therefore heavily overloaded. The plant system consist of the following facilities:

1) Receiving Box and Grit Chamber

Pumped sewage is discharged to the receiving box and flows into the grit chamber. The grit chamber is of reinforced concrete consisting of two parallel lines of narrow channels. Each channel is 10.5 m long and has a width of 30 cm and depth of 45 cm.

2) Imhoff Tank

The sewage flows into a circular Imhoff tank. The dimensions of the tank are 11 m diameter and 7.5 m deep. The tank is of reinforced concrete, and has a steel-made double deck. Sewage solids settle in the bottom compartment of the tank while the liquid flows into the upper compartment.

3) Contact Chamber

After the Imhoff Tank, there is a concrete contact chamber. The chamber consists of two tanks with dimensions 2.5 m by 12.6 m and 3.0 m deep. The purpose of this tanks is to mix the effluent with lime and chlorine before final discharge.

4) Chlorination Building

A building is provided beside the Imhoff Tank to house the chlorination equipment. Chlorination is no longer applied since it is not the legal requirement.

Layout of the existing treatment plant is presented in Figure 4.5.

Existing Treatment Plant No.2

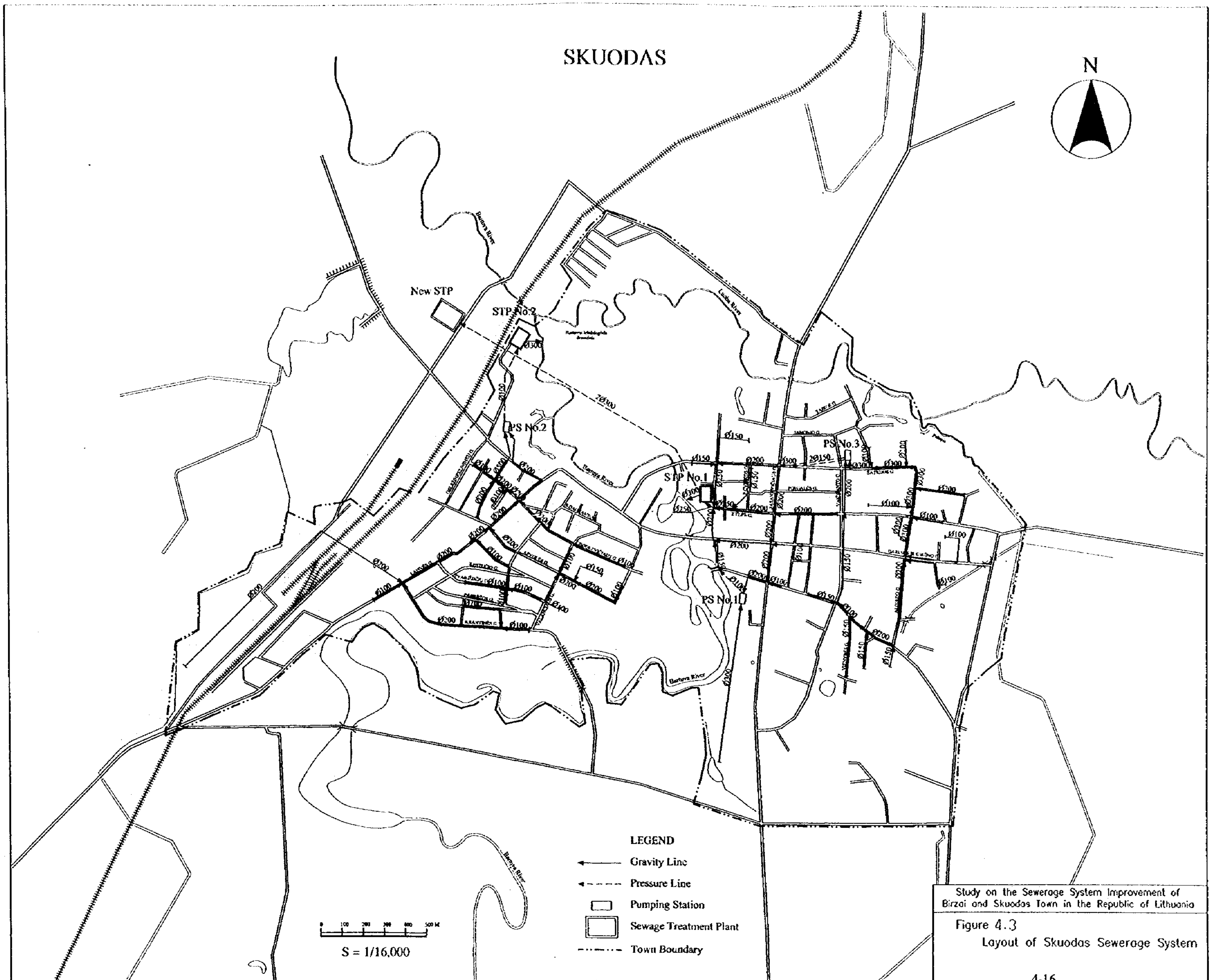
No.2 Treatment Plant is located in the northwest end of the town. The service area of this plant is the Old Town. The 213 sewerage service connection in this area are broken down to: 188 individual houses, 10 corporate houses, 3 commercial entities and 10 others. Present connected population is estimated at only 713. This figure is very small compared with the connected population of the No.1 plant, that is 6,018 with 220 connection. This is because the households in the service area are all individual houses while the service area of No.1 plant include a number of corporate houses.

The plant was constructed and owned by Land Reclamation Company with a design capacity of 340 m^3/day. It was then transferred to the Water Company in 1995. It receives sewage from Pump Station No.2. At present, the plant receives about 70 m^3/day of sewage. This amount is much less than the design capacity. Layout of the treatment plant No.2 is shown in Figure 4.6.

The plant system consist of the following facility:

1) Receiving Box and Grit Chamber

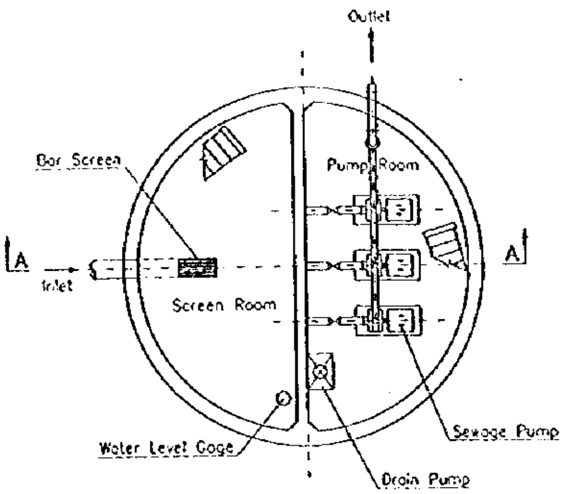
Pumped sewage is discharged to the receiving box and flows into the grit chamber. The grit chamber is of reinforced concrete consisting of two lines of narrow channels. Each channel is 13 m long and has a width of 30 cm and depth of 40 cm.



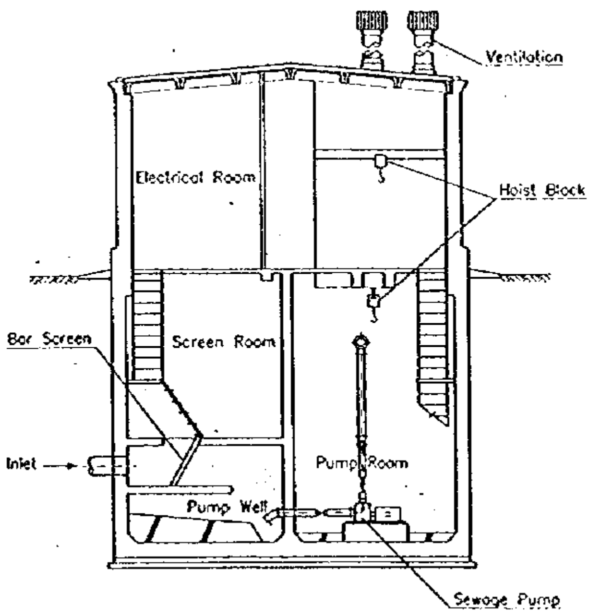
Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

Figure 4.3 Layout of Skuodas Sewerage System

A. Dry Pit Pump Type

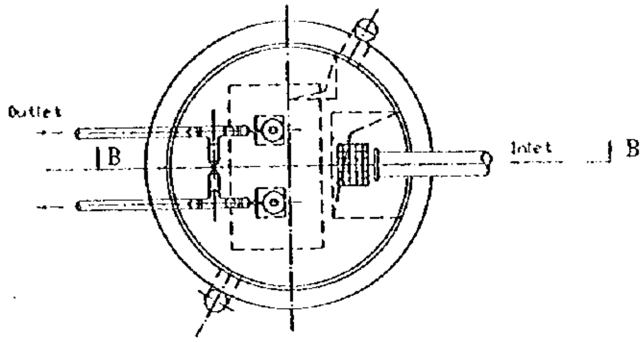


Plan

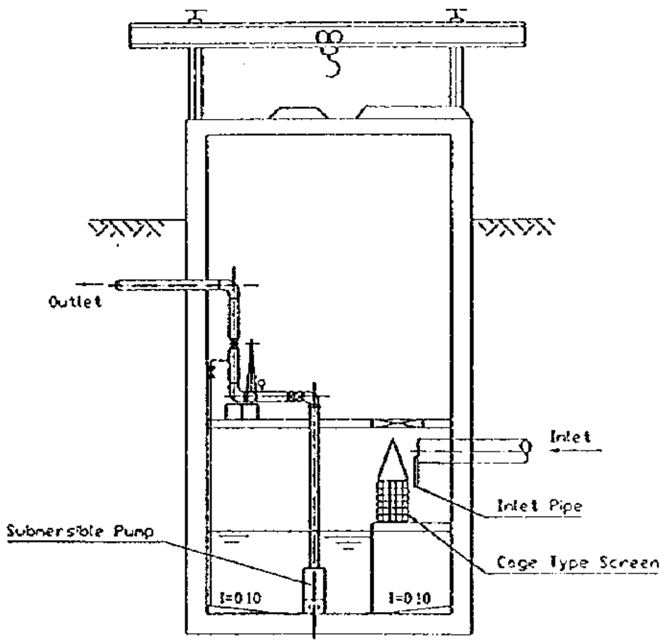


Section A-A

B. Submersible Pump Type



Plan



Section B-B

Figure 4.4
Typical Structure of
Pumping Stations

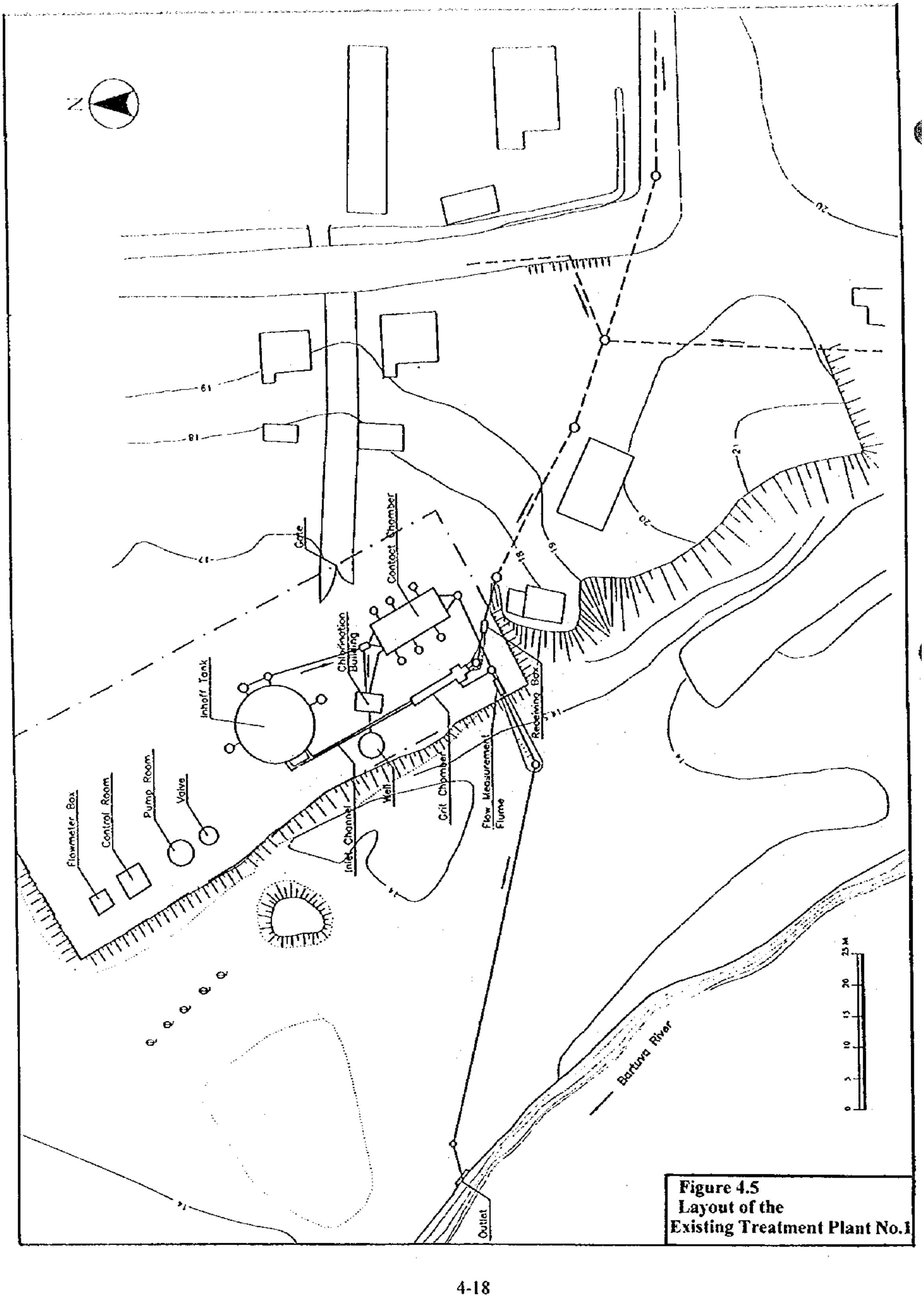
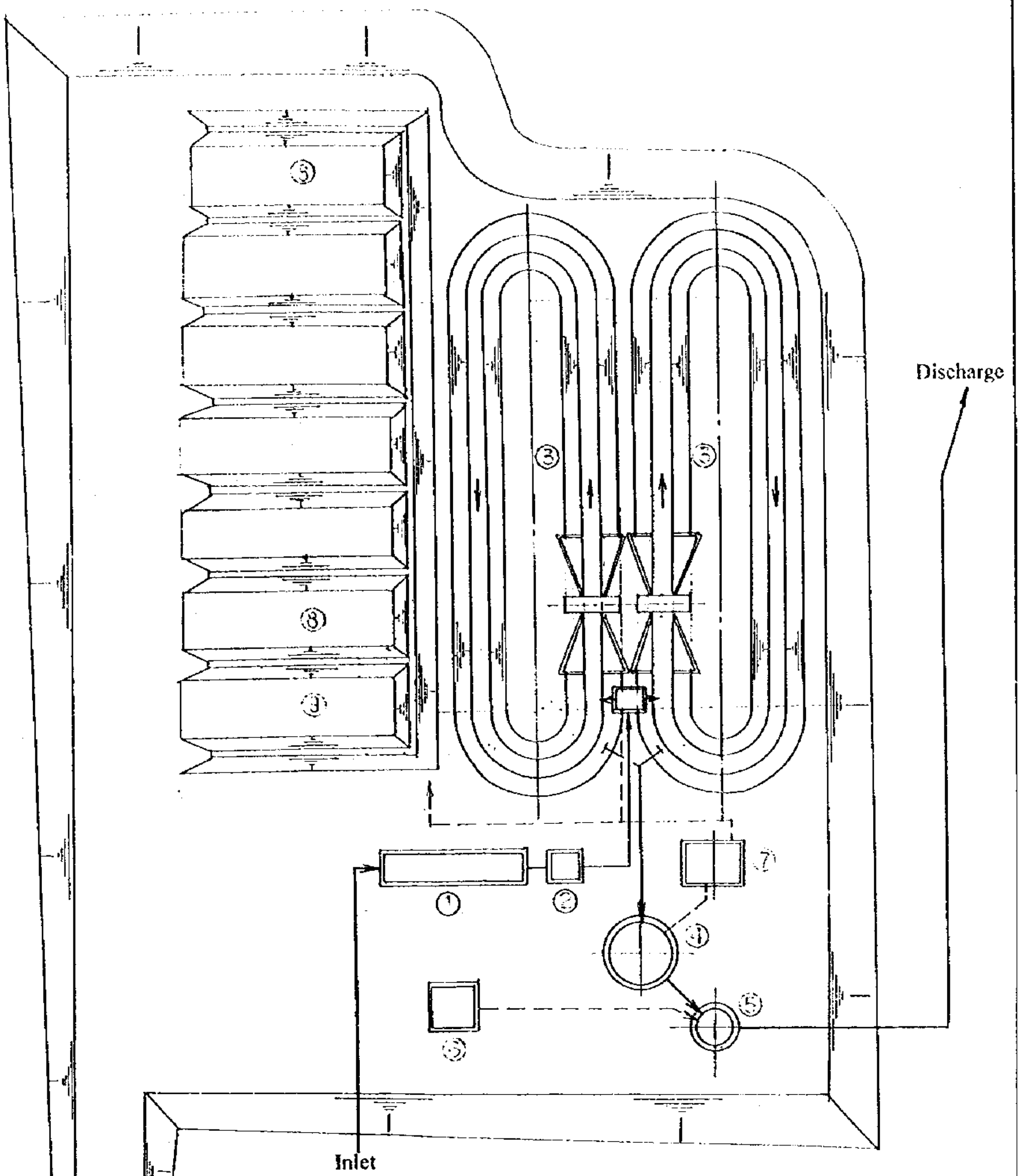


Figure 4.5
Layout of the
Existing Treatment Plant No.1



① Grit Chamber
② Flow Measurement Box
③ Oxidation Ditch
④ Sedimentation Tank
⑤ Chlorination Tank
⑥ Chlorine Disolving Tank
⑦ Sludge Pit
⑧ Sludge Drying Bed
⑨ Sand Lagoon

Figure 4.6
Layout of the Existing Treatment Plant No.2

2) Oxidation Ditch

There are two oxidation ditches. Each unit has a long ring shaped channel. Cross section of the channel is trapezoidal with dimensions of 1.45 m wide at bottom, 4.15 m wide at surface, and 0.9 m deep. Length in the center of the channel is 103.4 m. Volume of the channel is therefore calculated at 260.6 m^3. Side slope and bottom of the channel are lined with pre-cast concrete panels.

Each channel is equipped with a horizontal rotor. A blower was originally installed to add more oxygen and/or avoid settlement of sludge in the channel. However, the blower was removed after it had given trouble.

3) Final Sedimentation Tank

Two-stage final sedimentation tanks are provided after the oxidation ditch. Both tanks are of reinforced concrete and circular with diameters of 6.0 m and 4.0 m for the first and second tanks, respectively.

4) Sludge Lagoon

Four units of sludge lagoons are provided to store the sludge extracted from the sedimentation tanks. Each lagoon has a rectangular shape of 5.0 x 18.0 m, and about 1 m deep.

Sludge discharged into the lagoons is stored until it is sufficiently dried for easy handling. Supernatant is drained and discharged into the drainage channel together with the effluent of the plant.

5) Sludge Pump

One sludge pump is provided for recycle to the oxidation ditch and for discharge to the sludge lagoon.

4.4.1.4 Sludge Disposal

Existing Treatment Plant No.1

Sludge stored in the bottom compartment of the Imhoff Tank is removed by suction equipment from the manhole adjacent to the tank. Sludge settled in the contact chamber is taken away once every week or two. Removal of the sludge from the Imhoff tank is carried out about once a month using a tanker. At present, sludge is disposed to agricultural land as a normal practice in Lithuania.

Existing Treatment Plant No.2

After being dried in the drying bed, sludge is removed and disposed to agricultural land. As the incoming sewage amount is low, the sludge production is also minimal.

4.4.1.5 Discharge of Effluent from the Treatment Plant

The two existing treatment plants discharge effluent to the Bartuva River at the closest point from each plant site. Discharge point of the No.1 plant is located just downstream of the bridge connecting the old town and new town.

4.4.2 Characteristics of Sewage and Plant Performance

4.4.2.1 Existing Data of Sewage Characteristics

The Water Company conducts a water sampling and quality analysis of the influent and effluent of the treatment plant at Palanga Water Company once a month. Wastewater of the milk factory and other commercial entities are also taken and analyzed at Klaipėda Environmental Department four times a year.

The result of the quality analysis by the Water Company is summarized in Table 4.18 and Table 4.19. Influent quality of the treatment plant No.1 is shown in Figure 4.7.

4.4.2.2 Performance of the Existing Treatment Plants

Existing Treatment Plant No.1

As shown in the water quality data, the existing treatment plant No.1 does not satisfy the national effluent standards referred to in Section 3.5.1.1. The summary of the influent and effluent are shown below.

Table 4.17 Summary of Performance of the Treatment Plant No.1

	BOD_7		COD_{Mn}		SS		Total-N		Total-P		Detergent		Oil	
	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.
Maximum	973	307	222	97	428	144	142	67	16.0	8.6	9.1	3.0	1.40	1.30
Minimum	181	94	54	42	110	73	40	30	6.9	5.9	0.8	0.0	0.00	0.00
Average	459	225	112	65	244	116	67	49	10.5	7.2	3.5	1.4	0.37	0.25
Effluent Standard	20 (ave.) 30 (max.)		100 (ave.) 150 (max.)		30 (ave.) 45 (max.)		NA		NA		2		1	
Average of Removal Ratio	45%		37%		47%		23%		27%		47%		34%	

Effluent standard: for <10,000 p.e.

BOD_7 and suspended solid far exceed the maximum values set in the standards while the COD, detergent, and oil are within the acceptable range of the standards. This failure is easily explained from the design of the treatment process that is only physical treatment. However, from these results, effectiveness of the sedimentation process is evaluated in terms of the removal of pollutant as described below:

- In spite of heavily overloaded operation, the plant No.1 shows more than 45 percent removal for BOD_7 and SS, and 37 percent removal for COD.
- More than 20 percent of total nitrogen and phosphorus are removed.

Table 4.18 Water Quality Data at the Existing Treatment Plant No.1

unit: mg/l

Date	Temp. (°C)		BOD_7		COD_{Mn}		SS		Total-N		Total-P		Detergent		Oil	
	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.
23-Jan-96	6	5.5	213	210	88	67	147	126	64	58	13	7.0	2.1	1.6	0.2	0.18
13-Feb-96	8	9	471	258	140	84	422	124	70	50	14	7.0	4.0	3.0	0.0	0.00
19-Mar-96	1	2	378	227	91	89	222	102	74	52	14	7.1	6.3	0.0	0.5	0.19
09-Apr-96	9	9	181	174	86	66	158	114	48	46	6.9	5.9	2.2	1.3	0.2	0.09
18-Jun-96	15	16	416	223	75	73	198	132	65	54	11	7.5	3.2	1.6	0.1	0.09
16-Jul-96	20	20	317	211	90	88	216	123	59	52	8.9	7.5	7.3	1.2	0.5	0.18
27-Aug-96	19	18	767	199	105	76	385	127	66	56	9.4	8.5	3.5	1.4	0.0	0.09
17-Sep-96	10	10	581	251	146	81	313	131	87	56	13	7.9	3.1	1.0	0.2	0.18
29-Oct-96	14	13	424	212	121	50	428	120	49	45	9.2	6.1	6.3	-	1.4	1.30
19-Nov-96	12	12	298	94	54	45	173	121	48	35	7.6	6.7	0.8	0.7	0.1	0.00
10-Dec-96	10	11	431	185	131	63	178	103	47	45	9.6	8.6	1.9	1.3	0.1	0.09
16-Jan-97	9	8	281	220	93	47	172	128	53	53	6.9	6.7	3.1	1.5	1.0	1.00
18-Feb-97	8	6	593	198	162	64	177	100	40	30	7.6	6.5	1.8	1.1	0.4	0.36
18-Mar-97	8	6	638	190	222	44	323	73	74	48	13	7.6	4.6	1.9	0.4	0.36
22-Apr-97	6	8	608	228	183	51	296	78	60	45	12	7.0	1.9	1.4	0.3	0.26
21-May-97	8	9	441	281	85	51	194	109	68	54	16	7.8	2.1	1.3	0.2	0.19
17-Jun-97	11	12	350	289	100	55	286	136	73	47	12	7.2	4.3	1.2	0.5	0.18
22-Jul-97	17	17.5	973	307	146	97	329	130	142	43	16	7.8	3.0	2.0	1.1	0.45
12-Aug-97	18	19	450	256	98	89	270	139	83	67	8.7	7.9	9.1	0.8	0.5	0.09
16-Sep-97	16	17	419	217	82	52	110	73	63	55	7.3	7.0	2.9	1.4	0.3	0.18
21-Oct-97	13	13	326	233	76	49	192	116	83	46	7.6	6.6	2.0	1.8	0.3	0.00
10-Nov-97	8.5	9	535	285	84	42	182	144	57	45	7.2	6.9	1.6	1.3	0.2	0.09

Inf. = Influent quality
Eff. = Effluent quality
Source: Skuodas Water Company

Table 4.19 Water Quality Data at the Existing Treatment Plant No.2

unit: mg/l

Date	Temp.(°C)		BOD_7		COD_{Mn}		SS		Total-N		Total-P		Detergent		Oil	
	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.
23-Jan-96	6	6	152	15	99	22	115	10	61	31	10.0	6.1	1.5	0.4	0.19	0.09
13-Feb-96	4	5	517	10	172	9	648	14	44	31	13.0	3.6	7.7	0.0	0.09	0.09
19-Mar-96	4	6	272	15	98	19	398	13	68	28	9.8	7.2	4.3	0.9	0.36	0.18
09-Apr-96	8	10	42	6.3	19	13	47	7	18	25	1.5	2.2	0.4	0.2	0.27	0.19
18-Jun-96	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-96	12	15	453	15	167	20	744	15	36	24	12.0	4.6	3.3	0.4	0.28	0.09
27-Aug-96	11	20	466	16	225	16	856	14	41	30	10.0	2.0	6.2	0.9	0.08	0.09
17-Sep-96	12	11	267	9	71	16	211	15	51	24	11.0	4.4	2.0	-	0.18	0.10
29-Oct-96	13	13	118	212	54	22	182	26	22	15	8.1	3.0	2.7	1.0	0.27	0.23
19-Nov-96	13	14	28	10	20	18	71	15	16	8	2.8	2.3	0.1	0.0	0.19	0.09
10-Dec-96	7	8	49	12	29	12	40	11	18	15	3.8	3.4	0.3	0.0	0.10	0.00
16-Jan-97	3	4	26	23	12	11	40	29	15	14	1.2	1.2	0.4	0.2	1.10	0.45
18-Feb-97	4	1	57	38	27	14	38	24	26	19	2.5	1.6	0.4	0.4	0.45	0.35
18-Mar-97	3	4	82	38	42	20	83	21	31	21	3.2	2.4	0.9	0.5	0.66	0.00
22-Apr-97	5	5	1003	38	262	13	1367	15	46	20	15.0	1.7	5.8	0.7	0.28	0.00
21-May-97	9	9	39	25	26	13	46	10	25	25	3.7	2.6	1.0	-	0.09	0.00
17-Jun-97	12	12	133	37	39	14	92	12	40	28	6.6	3.6	2.8	0.4	0.10	0.00
22-Jul-97	13	19	2128	40	376	18	1853	28	81	23	16.0	3.4	9.6	0.8	0.50	0.09
12-Aug-97	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16-Sep-97	15	15	112	29	36	10	67	11	29	20	4.2	2.0	0.4	-	0.19	0.00
21-Oct-97	13	13	318	35	48	10	281	23	25	6.4	6.5	2.1	0.5	0.0	0.19	0.00
10-Nov-97	8	9	52.4	10	12	11	33	11	26	18	4.8	4.0	0.1	0.0	0.19	0.09

Inf. = Influent quality
Eff. = Effluent quality
Source: Skuodas Water Company

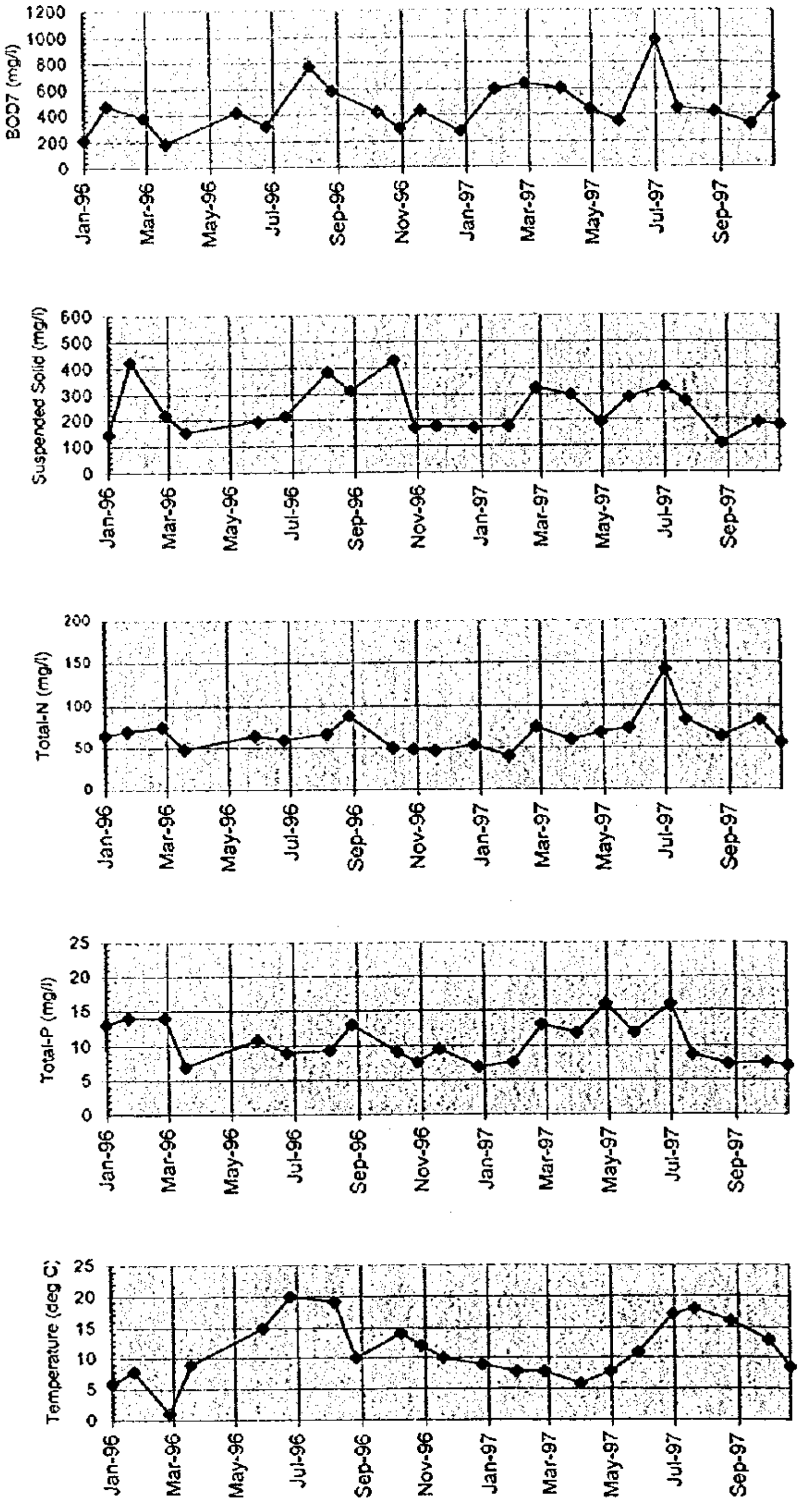


Figure 4.7 Influent Quality of Treatment Plant No.1

- Removal of these substances occurs only in the sedimentation process in the Imhoff Tank. It is therefore speculated that about 40 percent of the organic substances represented by BOD and COD are contained in the suspended solids removed by sedimentation. This fact means that the sedimentation is an effective measure to remove major part of organic substances.
- As well as organic substances, nitrogen and phosphorus are removed by sedimentation.

Existing Treatment Plant No.2

The existing treatment plant No.2 is being operated with less load than designed. Summary of the treatment performance is shown in table below.

Table 4.20 Summary of Performance of the Treatment Plant No.2

	BOD_7		COD_{Mn}		SS		Total-N		Total-P		Detergent		Oil	
	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.
Maximum	2128	212	376	22	1853	29	81	31	16	7.2	9.6	1	1.1	0.45
Minimum	26	6.3	12	9	33	7	15	6.4	1.2	1.2	0.11	0	0.08	0
Average	316	32	92	15	361	16	36	21	7	3	3	0	0	0
Effluent Standard	20 (ave.) 30 (max.)		100 (ave.) 150 (max.)		30 (ave.) 45 (max.)		NA		NA		2		1	
Average of Removal Ratio	68%		62%		82%		34%		41%		78%		61%	

Effluent standard: for <10,000 p.e.

Suspended solid and COD are well below the effluent standards. BOD7 does not comply with the standards. Considering that the plant is under-loaded, the aeration practice in the oxidation ditch is not satisfactory while the suspended solid and organic substances contained in the suspended solid are removed in sedimentation process.

4.4.2.3 Industrial Wastewater

In Skuodas, there is only one factory that is a milk company. In 1997, this factory consumed 40 m^3/day of water on daily average basis. As shown in Section 4.3.2, the total water consumption of this facility is only 6 percent of the total water consumption.

4.4.2.4 Results of the Water Sampling and Water Quality Analysis

The JICA Study Team conducted a water sampling and water quality analysis to supplement the data for sewage. Water samples were taken at the points and with a frequency as follows:

Raw Sewage

From the inlet channel of the treatment plant No.1 and No.2

4 days x 13 samples/day (every 2 hours for 24 hours)

= 52 samples

As well as water sampling, flow rate measurements were conducted at each sampling time.

Samples were analyzed at the Vikta Laboratory in Vilnius. Results of the sampling are summarized in Table 4.21.

Table 4.21 Results of Water Quality Analysis

item	unit	sampling date			
		Jul 28-29	Aug 06-07	Aug 13-14	Aug 20-21
Sewage Flow	m^3/day	1,253	1,001	1,476	526
SS	mg/l	490	362	157	209
BOD_7	mg/l	519	273	198	296
Soluble BOD_7	mg/l	201	94	78	165
COD	mg/l	957	757	396	589
Total-N	mg/l	57	65	55	58
Total-P	mg/l	11.8	9.7	13.6	9.3

Note: Concentrations are calculated as a weighted average of the concentrations and flow-rates of the 12 samples taken every 2 hours during 24 hours. Details are presented in Appendix 4.

4.4.2.5 Evaluation on the Characteristics of Sewage

Evaluation on the characteristics of sewage is made from the historical data and water quality analysis carried out by the JICA Study Team.

General

The characteristics of sewage in Skuodas are high concentration of pollutants as a result of low water consumption. Domestic sewage consists of about 95 percent of the total amount while the rest is industrial wastewater discharged from one milk factory.

Amount of Sewage

The highest peak in the variation of sewage flow occurs at around 10:00 p.m. and is approximately 2.0 times the average flow. There is a small peak in the morning. This pattern shows that the people use little water for shower, cooking or washing in the morning. The peak flow at night may occur in summer during which time people go out for dinner or meeting.

Estimated total daily flow is about 30 percent higher than the estimated water use. This fact is explained if there is substantial groundwater infiltration.

BOD

Amount of pollutant was calculated from the concentrations of each pollutant multiplied by the sewage flows measured every 2 hours. Daily average concentration was calculated from the total pollutant amount divided by the total flow of the day.

BOD level normally varies from 26 to 700 mg/l except for only one unusual value higher than 1000 mg/l. For the daily average level, the average BOD level ranges between 316 mg/l to 460 mg/l. In variation during 24 hours, the peak concentration time coincides the peak flow time. This pattern is commonly seen for the domestic sewage.

Nitrogen

Total nitrogen (Total-N) level varies from 30 to 100 mg/l except for one unusual value higher than 150 mg/l. The daily average level of Total-N ranges between 36 mg/l to 67 mg/l.

Phosphorus

Among the pollutants, phosphorus in Total-P shows the stable figures that range from 1 to 20 mg/l throughout the sampling period. Daily average level of Total-P is between 7 to 11 mg/l.

COD

In the historical data of the Water Company, COD is expressed as manganese COD that shows lower figures than chromium COD. In the sampling and analysis by the study team, chromium COD was used. COD presents the existence of organic substances more than BOD because of its stronger level of oxidation in the chemical reaction. Fluctuation of COD is largest among the items measured. It varies from 200 to 2,000 mg/l in a day. The Study Team's sampling results shows that COD is about two times the BOD concentrations.

pH

Value of pH ranges between 7.0 to 8.5. This seems reasonable for domestic sewage.

Others

A relatively large amount of screenings was observed at the pump stations. Screenings consists of plastics and other materials that are relatively large to be disposed of in the sewers. There is a possibility that someone disposes of garbage into the sewers.

4.5 RESIDENT AWARENESS SURVEY

4.5.1 Questionnaire Survey Conducted

The Study Team conducted a questionnaire survey to collect information for resident awareness on sewerage service and the willingness-to-pay. The survey was conducted from 20 to 25 July 1998 by the interview method with 50 people in Skuodas Town.

The questionnaire included the following items:

- family income and expenditure
- water use
- water supply conditions
- sanitary conditions and facilities
- willingness-to-pay for water charge

- willingness-to-pay for sewerage charge

4.5.2 Summary of the Survey Results

The major issues in the questionnaire survey are summarized in the tables below and described as follows:

- Average number of family member in Birzai is 3.40.
- Average monthly family income is 1,053 litas with a range of 500 to 1,500 litas being dominant.
- In about 70 percent of the households, two persons have income.
- Cost water and sewerage is about 3.8 percent (23 litas/month) of the total family expense. It is the lowest among the utility expenses.
- Few households connected to water and sewerage have their own well sources.

People show more willingness to pay higher fees for water supply than for sewerage service.

Table 4.22 Number of Family Member

no. of family member	no. of sample
1	2
2	10
3	13
4	18
5	5
6	2
Total	50
Average	3.40

Table 4.23 Family Income

monthly income (litas/month)	no of member having income				
	1	2	3	4	Total
<500	4				4
500-1,000	5	17	1		23
1,000-1,500	1	15		1	17
1,500-2,000		3			3
2,000<		1	2		3
Grand Total	10	36	3	1	50
			average monthly income		Lt.1,035

Table 4.24 Family Expenses

income class (litas/month)	average monthly expenses (litas/month)					
	total	water & sewerage	hot water	electricity	transport-ation	commun-ication
<500	213	16	13	37	87	10
500-1,000	527	16	34	27	110	32
1,000-1,500	645	24	39	39	163	34
1,500-2,000	1,167	36	37	117	417	47
2,000<	410	22	-	57	120	75
average	592	23	25	55	179	40
percentage	100.0%	3.8%	4.2%	9.3%	30.3%	6.7%

Table 4.25 Connection with Water Supply and Sewerage Systems

connection with sewerage system	connection with water supply system			
	connected		not connected (with shallow well)	total
	no other water source	with shallow well		
connected	33	6	3	42
not connected	3	0	5	8

Table 4.26 Affordability and Willingness-to-pay

water supply		sewerage		fee for sewerage new connection	
affordable amount (litas/month)	no. of sample	Affordable amount (litas/month)	no. of sample	Affordable amount (litas/month)	no. of sample
<20	22	<20	2	<10	1
20-40	5	20-40	4	10-20	2
40-60	20	40-60	1	20-30	5
60-90	-	60-90	1	30-50	2
90<	-	90<	-	50-100	1
				100<	-
do not accept		do not accept		do not accept	
To be free of charge	1	to be shouldered by gov.	12	to be shouldered by gov.	1
others	2	do not want to pay	25	do not want to pay	8

4.6 EXISTING CONSTRAINTS FOR SEWERAGE SYSTEM

4.6.1 Technical Aspects

4.6.1.1 Collection system

Discharge capacity of the pumping units at each pump station is too large when compared with the sewage flow. The comparison of capacity and sewage flow is as follows:

Table 4.27 Transfer Pump Capacity and Sewage Flow

Pump Station[1)]	Pump Capacity	Sewage Flow at Peak Time [2)]
Pump No.1	no.1: 80 m^3/hour = 22 l/sec (exist.) no.2: 58 m^3/hour = 16 l/sec (prop.) no.3: 58 m^3/hour = 16 l/sec (prop.)	12 l/sec (2010)
Pump No.2	no.1: 60 m^3/hour = 17 l/sec (exist.) no.2: 60 m^3/hour = 17 l/sec (exist.)	4 l/sec (2010)
Pump No.3	no.1: 110 m^3/hour = 30 l/sec (exist.) no.2: 110 m^3/hour = 30 l/sec (exist.)	15 l/sec (2010)
Pump No.4 (proposed at STP No.1)	no.1: 140 m^3/hour = 39 l/sec (prop.) no.2: 140 m^3/hour = 39 l/sec (prop.) no.3: 140 m^3/hour = 39 l/sec (prop.)	37 l/sec (2010)

Sewage flow = estimated average flow x peak factor (2.0)

Pump is switched on when the sewage level in the sump reaches a pre-set high level. Pump is then shut off when the sump reaches a preset low level. Because of the discharge capacity, sewage in the sump is drained in a very short time and at a very high flow rate. Consequently, the incoming sewage at the treatment plant has a very high peak flow when the pump is on, and no flow when the pump is shut off.

Pumped flow can be regulated to a proper range that is nearly the normal peak flow. There are some options to achieve a more regulated flow as follows:

Table 4.28 Improvement of Pump Operation

Countermeasure Option	Advantage	Disadvantage
Throttle the discharge valve at the pump station	Less costly. No capital investment required. Pump will be operated on higher discharge head than now. This means motor power requirement is increased for same daily sewage flow.	If the valve opening is fixed, flow rate will not be same for pumps of different capacities. Discharge valve will need to be more than half closed. The valve disc will therefore face a risk of erosion due to cavitation caused by very high velocity at the throttled opening area.
Replace the pump units with smaller capacity ones	Pumps will be operated at constant flow that should be set at nearly the peak flow of sewage.	Discharge rate is fixed by the pump characteristics. Intermittent flow will not be avoided to some extent. Flow regulation is therefore not so complete as speed control.
Install a speed control unit for each pump unit	Pumps will be able to produce any flow rate as pre-set. Flow rate can be regulated almost flat throughout a day.	Most costly

Improvement in pump operation and flow regulation will be recommended to achieve a proper hydraulic loading to the treatment plant. The degree of flow regulation will be dependent on the flexibility of the treatment process. Design of most treatment plants normally incorporates a peak flow factor 2 to 3, and the degree of flow regulation may not be therefore as severe.

4.6.1.2 Sewage treatment plant

Existing Treatment Plant No.1

The treatment plant No.1 was constructed for only 75 m^3/day and is therefore heavily overloaded. The plant is designed to remove suspended solid and organic substances using sedimentation. Organic removal is however unable to take place to the required level. Removal of nitrogen and phosphorous was not incorporated in the plant design.

The Water Company has already decided to abandon this plant. The Water Company constructed a pump station at this treatment plant, and dual transmission pipelines to transfer the incoming sewage to the proposed treatment plant site at the western suburb of the town.

Existing Treatment Plant No.2

The treatment plant No.1 was constructed for 340 m^3/day, and is substantially under-loaded at present. Of the two oxidation ditches, one ditch is not used due to mechanical breakdown of the rotor that has been removed from the ditch.

The failure of this plant in terms of BOD removal is likely resulted from absence of sludge recycle. Presently, liquid is recycled by pumping from the bottom of the sedimentation tank to the oxidation ditch. The liquid however does not contain solids so that MLSS (Mixed Liquor Suspended Solid) in the oxidation ditch cannot reach the optimum level, that is normally above 3,000 mg/l. Further, because of the insufficient mixing in the ditch, suspended solid seems to be settling in the ditch channel rather than in the sedimentation tank. The ditch therefore works as a sedimentation tank. If the oxidation ditch and sedimentation tank work normally, the recycled liquid must contain more condensed sludge. This speculation may be supported from the fact that the suspended solid in the effluent is well below the standard while the BOD removal is still high.

To properly operate the oxidation ditch, additional agitation should be provided to prevent the settlement of sludge in the ditch bottom. Recycling the sludge must also be controlled.

4.6.1.3 Industrial wastewater

The national standard LAND 10-96 sets the principal norms for sewage discharged into a public sewerage system as described in Section 3.4.1. LAND 10-96 also states that:

"the norms applied to other materials (substances) shall be established by an organization that operates the systems in making a contract with a sub-user".

With this provision, the municipality or Water Company is given authority to set the additional requirements for wastewater discharged from the users into the public sewerage system. In Skuodas at present, no additional standard has been set for this purpose. The factories therefore have no obligation to reduce their pollution as long as the wastewater meets the minimum requirements set in the LAND 10-96.

From the data of water quality and water consumption, BOD_7 load of the wastewater from the milk company's factory is estimated at about 6 percent of the total load incoming to the treatment plant. Impact of the organic load in the industrial wastewater is therefore considered insignificant.

4.6.2 Managerial Aspects

4.6.2.1 Collecting Incorrect Charges from Collective Housing

A controller of the company checks the meters of the enterprises and collective housing once a month, writes the bills, and delivers them to the enterprises and collective housing. The enterprises and collective housings then pay the charges to the banks and are issued a receipt.

One person, who is in charge of checking water usage and collecting charges from each resident in a collective housing, has to pay the total charges for the housing to the company. Collective housing has a single meter but has not necessarily meters for all flats.

It has been reported that some residents tried to manipulate meter reading to reduce the consumption by use of a magnet or by releasing water in so small amount that it cannot be detected by the presently used water meters. This problem may however be more or less overcome by replacing the existing meters with ones sensitive enough to detect small flow.

Some flats do not have meters. If so, they pay charges based on a norm, which is a standard usage of volume for those who have no meters. The company has not been collecting the correct charges from residents in collective housing because residents not having meters use more water than the norm. It is estimated that the company has been losing 15 to 20 percent of the correct charge.

The Water Company must install meters at all houses and flats by 2000 according to Government Decree and check all water usage from all collective housing. But installing meters is difficult because of lack of funds. Another problem is that meters in collective housing are normally installed inside of the flats in places such as the bath rooms. It will be difficult for the company to check meters when no one is home.

Another method that is suggested is to subtract the water usage from the flats with meters from the single meter reading the water usage from collective housing. The remainder would be divided by the number of flats without meters and each would pay a equal amount. In other words, change the norm that flats without meter pay.

4.6.2.2 *Self-Declaration System*

Individual house consumers who have water meters record the water usage from the meters every month by themselves and fill out the form in the subscription booklets. Based on a random sampling check by the company last year, 15 users out of 200 samples were found not paying the correct charges, accounting for some 7.5 percent of the sample. Since the number of residents is small, the percentage of people who do not pay the correct amount may be substantial.

4.6.2.3 *Short of Periodic Performance Evaluations*

The company has not conducted periodic performance evaluations for employees using clearly written requirements to meet and goals to perform. Employees may actually have a stronger desire to reduce costs and increase revenues by doing more active work to meet their goals. For example, the company is supposed to check all detached houses twice a year, but actually it chooses approximately 200 houses at random out of 514 houses and checks whether users have paid the proper amounts from April to July. About 15 customers were found to have not paid the proper amounts last year. If the company had checked all detached houses, about 40 users might have been found not paying the correct amount. More houses might be checked if employees were given goals to meet and performance evaluations were discussed with each employee.

4.6.2.4 *Lack of integrated management information system*

A computerized information system is to be installed in a controller room to manage billing and collection of the water and sewerage fees, as of June 1998. There are no more information systems planned for any of the management functions. Lack of information systems causes inefficiency in gathering correct information and inability to provide speedy action to meet problems.

4.6.2.5 *Process of a Self Supporting Management System*

The Water Company manages itself on a self-supporting accounting system and also follows policies for tariff collection for the municipality. The Water Company actually does not have an autonomous management. The Water Company believes that the state government is a borrower of foreign loans for the sewerage project and that the company will receive subsidies or budgets from the government. This is not correct since the government only guarantees the loans. This indicates that the Water Company does not have a self-supporting disposition. The Water Company should be more commercialized to cover revenues and costs because the state and municipality budgets are strictly regulated.

4.6.2.6 Process of Rationalization

Operation costs increased by 12.7 percent, the same as the increase in sales, although inflation (CPI) was 8.9 percent in 1997. The number of employees still remains at the same level as when the company started operation. As previously stated, the company must check the incorrect revenues and the number of staff members in charge of checking may not be enough. On the other hand, there may be some redundancies in other business units, mainly technical units.

Table 4.29 Personnel Costs Comparison

	Turnover and Personnel costs to it	Operating costs before depreciation and personnel costs to it	Personnel Costs
Severn Trent plc. in the U.K. (1997) million Pounds and (%)	1215.3 (20.9)	673.2 (37.8)	254.4
Anglian Water plc in the U.K. (1997) million Pounds and (%)	837.1 (16.1)	430.7 (31.3)	134.8
Pskov in Russia (1996) million Roubles and (%)	48,143 (22.5)	40,105 (27.0)	10,836
Public Sewerage Works in Japan (1994) million Yen and (%)	988288 (12.0)	374963 (31.7)	118,809
Skuodas (1997) thousands litas and (%)	587.6 (55.6)	539.2 (60.6)	326.7

Personnel costs to sales and to operating costs before depreciation in other companies such as large private water and sewerage companies in the U.K., a former Soviet Union company and public sewerage organizations are approximately 20 percent and 30 percent respectively. The same ratios for Skuodas are 56 percent and 61 percent respectively and much higher than the others. It is difficult to compare the Water Company with foreign companies directly, but it gives some guidelines for management and level of personnel costs.

4.6.3 Financial Aspects

4.6.3.1 Unclear Business Units

Financial analysis is based on sharing common indirect costs between the water and sewerage divisions. The sharing system for wages and salaries of staff members who work for both the water and sewerage divisions and some other common operational expenses has not been clearly defined.

4.6.3.2 Increase of Sales and Operating Costs

The company increased sales by 13.6 percent in 1997, mainly due to the tariff increase. The tariff increased by 25 percent for water supply and by 32 percent for sewerage system for residential users and by 9 percent for other users. The costs also increased by almost the same degree. The operation continued at a loss with only a 2.1 percent improvement in the operating loss level and 3.1 percent decrease in the net loss level.

4.6.3.3 Decrease of Usage

The volume of sales in 1997 decreased by more than 12 percent due primarily to the tariff increase. It is not clear whether the volume will again decrease. According to the questionnaire survey, 50 percent of those questioned do not want to pay the charge for sewerage service and 24 percent answered that the sewerage charge should be paid by the government. The tariff for sewerage in Skuodas is already at a relatively high level.

Table 4.30 Maximum and Minimum of Sewerage Tariffs of Water Companies Association

(litas/m^3, 1998)

	Max	Min
House charge	1.54	0.68
Industries	3.22	1.09

Table 4.31 Willingness to pay based on the Questionnaire Survey

	Sewerage charge	Fee for a new sewerage connection
To be paid by the government	12	1
Do not want to pay	25	8

4.6.3.4 Long Collection Period and Delayed Payment

There is a major delay of more than three months in bill collection from the hot water and heating company in Skuodas. Some public institutions have also delayed payment because of a shortage of funds. Some ten percent of customers have delayed payment.

4.7 FUTURE DEMAND FOR THE SEWERAGE SYSTEM

4.7.1 Design Year

The design year is set at the year 2010. This target is 12 years from the planning stage and considered suitable for the design horizon of the new facilities.

4.7.2 Service Area

The entire urban area is set as the service area for the proposed improvement plan of the sewerage system.

4.7.3 Planned Population and Sewage Amount

4.7.3.1 Population

Future population of the urban area of Skuodas is projected using the growth ratio applied in the projection of country's population prepared by the Department of Statistics as presented in Section 2.3.3.2. Of three medium scenarios, the medium-3 scenario (medium-high) is adopted since it has a slight increase in the country's population and is on the safe side in the projection of the amount of sewage. Yearly growth rates of population are tabulated as follows:

Table 4.32 Yearly Population Growth Rate

Year	Country Total (% / year)	Urban Area (% / year)
1997-2000	-0.02%	-0.05%
2001	0.09%	0.24%
2002	0.16%	0.32%
2003	0.19%	0.34%
2004	0.21%	0.37%
2005	0.24%	0.39%
2006	0.27%	0.42%
2007	0.26%	0.39%
2008	0.24%	0.35%
2009	0.23%	0.32%
2010	0.23%	0.31%

Calculated from Population Projections of Lithuania (Medium-3), Department of Statistics, 1998

Applying the growth rates in the table above, population of Skuodas town is calculated as follows:

Table 4.33 Projection of Urban Population

Year	Urban Population
1997	8,974
2000	8,970
2001	8,992
2002	9,020
2003	9,051
2004	9,084
2005	9,119
2006	9,158
2007	9,193
2008	9,226
2009	9,255
2010	9,284

4.7.3.2 Service Ratio and Population Served

As of 1997, the service ratio of water supply and sewerage expressed as population is 80.7 percent and 75.0 percent, respectively. The Water Company expects these figures to increase to 90 percent by 2010. Therefore, the population served by the water supply and sewerage would increase as calculated in table below.

Table 4.34 Projection of Population Served

Year	Water Supply		Sewerage	
	population served	service ratio	population served	service ratio
1997	7,245	80.7 %	6,731	75.0 %
2000	7,176	80 %	6,997	78 %
2005	7,752	85 %	7,660	84 %
2010	8,355	90 %	8,355	90 %

Population served = urban population x service ratio

4.7.3.3 Sewage Quantity

Domestic Sewage

From the water supply data in 1996 and 1997, per capita water consumption was calculated at 84 l/cap/day (1996) and 73 l/cap/day (1997). It may be interpreted that the drop in consumption from 1996 to 1997 is because of the increase in water tariff.

This unit consumption is very small for an urban area that would normally be more than 120 l/cap/day. The Water Company explained that the people of Skuodas are saving the cost of water after the tariff was increased. The Study Team also conducted an interview with residents in the town and found that people are living with minimum use of water even for bathing and washing.

The Water Company anticipates that the people's attitude of saving water would continue and that the per capita consumption in 2010 will likely not be higher than 110 l/cap/day.

For the projection of water consumption, increase in per capita consumption is therefore set at 80 and 110 l/cap/day for 2000 and 2010, respectively. It is assumed that 90 percent of the amount consumed is discharged into the sewers.

Table 4.35 Projection of Domestic Sewage

Year	Population served	Per capita water consumption (l/cap/day)	Domestic Sewage (m^3/day)
1997	6,731	73	477
2000	6,997	80	517
2005	7,660	95	663
2010	8,355	110	827

domestic sewage = population served x per capita consumption x 90%

Wastewater of Industry and Hospital

According to the manager of the milk company, there is no plan to expand the factory facility at present or in the near future. It is therefore assumed that the amount of industrial wastewater will maintain the present level (40 m^3/day) until 2010. For the purpose of projection, 50 m^3/day is adopted.

Wastewater of the hospital has records of 70 to 100 m^3/day in 1996 and 1997. The amount of discharge is normally dependent on the occupation ration of the hospital. For the projection, 100 m^3/day is adopted as a higher figure for industrial contribution of wastewater.

Infiltration

In the projection of sewage for the future, infiltration of groundwater into the sewers should be considered in addition to the domestic sewage and industrial wastewater. In the existing service area, quantity of infiltration is theoretically calculated as a balance between the water consumption and incoming sewage. From the flow measurements conducted in this study, amount of the infiltration is estimated at approximately 30 percent of the average water consumption although it varies.

For the projection for the year 2010, ratio of the infiltration is set at 30 percent of the other flow.

Projected Amount of Sewage

From the discussion above, the amount of sewage is calculated as follows:

Table 4.36 Projection of Amount of Sewage (Daily Average Flow)

unit: m^3/day

Year	Domestic sewage	Industrial wastewater	Hospital wastewater	Infiltration	Total Amount
Total Service Area (New Town and Old Town)					
2000	517	50	100	200	867
2005	663	50	100	244	1,057
2010	827	50	100	293	1,270
Service Area of Existing Plant No.1 (New Town)					
2000	450	50	100	180	781
2005	586	50	100	220	956
2010	740	50	100	267	1,156
Service Area of Existing Plant No.2 (Old Town)					
2000	53	0	0	16	88
2005	69	0	0	21	114
2010	88	0	0	26	145

In the projection above, the amount of infiltration increases while the sewer network may not be substantially expanded. This can be possibly explained by the fact that the increase in service connections and aging of the sewer pipes could lead to an increase in infiltration.

4.8 SEWERAGE SYSTEM IMPROVEMENT PLAN

4.8.1 Design Flow

The amount of sewage on a daily average basis is projected as shown in Table 4.36. The design of the sewerage facility also needs to incorporate the variation in sewage flow such as average daily flow, maximum daily flow, and peak hourly flow. These variations of sewage flow is defined as follows:

Daily average flow:	The average flowrate occurring over a 24-hour period during a year.
Daily maximum flow:	The maximum flowrate that occurs over a 24-hour period during a year.
Hourly peak flow:	The peak sustained hourly flowrate occurring during a 24-hour period.

For determining the daily maximum flow, the variation in water consumption was analyzed for daily and seasonal pattern from the water production data that have been recorded daily. Figure 4.8 shows the historic data of water production at the filtration plant.

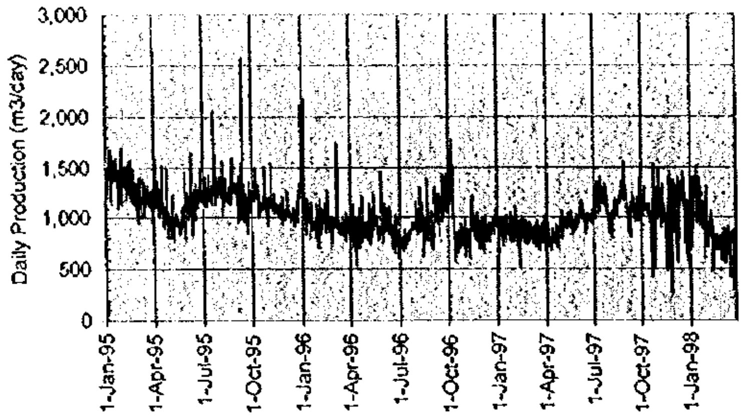


Figure 4.8 Daily Water Production Records

As there is a slight decrease in a total water production in each year, the variation pattern was analyzed for each year. The statistical analysis of the data for each year is presented Table 4.37.

Table 4.37 Statistical Analysis of Water Production

Item	1995	1996	1997
Total Production (m^3/year)	438,963	344,436	361,829
Daily Average Production (m^3/day)	1,203	944	991
Absolutely Maximum Production (m^3/day)	2,580	2,155	1,558
Absolutely Minimum Production (m^3/day)	780	536	273
95 Percentile Production (m^3/day)	1,550	1,283	1,330
05 Percentile Production (m^3/day)	927	705	707
Ratio of 95 Percentile to Average	1.29	1.36	1.34
Ratio of 05 Percentile to Average	0.77	0.75	0.71

As there are some unusually high and low figures in the data, 95-percentile and 5-percentile figures are calculated as shown. Ratios of the 95-percentile amount to the daily average variation of 1.29 to 1.34. The peak factor for the daily maximum flow is set at 1.35 for future planning.

To see the seasonal variation, monthly average productions were calculated from the daily production data. The results are shown in Figure 4.9. In 1995 and 1997, there was a small peak in August while 1996 data had a similar small peak in September. Difference between winter and summer is however not significant.

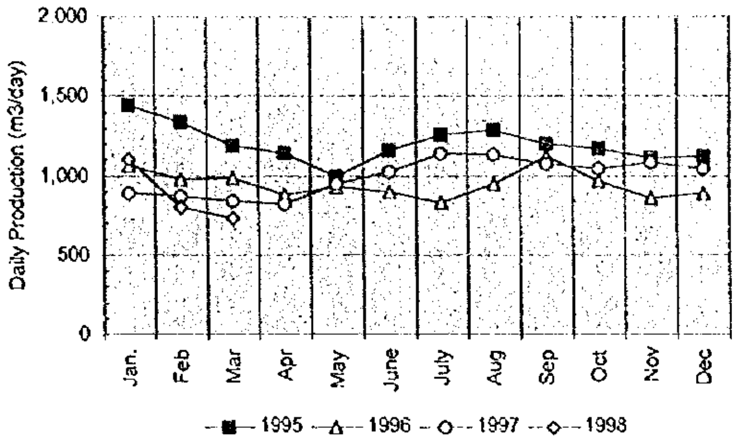


Figure 4.9 Seasonal Variation of Water Consumption

Magnitude of the hourly peak flow depends on the pattern of water use in a day of the people. As a rule of thumb, a formula[1] is used as follows:

$PF = 5/P^{1/6}$

where,

PF: peaking factor relative to the daily average flow

P: number of the population served in thousand

Applying the formula above with the population served in Table 4.34, PF is calculated as follows:

$$PF = 5/P^{1/6} = 5 / (\approx 8.3)^{1/6} = 3.5$$

This factor is applied to the domestic sewage amount while the industrial wastewater and infiltration is considered stable. The hourly peak flow for 2010 is therefore calculated as follows:

$$Q_{hp} = 827/24 \times 3.5 + (50 + 100 + 147)/24 = 133 \text{ m}^3/\text{hour}$$

This flow is 2.84 and 2.03 times the daily average flow and daily maximum flow, respectively. Aside from the calculation based on the population, the flow measurement conducted in this study shows that the peak flow is 2.0 times the average flow as presented in Section 4.4.2.5. Comparing the flow measurement results and calculation above, a peak factor of 2.0 seems reasonable. Therefore, peak factor 2.0 is applied as a peak hour factor to the daily maximum flow. Design flows are summarized in Table 4.38.

[1] Nicoll, E. "*Small Water Pollution Control Works: Design and practice*", John Wiley and Sons, 1988.

Table 4.38 Design Flow

	Flowrate			
	m^3/day	m^3/hour	m^3/min	m^3/sec
Daily average flow (Q_{da})	1,270	52.9	0.88	0.015
Daily maximum flow(Q_{dm})	1,600	66.7	1.11	0.019
Peak hourly flow (Q_{hp})	3,200	133.3	2.22	0.037

$Q_{dm} = Q_{da} \times 1.35$
$Q_{hp} = Q_{dm} \times 2.0$

4.8.2 Characteristics of Sewage and Population Equivalent

With the projected sewage and pollution load, characteristics of sewage are calculated using the per capita unit load (70 g-BOD_7/cap/day) as follows:

Table 4.39 Calculated BOD Load and Concentration

	Amount (m^3/day)	Population served	BOD_7 Load		BOD_7 (mg/l)	Population equivalent
			unit load (g/cap/day)	Total Load (kg/day)		
Domestic Sewage	827	8,355	70	585	707	8,355
Industrial Wastewater	50			125	2,500	1,786
Infiltration	293			-	-	-
Total	1,270			710	560	10,141

Note: Pollution load in the hospital wastewater is considered to be included in the domestic sewage.

Using the population equivalent calculated above, other pollution loads are calculated as follows:

Table 4.40 Calculated SS, Total-N and Total-P Loads and Concentrations

	SS	Total-N	Total-P
population equivalent	10,141	10,141	10,141
unit load (g/p.e./day)	70	12	2.7
total load (kg/day)	710	147	27
concentration (mg/l)	560	96	22

These calculated figures are compared with the water sampling and historical records to determine the final figures for the design. Comparison are summarized as follows:

Table 4.41 Design Loads and Concentrations

item	unit	design figures	Sampling Result				historical Record		by MOE norms
			Jul 28	Aug 6	Aug 13	Aug 20	average	95-percentile	
Sewage Flow	m^3/day	1,270	1,253	1,001	1,476	526	-	-	1,270
SS	mg/l	500	490	362	157	209	241	420	560
BOD7	mg/l	560	519	273	198	296	459	761	560
BOD5	mg/l	490	451	238	172	257	-	-	
Soluble BOD7	mg/l	200	201	94	78	165	-	-	
Soluble BOD5	mg/l	170	175	82	68	144	-	-	
COD	mg/l	1,000	957	757	396	589	-	-	
Total-N	mg/l	70	57	65	55	58	67	87	80
Total-P	mg/l	12	11.8	9.7	13.6	9.3	10	16	20

In the table above, the design figures are determined considering the following:

- Calculated concentrations of BOD_7 and suspended solids are at the high side of the sampling result.
- Total-N in the water sampling results is low comparing with that calculated from the norm. This may be because the nitrogen content in the industrial wastewater is relatively low. Design figure is therefore set from the water quality analysis results.
- Historical records are based on the spot samples taken once a month. They do not therefore represent the daily average figure. These records are shown as reference.

4.8.3 Effluent Standards to be Applied

LAND 10-96 stipulates the effluent standards according to the population equivalent as discussed in Section 3.4.1.1. In this case with the population equivalent of more than 10,000 as calculated above, the effluent standard shall be as follows:

Table 4.42 Effluent Standard for Sewage Treatment

Pollutants	Permissible Concentration (mg/l)	
	Average annual concentration (Cave)	Maximum instantaneous concentration (Cmax)
BOD_7 (>10,000 PE)	15	25
COD (≥10,000 PE)	75	120
Total-P (≥10,000 PE)	1.5	2.5
Total-N (10,000 – 100,000 PE)	20	35
Suspended Solid (<100,000 PE)	30	45

4.8.4 Evaluation on the Existing Treatment Plant

Existing Treatment Plant No.1

The existing treatment system does not have a biological treatment process. Therefore, it does not have a function to meet the required effluent standards for both organic substances and nutrients (N and P). The plant location is also a subject to be reviewed. This plant is located in the middle of residential area so that odor problem is a nuisance.

It is therefore recommended that this plant be abandoned as it had been planned.

Existing Treatment Plant No.2

This treatment plant was designed for 340 m^3/day sewage. The service area of the existing plant No.2 currently discharges only 10 percent of the total amount (70 m^3/day against the total 700 m^3/day) as mentioned in Section 4.4.1.3. The projected sewage quantity of the service area will remain small as shown in Section 4.7.3.3. Operating this plant with this small quantity of sewage is uneconomical considering the cost for operators and maintenance of the equipment. It is therefore recommended that this plant not be used with the present amount of incoming sewage.

There are two options for this plant as follows:

1. Abandon this treatment plant and transfer the incoming sewage to a new treatment plant.

   By abandoning this plant, sewage treatment will be carried out at only one plant so that control and maintenance will be easier than maintaining two small plants. Operation cost for running one plant will be cheaper than maintaining two small plants.

2. Use this treatment plant with the maximum design capacity (340 m^3/day) by diverting a part of the sewage from the treatment plant No.1 service area.

   By using this plant with the maximum capacity, the capacity of the new treatment plant for No.1 service area will be about 30 percent smaller. This existing plant No.2 would still require new equipment to achieve maximum performance. The new equipment should consist of one set of rotors for one ditch, two sets of mixing equipment to maintain the minimum flow in the ditches, two scrapers for the sedimentation tanks. The cost for this equipment will be a double investment with the equipment for the new treatment plant and will result in no saving.

   Further, it will be practically difficult to divert a limited amount of sewage from the pressure pipeline unless electronic control devises such as a flow meter with a motor driven valve are used.

Considering the cost and difficulty in controlling the flow, maintaining two treatment plants is not recommended in this case. The existing treatment plant No.2 is therefore recommended to be abandoned.

4.8.5 Improvement Plan for the Collection System

As discussed in Section 4.6.1.1, the existing pump system has sufficient pumping capacity. The new pump station to be completed at the Treatment Plant No.1 will have only two pump units.

The other pump stations will need improvement of flow regulation as described in Section 4.6.1.1.

4.8.6 Improvement Plan for the Treatment System

4.8.6.1 Location of the New Treatment Plant

In the previous development plan for constructing the new treatment plant, a site outside the town boundary was proposed. Dual 300 mm pressure pipelines have been laid from the existing plant No.1 to the new treatment plant site (proposed site No.1). In the course of the Study, the Mayor of Skuodas suggested using land inside the town boundary. One of such alternatives is the land around the existing plant No.2 (proposed site No.2). Another alternative site is a vacant area upstream of the Bartuva River from the treatment plant No.2 (proposed site No.3). These sites are shown in the location map in Figure 4.10.

For all alternatives, construction cost of the new treatment plant will be same. For the proposed site No.3, the transmission pipeline from the existing treatment plant No.1 to the proposed Site No.1 will need to be diverted at its middle point. This means that half of the historical construction cost will be wasted. This aspect is similar for proposed Site No.2 although its impact is smaller than the case of proposed Site No.3.

From the environmental point of view, a treatment plant should be located outside the town boundary to prevent nuisance to the residents nearby. Considering the operation of the plant in particular for drying, storing and transporting of sludge, emphasis must be given to the prevention of odor problem. Distances to the closest residential areas from proposed site No.2 and 3 are 250 m and 400 m, respectively. Proposed site No.1 has a minimum 700 m distance from the nearest residential area.

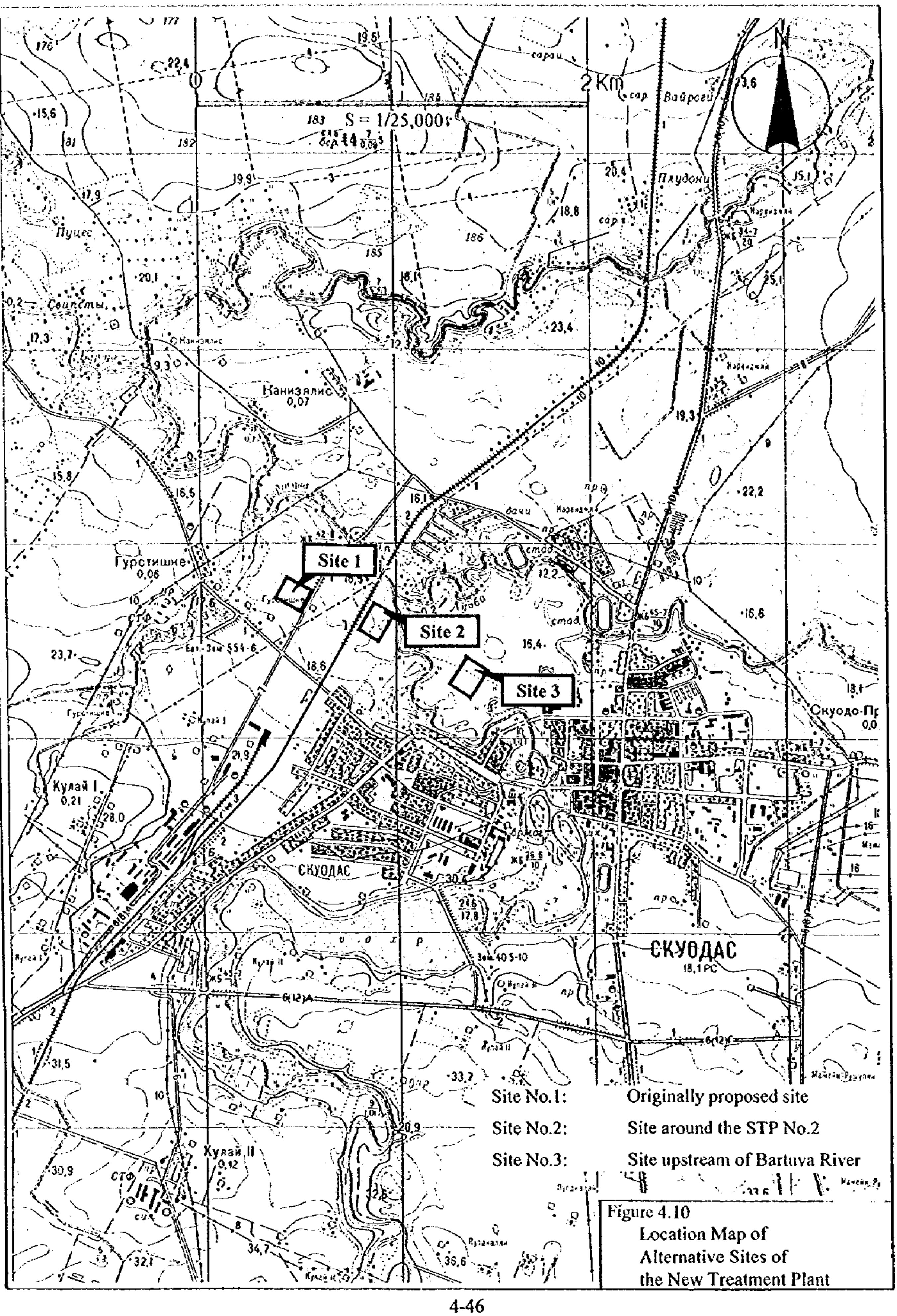


Figure 4.10
Location Map of
Alternative Sites of
the New Treatment Plant

The originally proposed site No.1 is located outside the town boundary and the transmission pipeline has been laid to this site. This site is recommended due to both the effective use of the past investment and the environmental advantage.

4.8.6.2 Alternative Sewage Treatment Method

Selection of the sewage treatment method considers that the system is relatively small and the sewage characteristic is typically domestic. Selection criteria for the treatment methods are listed as follows:

- **Ease of operation and maintenance:**
  Operation of the plant should be easy for less experienced operators. It is difficult for a small Water Company to employ an operator having high levels of skill, experience, and knowledge of the sewage treatment. Ease of operation and maintenance should therefore be given the highest priority in the selection criteria. Components of the treatment system should therefore be as simple as possible to avoid troublesome maintenance. Plant should also be free from complicated daily operations. Feedback information reported from the existing treatment plants may be the best reference for this aspect.
- **Flexibility against the shock load:**
  The treatment system should be able to accommodate fluctuation of sewage flow and concentration of pollutants, in particular for BOD. As presented in Section 4.4.2.5, there are large fluctuation in the sewage flow and concentration of pollutants. This is typical for the small scale sewerage system. The treatment system must be flexible to absorb shock loads occurring in a short period of time in a day. Longer retention times are normally a solution for this problem.
- **Sludge problem:**
  Sludge treatment and disposal is a common problem for any size of the sewerage systems. It is however more serious for a small-scale system since it should be carried out with the least cost to reduce the financial burden.

Two systems are evaluated as they are normally used for small-scale system:

1. Oxidation ditch (OD)
2. Sequencing batch reactor (SBR)

For each system, it is proposed that primary sedimentation is provided to reduce the high solids and BOD loading. As this is common to both options, it is not included in the comparison. Primary sedimentation is discussed further in Section 4.9.4.3.

Principal of each treatment process is described as follows:

Oxidation Ditch

The oxidation ditch method is one of the most popular treatment systems employed for a small-scale community in various countries. OD is designed and operated as an extended aeration activated sludge system with long hydraulic detention and sludge retention times. It has successful operation records for removal of both BOD and nutrients.

The OD reactor consists of ring-, horseshoe-, or oval-shaped channel equipped with mechanical aeration devices. Sewage flows into the channel and is aerated while circulating in the channel at a velocity of about 30 cm/sec. Because the OD makes an endless plug flow in the channel, the incoming sewage is mixed and diluted with the treated sewage circulating in the channel. This mixing mechanism is a unique feature of the OD system, and gives it flexibility against shock loads.

Nitrogen removal occurs in the ditch channel as aerobic and anaerobic zones are formed in accordance with the distance from the aerator. BOD removal and nitrification occur in the aerobic zone while denitrification takes place in anaerobic zone. Injecting the raw sewage into this anaerobic zone effectively provides carbonic energy source for denitrification.

Treatment performance of OD is summarized as follows:

BOD removal ratio	70 – 95 %
Nitrogen removal ratio	60 – 70 %

Removal of phosphorus is also reported in the operation of OD. Phosphorus removal occurs in the repetition of aerobic and anaerobic conditions in the channel.

Sequencing Batch Reactor

The sequencing batch reactor (SBR) is a form of secondary biological treatment which has the same treatment performance as the activated sludge process. Concept of the SBR is to carry out the biological treatment and sedimentation processes in a series of operation in one tank. The SBR operates in a batch-wise, rather than continuous flow mode, referred to as fill and draw. Normally, the SBR consists of two or more tanks that receive influent alternately so that the influent is treated on a continuous flow basis.

In the SBR operation, influent is introduced into the tank (fill stage), aerated and/or mixed (reaction stage), clarified by settlement (settling stage), and is removed from the tank by decanting (draw stage). This basic cycle repeats several times a day.

Advantage of the SBR is that the required area can be small because of absence of a sedimentation tank.

Nitrogen removal is achieved in the SBR by setting the combination of aeration and mixing. Nitrification occurs in aeration stage while denitrification takes place in the mixing stage without oxygen.

Treatment performance of the SBR is similar to that for the oxidation ditch method.

4.8.6.3 Recommended Sewage Treatment Method

Comparison of the two alternative treatment methods is summarized in Table 4.43. From this comparison, the oxidation ditch method is proposed by the reasons as follows:

- Daily operation and maintenance is extremely easy. Actually, no operation is required, as the major equipment will run continuously 24 hours a day.
- Because the circulating flow in the ditch continuously dilutes the influent, variations in the incoming loads (i.e. varying concentration of BOD) will be absorbed so that the biological reaction takes place in relatively stable condition.
- In case of mechanical trouble of the equipment (aerator, mixer or sludge collector), sedimentation tank will still work as a fail-safe device that will at least remove suspended solid and BOD contained in the solid. In case of SBR, any mechanical failure of a decanter will be fatal as the effluent is extracted by movement of the decanter.

Table 4.43 Comparison of Alternative Treatment Methods

Item	Oxidation Ditch (OD)	Sequencing Batch Reactor (SBR)
Flow in Reaction Tank	circulating plug flow	complete mixing
System Component	oxidation ditch (2,900m^3) sedimentation tank	flow regulation tank (450 m^3) batch reactor (3,920m^3)
Equipment	aerator/mixer sludge collector sludge pump	aerator/mixer decanter sludge pump
Operation	**24 hours continuous operation** aeration/mixing sludge recycling	**cyclic batch operation** sequential operation of inflow, aeration/mixing, settling, decanting
Manual operation	**easy** on-off operation of the equipment is not required in daily work all equipment run 24 hours a day without adjustment	**manual operation is actually impossible** sequential operation needs timer-set or computerized operation program
Daily maintenance	**actually none**	**scum removal** **checking sludge volume**
Against the variations in the incoming load	**flexible** no special adjustment required as variations are absorbed in the circulating flow	**flexible but needs high level of expertise** for adjusting the sequence
Stability of biological reaction	**stable** due to continuous operation and large absorbing capacity against the load variations.	**less stable** biological reaction in each batch occurs under varied load conditions.
Required Land Area	1.8 ha	1.8 ha
Construction Cost	Lt. 6.62 million	Lt. 6.00 million
Operation Cost	Lt.136,000/year	Lt.161,000/year
Total Cost in NPV*	8,130,000	7,875,000

* NPV: Net Present Value for 25 years operation, discount rate = 5 %/year

4.8.6.4 Sludge Treatment and Disposal

In Lithuania, sludge disposal is restricted as stipulated in the Ministry Order LAND 20-96 as described in Section 3.5.1.2. It requires that sludge must be treated before used for fertilizing agricultural land by some treatment process as stipulated. At present, this requirement seems not complied with.

To comply with the requirement in LAND 20-96 and to achieve ease of transportation of sludge, the water content must be reduced below 85 percent. Among the treatment processes specified in LAND 20-96, a composting method is recommended due to its simple operation and capability of producing sludge suitable for agricultural use. Recommended method is a natural composting that requires no special mechanical mixing device or chemical. In this treatment method, dewatered sludge is stockpiled on concrete slab and mixed by a tractor or front loader machine approximately once in one or two months. While the sludge is stockpiled, temperature inside the sludge naturally goes up to 70°C so that the most of bacteria and coliform are killed.

For dewatering, mechanical dewatering equipment is proposed to reduce the water content in sludge below 85 percent. Decanter (centrifuge) type dewatering is selected as a suitable method due to its high efficiency and ease of operation. Prior to dewatering, a gravity thickening process will be provided to reduce the water content from about 99.4 percent to 98 percent.

4.8.7 Conclusion and Recommendation

As discussed in the Sections above, the recommended improvement plan for the Skuodas Sewerage System is summarized as follows:

1. Sewage Collection System Improvement
   - Expansion of sewers will not be required except for small branch pipes for new house connections;
   - As the Water Company has purchased the pump units for the new pump station at the existing treatment plant No.1, installation of these units will be required. Number of pump to be installed is two;
2. Sewage Treatment System
   - Abandon the two existing treatment plants;
   - Construct a new treatment plant at the previously proposed site outside the town boundary;
   - New treatment plant will employ an oxidation ditch method for sewage treatment;
   - Treated effluent will be discharged into the Bartuva River;
   - Excess sludge will be treated by gravity thickening and mechanical dewatering using a centrifuge;
   - Dewatered sludge is treated by composting and stored for agricultural use; and
   - For emergency in case the dewatering machine breaks down, a sludge lagoon having one month storage will be provided.

4.9 PRELIMINARY DESIGN OF THE PROPOSED FACILITIES

4.9.1 General

A preliminary design of the proposed facilities for a sewage treatment plant is presented based on the recommendation described in the previous section. Detailed preliminary drawings are presented in Volume III Supporting Report. This section presents the engineering details of each facility of the sewage treatment plant.

4.9.2 Required Land Area of the Sewage Treatment Plant

For the proposed treatment facility, the required land area is estimated at 1.8 ha as shown in the plant layout in Figure 4.11. This land area is smaller than the previously proposed scheme that required a land area of approximately 3.9 ha.

4.9.3 Design Basis

Design basis of the treatment plant is summarized in

Table 4.44 Design Basis of the Treatment Plant

Item	Value		Remark
Design Flow			
Daily Average Flow	1,270 m^3/day		used for computing sludge amount and operation cost
Daily Maximum Flow	1,600 m^3/day		used for design of biological reaction tank and sludge treatment
Hourly Peak Flow	3,200 m^3/day		used for design of pipelines, inlet works and sedimentation tank
Influent Quality			
BOD_7	560 mg/l		BOD$_5$ is used for design of the biological treatment system.
BOD_5	490 mg/l		
COD	1,000 mg/l		
Total-N	70 mg/l		
Total-P	12 mg/l		
Suspended solid	500 mg/l		
Design Effluent Quality	Cave.	Cmax.	
BOD_7	15 mg/l	25 mg/l	LAND 10-96
BOD_5	13 mg/l	22 mg/l	
COD	75 mg/l	120 mg/l	
Total-N	20 mg/l	35 mg/l	
Total-P	1.5 mg/l	2.5 mg/l	
Suspended solid	30 mg/l	45 mg/l	
Minimum temperature	7°C		

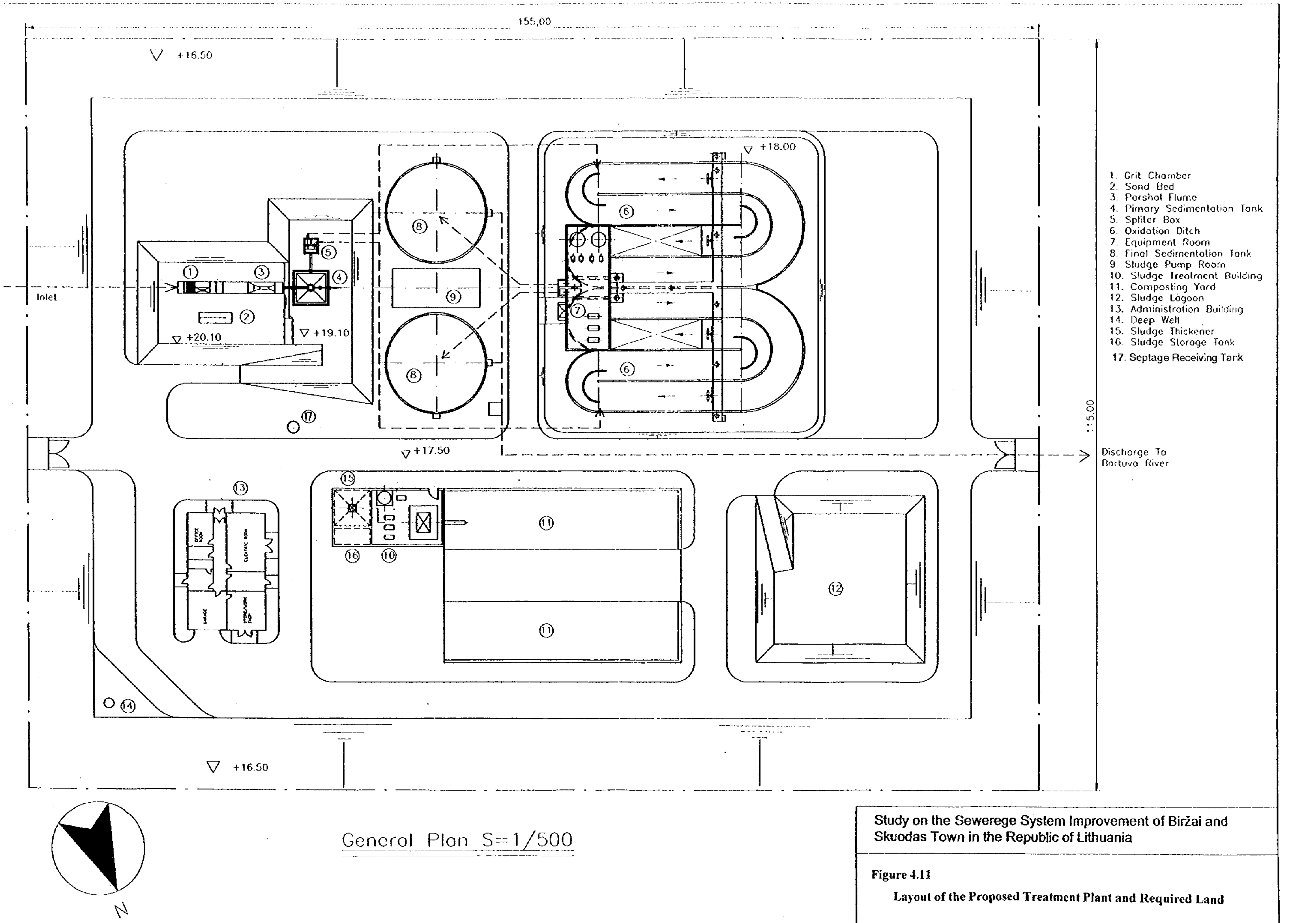


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Figure 4.11

Layout of the Proposed Treatment Plant and Required Land

4.9.4 Facility Design

4.9.4.1 Sewage Reception and Grit Removal

Incoming sewage will be received in a grit chamber. A gravity type grit chamber is proposed due to its simple structure and ease of operation and maintenance. There will be a pit in the bottom of the chamber to store the settled grit.

A main channel and a bypass channel will be constructed. A mechanical bar screen will be installed in the main channel while a manual bar screen will be installed in the bypass channel.

Dimensions and design parameters of the grit chamber are as follows:

- Surface load = 1,800 m^3/m^2/day
- Maximum velocity in the channel = 0.3 m/sec
- Shape = Rectangular
- Sand removal = by sand pump
- W 0.8 m x L 2.5 m x D 0.3 m x 1 unit (D = depth of water)
- Structure
  foundation = direct foundation
  super structure = reinforced concrete

Dimensions of the screen are as follows:

- Mechanical screen: W 0.8 m x H 1.0 m x Bar spacing 5 mm x 1 unit x 0.4 kW
- Manual screen: W 0.8 m x H 0.6 m x Bar spacing 20 mm x 1 unit

Other Provision:

A bypass of storm water should be provided to prevent the excessive amount caused by accidental inflow of stormwater from flowing into the treatment system.

4.9.4.2 Flow Measurement

Flow measurement will be carried out by a Parshall flume channel constructed after the grit chamber. A Parshall flume is recommended because it is one of the most common practices for flow measurement at a sewage treatment plant. Water depth measured in the channel is converted to the flow rate using a formula particularly set for the design of the Parshall flume.

Dimensions and design parameters of the Parshall flume are as follows:

- Range of measurement = min. 3.1 to max. 356 l/sec = (min. 635 to max.30,760 m^3/day)
- Shape = Rectangular
- W 0.31 m x L 3.25 m (W: width at a throttle)
- Structure
  foundation = direct foundation
  super structure = reinforced concrete

4.9.4.3 *Primary Sedimentation Tank*

A primary sedimentation tank will be provided to initially reduce the incoming loads. Reducing suspended solid and organic substances contained in the solids will lead to substantial reduction in the volume of the oxidation ditch. A comparison shows that the volume of the ditch is reduced by 1,310 m^3 by employing a primary sedimentation tank that has 88 m^3 volume.

Dimensions and design parameters of the primary sedimentation tank are as follows:

- Surface load = 70 m^3/m^2/day
- Shape = Rectangular
- Bottom slope = 55 degree
- Sludge collection = by gravity
- Sludge extraction = by pumping
- W 5.0 m x L 5.0 m x D 3.5 m x 1 unit (D = effective depth of water)
- Structure
  foundation = direct foundation
  bottom slab = reinforced concrete
  wall = pre-cast reinforced concrete panel

4.9.4.4 *Biological Reaction Tank (Oxidation Ditch)*

Aeration and mixing will be carried out separately using membrane diffuser and a propeller mixer to easily adjust the zoning of aerobic and anoxic zones. This selection will achieve a flexible operation to suit the actual condition of sewage characteristics. Dosage of a chemical coagulant will be provided at the outlet of the oxidation ditch for the phosphorous removal in the sedimentation tank.

Dimensions and design parameters of the oxidation ditch are as follows:

- MLSS = 4,000 mg/l
- BOD-SS Ratio (F/M ratio) = 0.05 kg-BOD/kg-SS
- Hydraulic retention time (HRT) = 43.5 hours
- Average velocity in the channel = 0.25 m/sec
- Aeration system
  Blower = Roots type, 14.5 m^3/min x 15 kW x 3 units (including 1 stand-by unit)
  Diffuser = membrane diffuser
- Mixing system

  Submersible propeller type mixer = dia. 1.6 m x 2.3 kW x 4 units
- W 4.5 m x L 132.8 m x D 2.5 m x 2 units (D = depth of water)
- Structure
  foundation = direct foundation
  bottom slab = reinforced concrete
  wall = pre-cast reinforced concrete panel

An equipment room will be constructed on the oxidation ditch to accommodate blower, chemical coagulant feeding equipment, and its control equipment. Dimensions and design parameters of the equipment room are as follows:

- Single story, W 6.5 m x L 19.0 m x 1 unit x Total floor area 124 m^2
- Structure
  foundation = directly on the oxidation ditch structure
  floor slab = reinforced concrete
  wall = brick wall
  roofing and support = tin plate roofing with ceiling

4.9.4.5 Final Sedimentation Tank

Two final sedimentation tanks will be provided to clarify the effluent of the oxidation ditch. Dimensions and design parameters of the sedimentation tanks are as follows:

- Surface load = 5 $m^3/m^2/day$

  from formula:

  $Vo = 4.9 \times 10^6 \times T^{0.95} \times Xa^{-1.35} \times [SVI]^{-0.77} = 10$ m/hour

  where,

Vo:	initial sludge settling velocity (m/hour)
T:	temperature (°C)
Xa:	MLSS (mg/l)
SVI:	sludge volume index = 150 ml/g

  $S < Vo/r = 2.0$

  where,

S:	surface load ($m^3/m^2/day$)
r:	peak factor to daily maximum flow (= 2.0)

- Shape = Circular
- Bottom slope = 10/100
- Mechanical sludge collector = hanging type, center driven sludge collector
- Sludge extraction = by pumping
- dia. 14.5 m x D 3.5 m x 2 units (D = effective depth of water)
- Structure
  foundation = direct foundation
  bottom slab = reinforced concrete
  wall = pre-cast reinforced concrete panel

4.9.4.6 Sludge Recycling

Settled sludge extracted from the final sedimentation tanks will be returned to the oxidation ditch to keep MLSS at the required level. Recycling will be carried out by sludge return pumps that will operate continuously.

Specifications of the sludge return pumps are as follows:

- Maximum recycling ratio = 200 % of the daily maximum flow
- Type of pump = Non-clog centrifugal - screw pump

- Number of pump = 4 units
- Capacity of pump = 0.6 m^3/min x 5 m head x 1.5 kW

4.9.4.7 Disinfection

In Lithuania, disinfection of effluent is required only when the effluent is discharged into bathing water. In this case, there is no bathing area immediately downstream of the treatment plant. Therefore, disinfection facility will not be provided.

4.9.4.8 Sludge Treatment

Sludge in the primary sedimentation tank and excess sludge in the final sedimentation tanks will be withdrawn from each tank using sludge pumps. Sludge extraction pumps will be operated by pre-set timer to maintain the sludge surface level in each tank. Sludge extracted from each sedimentation tank will be pumped to a sludge thickener provided in the sludge treatment building. The sludge thickener is provided to reduce the water contents in the sludge. Thickened sludge will be discharged to a sludge storage tank before it is transferred to a sludge dewatering machine.

Dewatered sludge will be transferred to a composting yard by a screw conveyor. In the composting yard, sludge will be stored for three months.

In these processes, water contents of the sludge is set as follows:

Primary sludge:	98.0%
Excess (secondary) sludge:	99.4%
Thickened sludge:	97.5%
Dewatered sludge:	84.0%

Design criteria and parameters of each sludge treatment process are described below:

Sludge Extraction Pumps

(1) Sludge pump for raw sludge from the primary sedimentation tank

- Type of pump = Non-clog centrifugal pump
- Number of pump = 1 unit
- Capacity of pump = 0.3 m^3/min x 5 m head x 1.5 kW

(2) Sludge pump for excess sludge from the final sedimentation tanks

- Type of pump = Progressive cavity pump
- Number of pump = 2 units
- Capacity of pump = 7.5 m^3/hour x 10 m head x 2.2 kW

Sludge Thickener

- Dry solid surface load = 40 kg-DS/m^2/day
- Solid yield = 80%

- Shape = Rectangular
- Bottom slope = 50 degree
- Mechanical sludge mixer = hanging type, center driven mixer with picket fence
- Sludge extraction = by pumping
- W 5.0 m x L 5.0 m x D 4.0 m x 1 unit (D = effective depth of water)
- Structure
  foundation = direct foundation
  bottom slab = reinforced concrete
  wall = pre-cast reinforced concrete panel

Sludge Storage Tank

- Retention time = 2 days
- Shape = Rectangular
- Mixing = by a blower
- W 3.0 m x L 5.0 m x D 4.0 m x 1 unit (D = effective depth of water)
- Structure
  foundation = direct foundation
  bottom slab = reinforced concrete
  wall = pre-cast reinforced concrete panel

Sludge Dewatering Machine

- Type of machine = centrifugal dewatering machine (decanter)
- Solid yield = 95%
- Number of unit = 1 unit
- Capacity = 5.0 m^3/hour x 22.2 kW

Sludge Composting Yard

- Storage period = 6 months
- Mixing and turning over = by a front loading vehicle
- Stockpiling yard = W 9.0 m x L 36.0 m x 2 lines
- Transporting corridor = W 8.0 m x L 36.0 m between the two stockpiling yards
- Structure
  foundation = direct foundation
  bottom slab = pre-cast reinforced concrete panel
  wall = pre-cast reinforced concrete panel (1 m high around each stockpiling yard)
  roofing and support = metal roofing with steel columns and steel frame trusses
  (roofing only on the stockpiling yards)

4.9.4.9 Sludge Lagoon

For emergency, in case the sludge dewatering machine breaks down, a sludge lagoon will be provided to receive the thickened sludge.

Dimensions and design parameters of the sludge lagoon are as follows:

- Storage volume = one month volume of sludge for daily average production
- W (top) 23.0 m-(bottom) 20.0 m x L (top) 23.0 m-(bottom) 20.0 m x D 1.5 m x 1 unit (D = depth of water)
- Structure: soil (open cut)

4.9.4.10 Chemical Feeding Facility

Chemical feeding facilities used in the proposed treatment system are as follows:

For Phosphorous Removal

- Type of chemical = Alum-oxychloride
- Dosage ratio = average 7.4 mg/l -- maximum 11.1 mg/l as Al_2O_3
- Chemical mixing tank = FRP made, 5 m^3 equipped with a mixer x 1 unit
- Chemical feeding pump = diaphragm pump, 0.1 l/min x 2 units

For pH Control in Sewage Treatment

- Type of chemical = Caustic soda
- Dosage ratio = average 84 mg/l – maximum 126 mg/l
- Chemical mixing tank = FRP made, 4 m^3 equipped with a mixer x 1 unit
- Chemical feeding pump = diaphragm pump, 0.1 l/min x 2 units

For Sludge Dewatering

- Type of chemical = Polymer
- Dosage ratio = average 1.3 % of dry solid
- Chemical mixing tank = FRP made, 5 m^3 equipped with a mixer x 1 unit
- Chemical feeding pump = Progressive cavity pump, 0.9 m^3/hour x 1 unit

4.9.4.11 Septage Receiving Tank

The sewage treatment plant will receive some kinds of wastewater or sludge taken out of septic tanks at households or factories that are not connected with the sewerage network. Such wastewater will be transferred by tanker trucks and dumped into the treatment process. Such wastewater should be defined as "septage" that is normally named for waste from a septic tank.

Septage dumped from the tanker trucks will be either transferred to the sludge thickener or to the biological process depending on its characteristics and load condition of the treatment plant.

Septage receiving and transfer system consists of the following facilities:

- Septage receiving tank with screen
- Septage transfer pump

Specification of the septage receiving tank is as follows:

- Storage volume = 4 m^3 (same as the volume of a tanker truck)
- Shape = Circular

- Manual screen: W 1.0 m x L 1.0 m x Bar spacing 15 mm x 1 unit
- Dia. 2.0 m x depth 2.5 m 1 unit
- Structure
  foundation = direct foundation
  bottom slab = reinforced concrete
  wall = pre-cast circular barrel

Pump equipment will be provided in the septage receiving tank as follows:

- Type of pump = submersible non-clog pump
- Number of pump = 1 unit
- Capacity of pump = 0.3 m^3/hour x 10 m head x 1.5 kW

4.9.4.12 Instrumentation

For Skuodas, central monitoring system using computer will not be provided to minimize construction and operation costs. All monitoring and control of equipment operation will be carried out at site by operators.

4.9.4.13 Power Supply

Power supply will be provided from the Power Company's power line. The Power Company will install an extension line and a transformer of a capacity required for the treatment plant. A 100 KVA transformer will be required for the operation of the proposed treatment plant.

In Skuodas, the entire volume of sewage will be transferred from the sewer network to the treatment plant by pumping. Flows through the treatment plant and discharge to the Bartuva River are all by gravity. There is no risk that sewage will spill over inside the treatment plant. Stand-by generator will therefore not be provided.

4.9.4.14 Auxiliary Facilities

Administration Building

An administration building will be constructed as follows:

- Rooms included = electric room, workers room, laboratory room, office, store room/warehouse, toilet, and garage
- Single story, W 12.0 m x L 18.0 m x Total floor area 216 m^2
- Structure
  foundation = footing foundation
  floor slab = pre-cast reinforced concrete panel
  wall = brick wall
  roofing and support = metal roofing with ceiling

Sludge Building

A sludge building will be constructed to accommodate the sludge dewatering machine and chemical feeding system as follows:

- Rooms included = sludge dewatering machine and chemical feeding room
- Single story, W 9.0 m x L 11.0 m x Total floor area 99 m^2
- Structure
  foundation = footing foundation
  floor slab = pre-cast reinforced concrete panel
  wall = brick wall
  roofing and support = metal roofing with ceiling

Sludge Pump Building

A sludge pump building will be constructed between the two final sedimentation tanks to house the sludge pumps for both primary and final sedimentation tanks as follows:

- Single story, W 6.0 m x L 12.5 m x Total floor area 75 m^2
- Structure
  foundation = direct foundation
  floor slab = pre-cast reinforced concrete panel
  wall = brick wall
  roofing and support = metal roofing with ceiling

4.10 OPERATION AND MAINTENANCE PROGRAM

4.10.1 Maintenance of Sewage Collection System

4.10.1.1 Sewer Facility

(1) Inspection

Objectives of operation and maintenance of the sewer facility includes:

maintenance of flow capacity
prevention of damage
prevention of infiltration and rainwater intrusion
extension of life

- Raw sewage contains various materials such as human wastes, garbage, and solids that may settle in the pipe and cause problems. Possible troubles caused by such settlement are clogging, reduction in dissolved oxygen, emission of hydrogen sulfide, etc. Deterioration of sewage, in particular, excessive anaerobic conditions also results in poor treatment performance at the treatment plant. Maintenance of sewers is therefore of importance to prevent deterioration in the sewerage system and treatment.
- It is recommended that the Water Company prepare a schedule for inspection and repair of the sewer system. Frequency of inspection and repair will be dependent on the age of pipes and local conditions.
- Major inspection items are summarized below.

Table 4.45 Major Inspection Items for Sewage Collection System

Item	Point of Inspection
Pipe & Culvert	flow conditions, sediments land or pavement settlement any physical damage to structures infiltration of groundwater intrusion of rain and surface run-off existence of hydrogen sulfide offensive/illegal activity on the sewers
Manhole	safety of manhole cover erosion and corrosion on inside walls any physical damage to structures
House connection	any physical damage to structures sediment in connection boxes intrusion of rain and surface run-off

(2) Cleaning and Maintenance

Cleaning the sewers will be required to maintain the sewage collection system in good condition. Frequency of cleaning may be once in a few years depending on the actual condition of sediment in the sewers. An effective method of sewer cleaning is to use a high pressure flushing machine. Sewer cleaning, using such a machine, can be carried out under a sub-contract with a firm that provides this service.

As the size of the sewage transmission pipeline (dia. 300 mm) is larger than the optimum size of 150 mm, the pipe is expected to have solids at the bottom over the long distance to the treatment plant. To remove this sediment, it is recommended that all pumps at the new Pump Station at the existing treatment plant No.1 be operated at the same time occasionally so that the high flow will flush out sediments in the pipe.

(3) Recording of Maintenance

Recording the activities of inspection and maintenance and information obtained through such activities is important and useful for future operation and management of the Water Company.

Data and information to be collected and compiled must include the following items:

- date and activities performed
- costs of repair or maintenance
- as-built drawings if there is any construction or modification work on the existing facilities
- cause of the problem

4.10.1.2 Pump Stations

(1) Normal Operation

All existing pump stations are operated by an automatic on-off system linked with a water level detector installed in the pump wet well. As this operation will continue in the future, the Water Company will need to properly maintain the automatic operation system.

Aside from maintenance of the instrumentation equipment, physical conditions at each pump station should be inspected periodically. An inspection checklist is presented in Volume III, Supporting Report, together with the inspection check lists for the treatment plant.

Data from the pump operation will be useful to evaluate the sewage flow, variations in sewage discharge, power cost, estimates of infiltration etc. Operational data to be recorded must include running time of each pump, electric consumption each day and when lubrication is performed, and repairs performed.

(2) Inflow of Stormwater

As discussed in Section 4.6.1.1, the existing pump system has a sufficient pumping capacity for the projected sewage flow. The most serious problem for the sewerage system is intrusion of stormwater into the sewers. This problem would cause an excessive amount of flow from the pump stations to the sewage treatment plant.

By-pass facility should be provided to avoid the hydraulic overloading in the treatment plant. Particularly, overloading in the reaction tank will result in the washout of the MLSS and cause malfunction of the biological reaction in the tank.

4.10.1.3 Organization for Operation

(1) Required Staff

It is recommended that operators of the treatment plant circulate around to each pump station for operation and maintenance.

In case any additional manpower is required, which exceeds the Water Company's staff for special work such as cleaning operations, employing temporary workers is recommended as an economical measure.

(2) Emergency and Security

The most probable emergency situation may be an interruption in the power supply. Stoppage of the pumps will cause serious problems at the pump stations. No pump station is equipped with a stand-by generator. It is recommended that the Water Company purchase a mobile generator with a capacity to support any one of the of pump units at any of the three pump stations.

4.10.2 Sewage Treatment Operation

4.10.2.1 Operation and Maintenance of the Proposed Sewage Treatment Plant

(1) Principle of Secondary Biological Treatment

Oxidation Ditch Process

The oxidation ditch has various advantages such as its simple operation, stability against variations both in the incoming pollution load and flow, little equipment to maintain, etc. Oxidation ditch process normally does not require frequent adjustment in equipment operation. The equipment runs almost operation free. Major equipment such as blowers, mixers, sludge collectors, and return sludge pumps will run continuously over 24 hours. Some equipment (excess sludge pumps) will run in a pre-set operation mode by timer control.

Phosphorous Removal and Chemical Coagulant Dosage

A chemical coagulant system is provided to supplement phosphorus removal in the biological treatment process. Phosphorus will likely be reduced to 1.5 mg/l by biological treatment when phosphorus in the influent is not higher than 6 mg/l (daily average). The chemical coagulant system can be used only when the biological treatment cannot reduce the phosphorus to the required level of 1.5 mg/l. As the chemical coagulant is an additional operation cost, the dosage amount must be minimized. To reduce the chemical dosage, biological reaction for phosphorus removal should be carefully monitored and should be set to the most appropriate condition as much as possible.

If the pH in the effluent decreases to a low value because of the addition of the alum coagulant, a caustic soda feeding system is provided for pH adjustment.

(2) Operation of the Secondary Treatment Plant System

This section describes the operation procedure of each component of the proposed secondary treatment system.

Grit Chamber

At the grit chamber, large floating materials will be removed by the mechanical screen while relatively heavy particles will settle in the hopper provided in the channel. Materials trapped at the bar screen will be automatically removed as screenings and dropped into a container. Screenings stored in the container should be disposed of every few days either to the Municipality garbage disposal facility or be buried on site.

Settled grit in the hopper will be removed by a sand pump that will pump a grit solution to the sand bed for separation of solids and water. Dry grit should be removed for disposal every few weeks.

Parshall Flume

At the Parshall flume, the water level in the flume is measured, indicated and recorded for conversion to a flow rate for the incoming sewage. There is no activity or operation for the Parshall flume.

Primary Sedimentation Tank

The primary sedimentation tank will separate suspended solids from the influent. A tank is rectangular in shape without a mechanical sludge collector. Settled sludge is collected at the center of the tank by gravity and removed by sludge pumps. Operation of the primary sedimentation tank will be as follows:

- Extraction of primary sludge will be carried out to maintain the sludge surface in the sedimentation tank below a certain proper level;
- Scum will need to be removed by operator.

Biological Reaction Tank (Oxidation Ditch)

In the continuous channel of the oxidation ditch, aerobic and anaerobic zones will be formed according to the distance from the aerators. After aeration, the sewage will contain dissolved oxygen which is then reduced as the wastewater flows and the dissolved oxygen is consumed during removal of organic substances and nitrification. In the anaerobic zone, denitrification occurs.

Once the intensity of aeration is set, the same operation can be continued for a substantial period unless the characteristics of the incoming sewage change substantially.

The operation of equipment for the oxidation ditch will be controlled as follows:

Mixing: Mixing the liquid in the channel will be carried out by operating the submersible mixers installed at the bottom of each tank. Flow velocity in the ditch should be maintained at about 25 cm/sec as an average in the sectional area of the channel. All mixers will operate 24 hours a day.

Sludge Recycle: Settled sludge, in the amount of about 200 percent of the incoming sewage flow, will be returned by recycle pumps from the final sedimentation tank to the inlet of the reaction tank. The amount of sludge recycle will be decided based upon keeping the MLSS level in the oxidation ditch at a proper level, nonnally 4,000 mg/l.

Aeration: Aeration will be operated for removal of organic substances and for nitrification. Aeration should continue either 24 hours a day or intermittently depending on the incoming load. If the daily total amount of pollution load is small, aeration time may be reduced.

Final Sedimentation Tanks

The final sedimentation tanks will separate suspended solids from the effluent of the reaction tanks. Each tank is circular in shape and equipped with a mechanical sludge collector.

Settled sludge is collected at the center of the tank by the mechanical sludge collector and removed by sludge pumps for return to the reaction tank and for removal as excess sludge. Operation of the sedimentation tanks will be as follows:

- Extraction of the return sludge must be made by pumping basically in a continuous mode over 24 hours;
- The amount of return sludge will be dependent on the MLSS in the reaction tanks and suspended solid concentration in the return sludge. A rule to follow is to maintain the MLSS in the reaction tanks at about 4,000 mg/l;
- Extraction of excess sludge will be carried out to maintain the sludge surface in the sedimentation tank at a certain proper level;
- Proper extraction of excess sludge is to be given high importance since the accumulation of excess sludge in the system will cause problems such as anaerobic conditions, deterioration of biological treatment, and degrading the settlement in the sedimentation tanks. Extraction of sludge must therefore be carefully controlled observing the incoming pollution load and accumulation of sludge.
- Scum will also be automatically removed by a scum skimmer rotating with the mechanical sludge collector. When scum is not properly removed by the scum skimmer, it should be manually removed.

(3) Operation of the Sludge Treatment System

This section describes the operation procedures for the proposed sludge treatment system. The most important issue in sludge treatment is to remove excessive sludge from the system immediately. This operation is important to prevent release of phosphorus from the sludge under anaerobic conditions. Phosphorus released from the sludge is returned to the network through removal of supernatant from the sludge thickener and increases the phosphorus concentration in the effluent. If chemical coagulant is used, release of phosphorus can be controlled.

Sludge Thickener

A gravity sludge thickener will be provided for reducing the water content in the sludge extracted from the sedimentation tanks. The thickener is rectangular in shape and equipped with a mechanical picket fence that rotates in the tank to accelerate sludge settlement. Settled sludge is automatically collected by hydraulic means from a pit at the bottom and transferred using sludge pumps to a sludge storage tank located adjacent to the thickener. Operation of the sludge thickener is to be carried out as follows:

- Excess sludge pumping from the sedimentation tank needs to be regulated at a constant rate as much as possible to avoid a peaking load at the thickener;

- Extraction of the thickened sludge from the storage tank must be made every day by pumping set by a timer;
- The sludge surface in the thickener should be maintained at a level not higher than 1 m from the water surface;
- Design retention time of the sludge should be limited to 19 hours, at a maximum.

Sludge Dewatering Centrifuge (Decanter)

A mechanical centrifuge will be provided to further dewater the thickened sludge up to about 85 percent water content. Polymer needs to be added to the thickened sludge prior to the centrifuge operation. Operation of the centrifuge is to be carried out as follows:

- The centrifuge is designed to operate every day for 6 hours each day;
- Operating parameters such as dosage rate of the polymer, rotating speed, differential speed, etc. will need to be determined by trial operation by the supplier, before delivering the plant to the Water Company;
- Loading the thickened sludge into the centrifuge should be at a constant rate as much as possible to achieve a high degree of dehydration;
- Characteristics of the supernatant discharged from the centrifuge should be monitored.

Sludge Composting Yard

A sludge composting yard with enough space for a six month volume of the dewatered sludge will be provided. Dewatered sludge will be transferred from the centrifuge by a screw conveyor to the composting yard. In the yard, stockpiled sludge will need to be turned over periodically by a tractor or front-loading vehicle. The drying and composting reaction will proceed naturally during the six-month storage period.

Sludge Lagoon

For emergency conditions, if the centrifuge ceases to operate for more than a few days or for repair or maintenance, a sludge lagoon will be provided for storing the sludge to be extracted from the thickener. The sludge lagoon also has a volume for one-month storage of the thickened sludge. No daily operation will be required for the sludge lagoon.

(4) Septage Receiving Facility

Septage receiving system will be operated to receive septage transferred from the households or factories that are not connected with the sewerage system.

Receiving tank will be provided with a manual screen to remove objects included in septage. Septage received in the receiving tank will be pumped either to the sludge thickener or to the biological reaction tank. Selection of these two routes will be made by manually operating valves.

(5) Inspection and Maintenance

There are various points to be inspected and maintained in the sewage treatment facilities. Major activities are defined in categories as follows:

Daily Inspection: This will be carried out by the operators every day at each of the treatment process units and at each piece of equipment. Activities include operation of equipment, observation of conditions of the running equipment, treatment performance (i.e. conditions of effluent and sludge), data acquisition from instrumentation and meters, etc.

Periodic Maintenance : This will be carried out about once a year, normally by shutting off each piece of equipment. Activities include detailed inspection and maintenance for lubrication, adjustment, calibration, etc.

Special Maintenance : This should be normally performed by a sub-contractor, usually a manufacturer of the equipment. Frequency will depend on the condition of equipment. This activity is required only for equipment that needs special knowledge, skills, or spare parts for maintenance.

(6) Data Acquisition and Compilation

Equipment

Data and information acquired for the operation of the treatment plant needs to be compiled for management of the treatment system. Such data will be useful for evaluating the treatment performance and for financial evaluation of maintenance and operation. Data to be acquired and compiled are as follows:

Equipment inventory: Upon completion of the treatment plant, an inventory listing all the details of equipment should be provided by the contractor/manufacturer.

Operational data: Operator will need to record operational data for the equipment at the treatment plant. Data must also include records of trouble and repair.

Water Quality

Water quality must be monitored at various points in the treatment process. Recommended sampling and analysis is suggested as follows:

Location	Daily	Once a week	Once a month
Raw sewage	odor, temperature, transparency, pH	SS, COD	BOD, NH_4-N, Total-N, Total-P
Reaction tank	odor, temperature, transparency, pH ORP, DO, MLSS	MLSS, ORP	MLSS
Final sedimentation tank effluent	transparency, pH	SS, COD, NH_4-N, NO_3-N	BOD, NH_4-N, Total-N, Total-P
Final Effluent	transparency, pH	SS, COD, DO	BOD, NH_4-N, Total-N, Total-P

Characteristics of Sludge

It is recommended that characteristics of sludge be tested and monitored as follows:

Location		Daily	Once a Week
Sludge thickener	Thickened sludge	examine visually	temperature, pH, solids, sludge surface level *heavy metal (*as required)
	Supernatant	TSS, SS	BOD, Total-N, Total-P
Dewatering	Dewatered sludge	examine visually	water content
	Supernatant	SS	BOD, Total-N, Total-P
Sludge storage	Storage	examine visually	water content, *bacteria *heavy metal (*as required)

4.10.2.2 Organization for Operation

(1) Required Staff

It is recommended that the treatment plant be manned 24 hours a day with 2 operators during the day and one operator at night. The total number of operators will be four. Suitable procedures must be adopted to safeguard the single night operator from accidents.

(2) Emergency

Emergency and Security

The most probable emergency at the treatment plant may be an interruption in the power supply. Power failure will result in stoppage of all equipment in the plant. Sewage will however, flow through the plant by gravity as long as the upstream pump stations in the sewage collection system operate and transfer sewage to the treatment plant.

4.10.3 Sludge Disposal

Sludge will be transferred to agricultural land for soil conditioning or fertilizing the land in accordance with the requirement and classification set in LAND 20-96. It is expected that the composted sludge will meet the requirement for Class B or Category III or better.

The estimated amount of sludge is 3.1 wet-ton/day or 1,132 wet-ton/year.

4.11 CONSTRUCTION PLAN AND PROJECT COST ESTIMATES

4.11.1 General

This Section discusses the planning for construction and details the construction schedule for Skuodas. In addition, the basis for estimating the construction cost is discussed as well as the basic unit rates used in estimating the construction cost and other costs which have been included to arrive at a project cost.

The major elements to be constructed at Skuodas includes:

- New treatment plant at Site 3 (Oxidation Ditch Process, 1,270 cum/d)
- Pump station modifications
- New influent pipeline from the existing Pump Station No. 2 connecting to the two new pressure mains from the existing treatment plant No.1 to the new site.
- Demolition of two existing treatment plants

The new influent pipeline from the existing Pump Station No.2 is relatively small in size (100 mm) and length (130 m) and is considered an item which could be performed by a competent civil contractor experienced in treatment plant construction. Pump station modifications are also considered to be similar to the treatment plant construction work proposed. It is therefore recommended that a single contractor, experienced in treatment plan construction, construct all of the major elements of work at Skuodas.

The two towns of Birzai and Skuodas are about 350 km apart and management of two construction projects at the same time by a single contractor would be difficult. The sizes, process and equipment are also different at each site. For these reasons, it is recommended that two construction contracts be prepared, one for each city.

The Skuodas treatment plant will have minimal mechanical equipment, all in the smaller range of available sizes. To maintain single unit responsibility for construction completion on schedule, a separate procurement contract is not warranted. Because of the number and size of the equipment, it is believed that any savings in cost by purchasing the major equipment for both the Skuodas and Birzai plants by a single package would be minimal.

Likewise, because of the number and size of the equipment, it is believed that a separate contract for mechanical and electrical work (procurement and installation) would not benefit the project to any great extent. A separate contract would also allow the civil contractor to blame the mechanical/electrical contractor for delaying his work, and vice versa. Therefore, it is proposed that a single contractor perform both the civil and mechanical/electrical work at Skuodas. If necessary, a contractor could hire a subcontractor to perform a portion of the work but only the main contractor would be responsible for insuring the subcontractor finished his work without delay to the main contract and that the entire work was completed on schedule.

In summary, it is suggested that a single construction contract be prepared for Skuodas incorporating both civil work and mechanical/electrical procurement and installation. The contract should also include testing and start-up of the facilities and operation, maintenance and training for a period of time after commissioning. Construction contracts would then be advertised for competitive bidding with the lowest priced contractor awarded the work.

To insure that only competent contractors bid the work, it is recommended that a prequalification process occur during the design period to obtain a list of prequalified contractors. Plans and contract documents would then only be issued to the list of prequalified contractors for bidding purposes.

4.11.2 Construction Plan

The construction plan is composed of many elements but to simplify the plan. Only two major parts are considered. These are the construction of the civil works (earthworks, structures, piping and buildings) and plant equipment works which includes the mechanical/ electrical work (manufacture, delivery and installation) and instrumentation work.

4.11.2.1 Civil Work

The civil work will begin immediately after mobilization during which the contractor will bring his construction equipment to the site and mobilize his forces for construction. The contractor will also set up local construction offices including offices for the resident inspectors, storage facilities for equipment and materials delivered early and possibly a concrete batch plant to produce concrete for the various structural elements.

Civil work includes constructing the influent pressure pipeline, rough grading and excavation for the structures, foundation preparation, the concrete structures, yard piping, buildings, finish grading, paving and drainage work, landscaping, fencing and demolition of the two existing treatment plants. This work will continue over the entire construction period.

4.11.2.2 Plant Equipment Work

Plant equipment work includes the manufacture, delivery and installation of the plant mechanical, electrical and instrumentation equipment. The pumps and auxiliary equipment and appurtenances will also be modified at Pump Station No.2 using the equipment purchased by the Municipality to connect to the existing but unused pressure mains from the existing Treatment Plant No.1 to the site for the proposed treatment plant. The installation schedule depends upon the manufacture and delivery period. Some off-the-shelf items such as small pumps, valves, etc. can be installed once the structures are completed but for the larger items, time must be allowed for ordering, designing, shop drawing approval by the engineering consultant, manufacture, shipping and delivery. The plant equipment installation work usually begins much later than the civil work and finishes late in the construction period but allowing time for final testing and start-up.

The pumps and electrical equipment, purchased by the Municipality for the new unused pump station at Pump Station No.1, would also be installed and tested.

4.11.2.3 Construction Schedule

An overall construction schedule for Skuodas is presented in Figure 4.12 and is 13 months in length including the demolition of the existing treatment plant. Also included is a facilities construction schedule, shown in Figure 4.13 which shows the schedule for the various components of the work.

Testing and startup includes testing of individual equipment items and process units. The entire treatment facility would then be brought on line to prove it performs as specified. During this period, the contractor would also train the Water Company's personnel in operation and maintenance.

It appears that the construction contract may be awarded in the winter and therefore the first several months for the contractor would be spent on mobilization, ordering equipment, reviewing shop drawings, factory pre-casting, and planning for his summer activities. The last few months of the construction period for Skuodas, during the winter again, would be spent in training, testing, removing items from the punch list and start-up of the plant. These factors were considered in estimating the construction schedule.

The contractor would be required by the contract documents, after award, to submit his construction schedule based upon his methods of construction in sufficient detail to show chronological relationships to all activities of the project. These include:

-Estimated starting and completion dates
-Submittal of shop drawings for approval
-Procurement of materials
-Scheduling of equipment manufacture, delivery and installation
-Civil work sequences

The schedule would reflect completion of the work within the time specified in the contract documents.

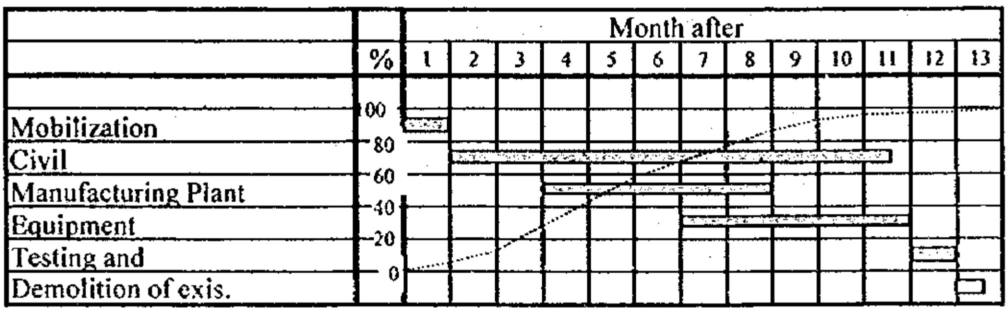

Figure 4.12 Overall Construction Schedule

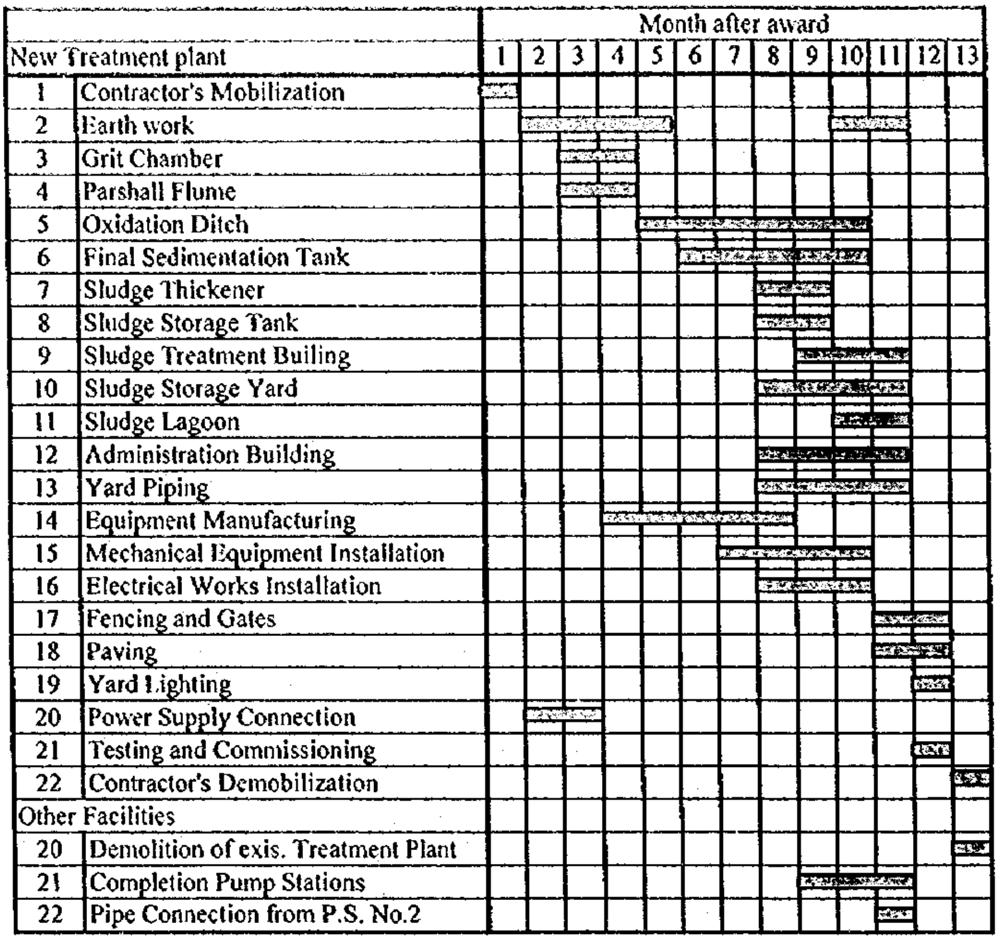

Figure 4.13 Facilities Construction Schedules

4.11.2.4 Construction Supervision

To obtain a quality product on time, within the construction funding limit, it is necessary to have full time inspection/supervision of the contractor's activities. It is proposed that the design engineer also perform the inspection/supervision work to avoid design/construction disputes and for a better, more prompt interpretation of the contract documents. A construction resident manager should report directly to the Ministry of the Environment and the local Water Company on the physical and financial status of the work. Under the resident manager would be several resident inspectors and technicians. Specialists in other disciplines would be available as needed from the design engineer's office.

Inspection at the factory of pipe and equipment manufactured outside Lithuania is not considered necessary.

4.11.3 Basis of Cost Estimate

In the following sections, the basis for cost estimating is discussed. The basis is in general, a time and material estimate where civil work is estimated by the amount of labor required, the necessary materials to be incorporated in the work and the construction equipment time required to perform the work. Plant equipment work is estimated by the cost of imported and local equipment and the installation, testing and start-up costs.

To determine the beginning and midpoint of construction for the financial analysis and cost estimating purposes, a schedule for the pre-construction activities was developed, as shown below.

	1998			1999											
Month	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Feasibility Study	■	■	■												
Funding Arrangement	■	■	■												
Selection of Consultant		■	■												
Detailed Design				■	■	■									
Pre-qualifiction of contractors			■	■	■	■									
Bidding and award							■	■	■						
Construction work										■	■	■	■	■	■

Figure 4.14 Schedule for the Pre-construction Activities

4.11.4 Basic Unit Costs

A unit cost includes several basic items, i.e. pipe laying, which includes excavation, the price for delivered pipe, lowering the pipe into the excavation upon the pipe bedding, joining the pipe together, checking the grade and applying any pipe joint protection (such as wrapping or painting), backfill, compaction and hauling waste material from the site. These unit costs are based upon an average basic unit cost for labor, materials and construction equipment. Basic unit rates used in these cost estimates are shown in the corresponding section in Chapter 4.

4.11.4.1 Construction Materials

Unit costs for construction materials were obtained from suppliers and previous construction contracts updated to July 1998 for both local and imported materials. Unit costs used herein are shown in the corresponding section in Chapter 4.

4.11.4.2 Equipment

Equipment to be incorporated into each treatment plant and the cost thereof is shown in Table 4.46. The prices are shown in Litas as of July 1998 and shipping and insurance costs are included. The value added tax of 18 percent is not included.

4.11.4.3 Labor

Labor unit costs are shown in the corresponding section in Chapter 4, as of July 1998 for the various categories of personnel to be involved in construction activities.

Table 4.46 Cost of Equipment Incorporated in the Project

Items of Equipment	No. of Units/Sets	Unit Cost	Total cost
Mechanical Bar Screen	1	77,940	77,940
Bypass Screen	1	1,700	1,700
Sand Pump	1	7,500	7,500
Flow Metering Equipment	1	7,000	7,000
Stop Logs	4	2,000	8,000
Raw Sludge Pump	1	10,500	10,500
Submerged Mixers	4	36,400	145,600
Diffusers	256	360	92,160
Aeration Blowers	3	33,000	99,000
Coagulant Tank	1	27,000	27,000
Coagulant Feed Pumps	2	8,500	17,000
Caustic Soda Tank	1	25,000	25,000
Caustic Soda Feed Pumps	2	8,500	17,000
Bypass Gate	1	7,300	7,300
Final Sedimentation Tank Mechanisms	2	110,000	220,000
Return Sludge Pumps	4	10,500	42,000
Excess Sludge Pumps	2	13,300	26,600
Plant Water Pump	1	7,500	7,500
Sludge Thickener Mixer	1	30,000	30,000
Thickened Sludge Pumps	2	13.300	26,600
Sludge Mixing Blower	1	6,000	6,000
Sludge Feeding Pump	1	13,300	13,300
Sludge Dewatering Unit	1	150,000	150,000
Sludge Cake Conveyor	1	19,500	19,500
Polymer Tank	1	27,000	27,000
Polymer Feeding Pump	1	7,000	7,000
Septage Transfer Pump	1	6,300	6,300
Drain Pump	1	6,300	6,300
Standby Water Pump	1	7,500	7,500
Standby Sludge Pump	1	10,500	10,500
Well Pump	1	12,500	12,500
Hoists	3	1,000	3,000
TOTAL			1,164,300

4.11.5 Construction Costs

The construction costs for the project components are shown in Table 4.47. A five percent contingency has been added to both the material and equipment costs. Twenty percent has been added to the labor cost for only those personnel who perform seasonal (15 percent) and specialty (5 percent) work. A further 17.3 percent has been added to the labor cost for field supervision (foreman) cost. Supervision and overhead by the contractor are included at 70 percent and social insurance on the total labor cost is also shown at 30 percent. A contingency of 3 percent is added to cover price variance and a profit for the contractor of 10 percent is included. The value added tax of 18 percent of the total has also been included.

Table 4.47 Construction Costs for the Skuodas Project

		Amount (Litas)	% of F/C	F/C	L/C
Construction Cost					
Treatment Plant					
1 Structures		2,809,748			
1 Grit chamber	11,729		50%	5,864	5,864
2 Parshall flume	2,380		50%	1,190	1,190
3 Primary sedimentation tank	42,867		50%	21,434	21,434
4 Splitter box	8,288		50%	4,144	4,144
5 Oxidation ditch	942,620		50%	471,310	471,310
6 Sludge pump house	101,673		50%	50,836	50,836
7 Final sedimentation tank	341,362		50%	170,681	170,681
8 Sludge thickener	61,352		50%	30,676	30,676
9 Sludge storage tank	28,143		50%	14,072	14,072
10 Sludge treatment building	159,960		30%	79,980	79,980
11 Sludge composting yard	721,447		50%	360,724	360,724
12 Administration building	287,928		30%	86,378	201,550
13 Miscellaneous structures	100,000		30%	30,000	70,000
2 Earth Work		26,648	30%	7,994	18,654
3 In-plant Piping		122,364	70%	85,655	36,709
4 Site Development		437,764	30%	131,329	306,435
5 Plant Equipment and Electrical Works		2,895,000	80%	2,316,000	579,000
6 Water Supply Facility		80,000	70%	56,000	24,000
7 Landscaping		30,000	30%	9,000	21,000
8 Procurement of vehicles and maintenance equipment		300,000	80%	240,000	60,000
Pipeline Connection to the existing Pressure Mains					
DIP dia.100 mm, L = 100 m		10,000	80%	8,000	2,000
Demolition of the Existing Treatment Plants		30,000	30%	9,000	21,000
Construction Cost Total		6,742,000		4,190,267	2,551,257

Demolition involves removing all above ground structures and buildings from the existing treatment plant site, removing all slabs at grade, cracking of the bottoms of below grade structures so water will not accumulate, filling all below grade tanks and basins with earth or sand to ground level, salvage of all reusable equipment or material, removal of off-site services (electricity, telephone, water and heat/hot water), and removing and disposing of all trash, unused equipment and materials, and waste from the site. The site would be left in a condition for further development or sale.

4.11.6 Operational Cost

Operational costs for the project include operation and maintenance labor, social insurance, and other related costs. Since these costs occur on an annual basis, the present worth has been calculated and added to construction to obtain the project cost.

Other operational costs include outside services for electrical energy, laboratory analysis, spare parts and small tools, telephone and telemetry, fuel supply and chemical supplies. It is planned to use plant personnel for trash, screenings and grit disposal at a nearby landfill. Dried sludge will be given to local farmers for a soil conditioner and low level fertilizer. A potable water supply system by deep wells would be included in the plant design. Sewerage service would also be included in the plant design through a sewer and drain system, pumping to the plant inlet. A heat and hot water system would also be provided by an in-plant system for the Administration Building. A plant water system would provide treated effluent for washdown, toilet flushing, fire protection, water seals and chemical solution water as applicable. Operational costs for Skuodas is shown in Table 4.48.

Table 4.48 Operational Costs

Item	Cost/Year (Lt./year)
Power - 100 kW	36,000
Chemicals	52,000
Fuel and Spare Parts/Tools	48,000
TOTAL	136,000

4.11.7 Other Costs

Other costs shown in Table 4.49 include land acquisition and engineering costs for Skuodas. Land acquisition is not required at Skuodas as the municipality owns the proposed treatment plant site and the easements necessary for pipeline construction and maintenance. An easement along the effluent discharge pipe to the canal which empties into the Bartuva River must be obtained prior to construction to avoid claims from the contractor for delay. Usually, the Ministry or Water Company will obtain any required land for the project and costs for repayment are not included in any project grants or loans.

Engineering costs are usually reimbursable under the grant or loan from funding agencies. These costs include final design and construction inspection services, topographical survey and geotechnical work and assistance in tendering and award. The Water Company has only limited equipment for operation and maintenance (2 tractors and 1 excavator) and no laboratory equipment is available. Costs for operation and maintenance equipment and laboratory equipment needed for operation control, are included in the capital cost.

Table 4.49 Other Costs

Item	Cost (Lts)
Land/Easements	-
Engineering	
Final Design	269,680
Construction Supervision	404,520
TOTAL	674,200

4.11.8 Project Cost

The final project cost for Skuodas is shown in Table 4.50. This cost includes the construction cost and other cost, including land acquisition, administration and engineering costs and a project contingency of 5 percent. The total project cost is 7.7 million Litas or 1.95 million US dollars. Project cost is shown in local and foreign costs. Foreign cost is the amount required to purchase services, materials and equipment from sources outside Lithuania. This includes the mechanical, electrical and instrumentation equipment to be incorporated into the work, pressure piping, operation and maintenance equipment, portions of the engineering services and some construction materials and equipment.

Table 4.50 Project Cost

unit: 1000 litas

Item	Foreign Cost	Local Cost	Total Cost
Construction Cost	4,190	2,551	6,742
Other Costs	472	202	674
Contingency (5%)	230	140	371
TOTAL PROJECT COST	4,892	2,894	7,787