Part II. Survey of Wastewater Treatment Facility Installations in the Enterprises of Jiangsu Province

1. Geography, Economy and Society of Jiangsu Province

1.1 Geography

Jiangsu Province is situated in the middle of east coast of China. It stretches from116’18E to 121’57E, and from 30’45N to 35’20N. It faces Yellow Sea in the east, and borders Anhui provinces in the west. To its north is Shandong province and to its southeast is Zhejiang Province and Shanghai Municipal. Its total area is about 102.6 thousand km^3, ranked the 24^{th} in China.

Yangtze River flows across and many lakes scattered in this province. Its water area is about 17.3 thousand km^3, or 10.43% of the total fresh water area in the whole country. As a famous area with river network, it is called “watery region-Jiangsu”.

Its coastline is as long as 954 km, with a 35.0 km^3coastal area. Yangtse River flows from west to east (about 425 km in its churchyard) and Beijing-Hangzhou Cannel Stretches form north to south (about 690 km in its churchyard). Additionally, it owns more than 2900 rivers, including Huai River, Yi River, Mu River, Si River, Qinghuai River and North Jiangsu Irrigation Dyke. Two of the 5 largest fresh water lakes, Tai Lake and Hongze Lake, are in Jiangsu, located in the South and North of Yangtse River, respectively. Its plain area is about 70.6 km^3, or 69% of its total area. Low hills area is about 14%, most of which concentrated in the southwest and north area.

Jiangsu is at the transitional area between subtropical zones to warm temperature zones. It has a kind climate, moderate precipitation and distinct four seasons. The annual average temperature is between 13 to 16 Celsius Degrees, and the annual precipitation is about 1,000 mm.

There are 13 municipalities directly under the jurisdiction of the provincial government in Jiangsu. They are Nanjing, Wuxi, Xuzhou, Changzhou, Suzhou, Nantong, Lianyungang, Huaian, Yancheng, Yangzhou, Zhenjiang, Taizhou, and Suqian. Under the jurisdiction of these municipalities, there are 18 country level cities, 30 counties and 51 urban districts in all. The province has 1425 townships.

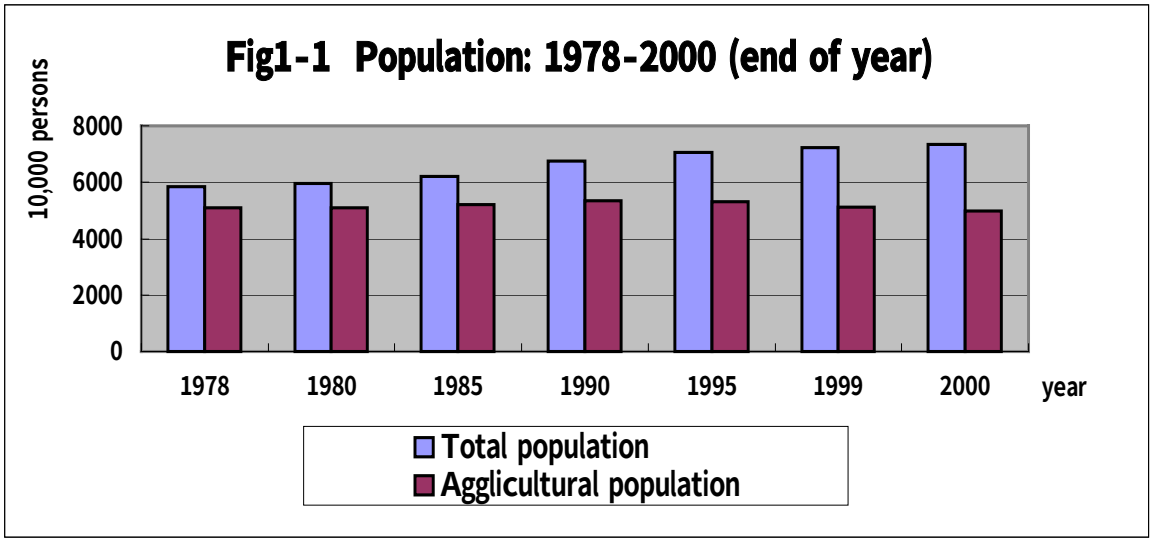
1.2 Population

Population Changes in Jiangsu Province since 1978 were shown in Table 1-1 and Figure 1-1. Jiangsu is a province with high population density as well as lack resources, so it must follow the road of sustainable development. Since 1978, the population growth in Jiangsu has been effectively controlled. Population quality

increased continuously, also the employment structure optimized. This has promoted the development of provincial economy and society, accelerating the progress to a prosperous and modernized future.

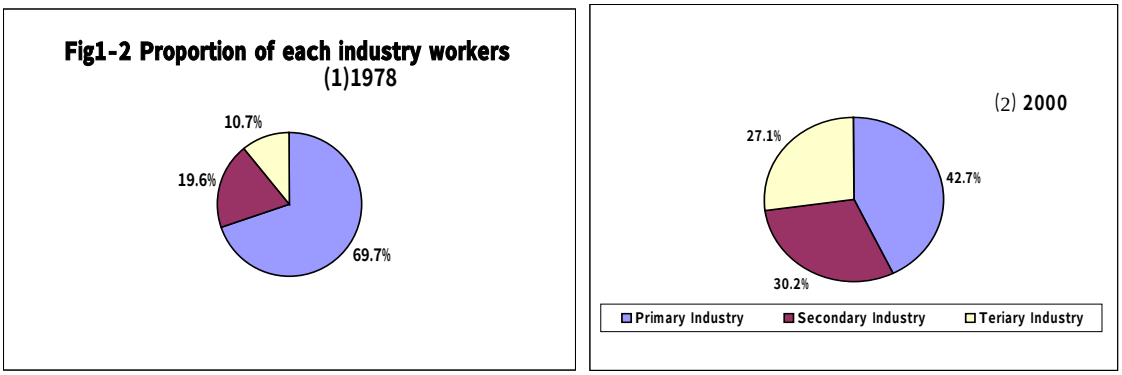
Table 1-1 Population Changes in Jiangsu, 1978-2000

Year	Population (10,000 capita)	Population Density (Capita/km^3)	Natural Growth Rate (‰)	Agriculture (10,000 capital)	Non-Agriculture (10,000 Capital)	Employment (10,000 Capital)	Structure of Employment (%)		
							Primary Industry	Secondary Industry	Tertiary Industry
1978	5834.33	569	9.54	5106.22	728.11	2777.72	69.7	19.6	10.7
1980	5938.19	579	8.12	5085.67	852.52	2821.03	70.4	19.4	10.2
1985	6213.48	606	4.97	5199.87	1013.61	3262.97	53.2	32.7	14.1
1990	6766.90	660	14.01	5345.85	1421.05	3569.13	48.9	33.8	17.3
1991	6843.70	667	10.55	5392.84	1450.86	3600.27	49.2	33.3	17.5
1992	6911.20	674	8.95	5403.18	1508.02	3613.90	47.6	33.8	18.6
1993	6967.27	679	7.36	5331.25	1636.02	3639.40	45.4	34.6	20.0
1994	7020.54	684	6.92	5333.03	1687.51	3639.90	44.4	34.4	21.2
1995	7066.02	689	5.76	5308.39	1757.63	3649.69	42.9	34.8	22.3
1996	7110.16	693	5.53	5216.52	1848.64	3647.09	42.5	34.2	23.3
1997	7147.86	697	4.59	5257.13	1890.73	3658.05	42.5	33.3	24.2
1998	7182.46	700	4.13	5251.81	1930.65	3570.60	43.4	31.0	25.6
1999	7213.13	703	3.56	5124.93	2088.20	3533.28	43.1	30.4	26.5
2000	7327.24	714	2.56	4972.27	2354.97	3504.87	42.7	30.2	27.1



Since 1990, the population natural growth rate in Jiangsu Province decreased continuously. Up to 2000, it has been as low as 2.56‰. According to all previous population censuses, in 1982, the numbers of educated people in deferent level among every 100,000 capital are: university or higher, 639; High School, 6,981; Secondary School, 20,049; Primary School, 32,613. In 2000, these figures changed to: university or higher, 3917; High School, 13,039; Secondary School, 36,372; Primary School, 32,881. In 1978, the percentages of employment population in primary, secondary and tertiary industries are 69.7%, 19.6%, and 10.7%. In 2000, percentages of employment population in the three industries has become to 42%, 30.2%, and 27.2%, respectively (see Figure 1-2).

By the end of 2000, total population in Jiangsu province has reached 73.2724 million, or 5.8% of the total in the whole country, ranked after Henan, Shandong, Guangdong and Sichuan.



1.3 Economic Development

Since 1978, the economic and social situation of Jiangsu has been changed greatly. Its GDP increased from 24.924 million Yuan in 1978 to 858.273 million Yuan in 2000 with an average annual growth rate of 12.4%. In 1992, the economic scale was four times of that in 1978, that is, 8 years ahead of the schedule. Provincial financial income increased from 6.229 billion Yuan in 1978 to 86.513 billion Yuan in 2000 with an average annual growth rate of 12.8%. As to production value, the average annual growth rate is 5.2% of primary industry, 14.0% of secondary industry, and 15.0% of tertiary industry. The difference of development speed in different industries has chanced their sequence from “Secondary, Primary, and Tertiary” to “Secondary, Tertiary and Primary”. The percentage of tertiary industry has increased dramatically (see Figure 1-5). Most regions of this province have reached comparatively well-off level and are striding toward modernization.

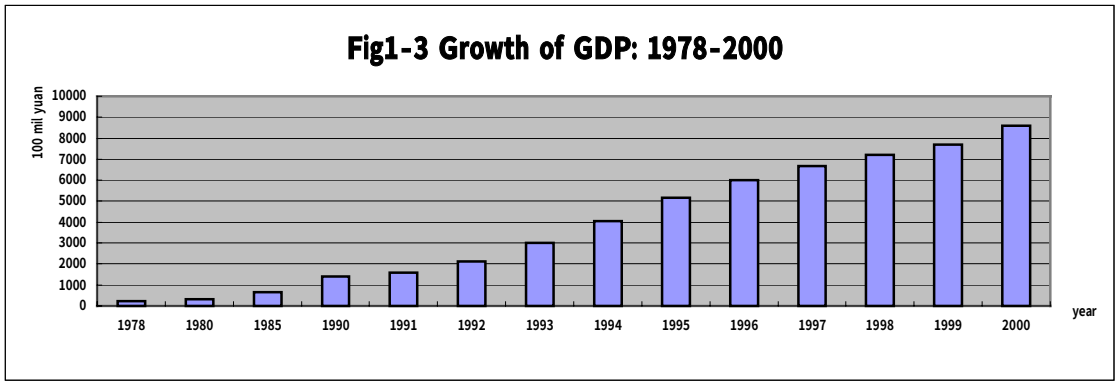
In 2000, Jiangsu’s GDP was 858.37 billion Yuan, or 9.6% of the total in the whole country, ranked after Guangdong Province. Its financial income was about 86.513 billion, or 6.5% of the total in the whole country (see table 1-3).

Table 1-2 GDP Growth in Jiangsu Province, 1978-2000

Year	GDP (10^8 Yuan)	GDP index (100 in 1978)	GDP Structure (%)		
			Primary Industry	Secondary Industry	Tertiary Industry
1978	249.24	100.0	27.6	52.6	19.8
1980	319.80	117.4	29.5	52.3	18.2
1985	651.82	217.9	30.0	52.1	17.9
1990	1416.50	351.1	25.1	48.9	26.0
1991	1601.28	380.3	21.5	49.6	28.9
1992	2136.02	477.6	18.4	52.4	29.2
1993	2998.16	572.1	16.4	53.3	30.3
1994	4057.39	666.6	16.6	53.9	29.5
1995	5155.25	769.3	16.4	52.7	30.9
1996	6004.21	863.2	16.1	51.2	32.7
1997	6680.34	966.8	15.1	51.1	33.8
1998	7199.95	1073.1	14.1	50.6	35.3
1999	7697.82	1181.5	13.0	50.9	36.1
2000	8582.73	1306.7	12.0	51.7	36.3

Table 1-3 Main Economic Indicators of Jiangsu Province and the Whole Country, year 2000

Indicator	The Whole Country	Jiangsu Province	Jiangsu's Percentage in the Whole Country (%)
Population in the End of this Year	126483	7327.24	5.8
GDP (10^8 Yuan)	89404	8582.73	9.6
Primary Industry	14212	1031.17	7.3
Secondary Industry	45488	4435.89	9.8
Tertiary Industry	29704	3115.67	10.5
Investment on Fixed Assets of the whole Society (10^8 Yuan)	32619	2995.43	9.2
Financial Income (10^8 Yuan)	13380	865.13	6.5
Financial Payout (10^8 Yuan)	15879	645.57	4.1



2. Industrial development in Jiangsu Province

Jiangsu is one of the cradles of Chinese national industry. After 1978, its industry experienced a very rapid growth. From 1981 to 2000, annual growth rate was as high as 14%. For a long time, industrial added value of Jiangsu was ranked the 2nd place in the whole county, which broke through 100 billion Yuan in 1992 and reached 384.85 billion Yuan in 2000, just after Guangdong Province. In 2000, there are 18352 state owned or non-state owned enterprises in Jiangsu Province whose annual sales income were over 5 million Yuan. The total sales income of the enterprises in Jiangsu was over 997.101 billion Yuan, also ranked 2nd in the whole country.

After 1978, the development of light & textile industry was given a priority in Jiangsu. Up to 1983, ratio between light and heavy industry has been 58:42. In 1980s, chemical industry in Jiangsu experienced a rapid growth, causing that production of heavy industry was more than that of light industry in 1993. Hereafter, the industrial structure in Jiangsu was tending to more rational one. Up to 1998, ratio between light and heavy industry has become 51.9: 48.1.

In 1980s, Jiangsu took the advantaged chances of rural reform, making great efforts in developing township enterprises and taking the lead in the whole country. After two decades, now there are 1,370 large or medium township enterprises who meet the state planning standards, of which the sales income and total pre-tax profits occupies 40% of that of all large or medium enterprises in the whole province. There were 496 towns whose operation income exceeded 500 million Yuan each and also 739 enterprises whose operation income exceeded 100 million each. In 2000, township enterprises in Jiangsu Province realized added value of 241.1 billion Yuan, operation income of 954.4 Yuan and export value of 136.5 billion Yuan.

At the same time, ownership structure of industrial enterprises in Jiangsu also changed. In 2000, there were 1880 state owned enterprises at provincial level, of which the gross output value was 132.770 billion Yuan, or 12.7% of that of all the enterprises at provincial level, and of which the added value was 40.454 billion Yuan, or 15.5% of that of all the enterprises at provincial level. In the same year, there were 4091 collective enterprises at provincial level, of which the gross output value was 189.783 billion Yuan, or 19% of that of all the enterprises

at provincial level, and of which the added value was 46.482 billion Yuan, or 17.8% of that of all the enterprises at provincial level. In 2000, there are 3160 foreign funded (including Hong Kong, Macau and Taiwan funded) industrial enterprises, of which the added value was 70.980 billion Yuan, the fixed assets at cost was 164.527 billion Yuan, and the sales income was 275.601 billion Yuan.

In 2000, enterprises in food, beverage, textile (dyeing), paper making, chemical and Pharmaceutical industries of Jiangsu Province was shown in Table 2-3.

Table 2-1 Industrial developments in Jiangsu, 1978-2000

Year	Gross Output Value of Industry (10^8 Yuan)	Output Value of Heavy Industry (10^8 Yuan)	Output Value of Light Industry (10^8 Yuan)	Added Value of Industry (10^8 Yuan)
1978	337.65	160.71	176.94	117.10
1980	467.82	199.85	267.97	151.22
1985	1036.67	484.44	552.23	307.89
1990	2764.10	1253.53	1510.57	634.13
1991	3161.60	1478.84	1682.76	725.83
1992	4673.57	2294.57	2379.00	1017.94
1993	7096.46	3656.96	3439.50	1451.97
1994	9826.50	4811.96	5014.54	2002.22
1995	9807.19	5021.77	4785.42	2467.63
1996	11555.47	5879.13	5676.47	2754.80
1997	12542.40	6159.44	6382.96	3016.44
1998	13185.70	6342.40	6843.38	3157.69
1999	14621.82	7072.64	7549.18	3387.99
2000	10452.87*	5934.75*	4518.12*	3848.52

*： Gross output value of industry, output value of light industry, output value of heavy industry at provincial level in 2000

Table 2-2 Main Economic Indicators of industrial Enterprises in Jiangsu at provincial Level or above, year 2000

Indicator	Number of Enterprises	Gross Output Value of Industry (10^8 Yuan)	Structure of Gross Output Value (%)	Added Value of Industry (10^8 Yuan)
Total	18309	10452.87	100	2604.37
Classified by Registration Type				
Domestic Enterprises	15149	7555.92	72.3	1894.57
State owned Enterprises	1880	1327.70	12.7	404.54
Collective Enterprises	4091	1987.83	19.0	464.82
Limited Co.	1451	1489.03	14.2	347.25
Stock Co., Ltd.	495	860.85	8.2	233.96
Hong Kong, Macau, and Taiwan-funded Enterprises	1516	953.64	9.1	257.26
Foreign Funded Enterprises	1664	1943.31	18.6	452.53

*：Industrial Enterprises at provincial level or above refers to all the state owned and non-state owned industrial enterprises whose annual sales income is beyond 5 million Yuan

Table 2-3 Basic Information of the Industrial Enterprises at Provincial Level or above, Year 2000

Industry	Number of Enterprises	Employee Number (10^4 Capital)	Added Value of Industry (10^8 Yuan)
Food Processing	899	13.41	69.37
Food Manufacturing	302	5.86	29.52
Beverage Manufacturing	186	6.76	34.67
Textile (Dyeing)	2056	83.53	294.71
Paper Making and Paper Products	331	7.55	34.10
Raw Chemical Materials and Chemical Products Manufacturing	1773	40.46	234.37
Medical and Pharmaceutical Products	264	8.08	50.59

3. Industrial Wastewater Discharge and Treatment in Jiangsu Province

3.1 Industrial Water Usage and Its discharge

Industrial water in Jiangsu province comes from surface water, ground water, water supply and seawater. In 2000, industrial water usage in Jiangsu was 17.5 billion tons, among which there were 8.85 billion tons fresh water and 8.7 billion tons reused water. That is, the reused water rate was 50%. In the 13 municipalities directly under the jurisdiction of the provincial government, Nanjing was ranked first if listed by the volume of industrial water usage, reaching 4 billion tons, or 22.6% of the total of whole province. Suzhou, Zhenjiang and

Xuzhou were ranked 2nd to 4th respectively with industrial water usage of 20~26 tons.

In 2000, industrial wastewater discharge in the whole provincial was 2.02 billion tons, among which wastewater up to the discharge standards was 1.86 billion tons. Up-to-standard rate of industrial wastewater discharge is 92%. In the 13 municipalities directly under the jurisdiction of the provincial government, Nanjing was also the largest discharger of industrial wastewater, occupying 32.2% of the total of the whole province. The following dischargers were Suzhou, Wuxi and Changzhou, occupying 17.0%, 8.9% and 7.3% of the total of whole province, respectively. For more details, see table 3-1.

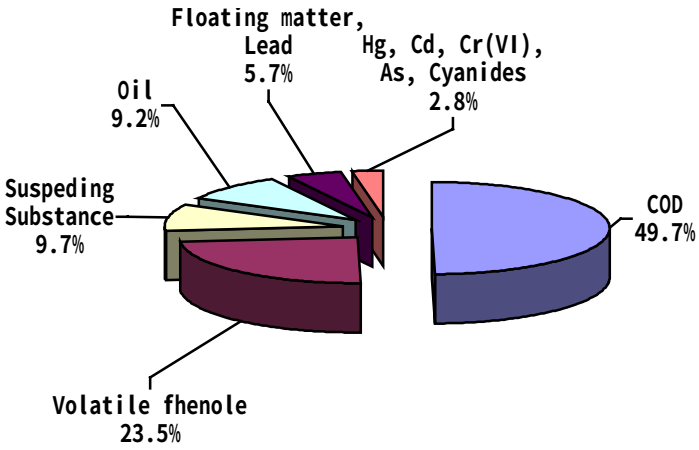
Table 3-1 Industrial Water usage and Wastewater Discharge in Jiangsu, year 2000

Area	Industrial Water Usage (10^4 tons)	Fresh Water Usage (10^4 tons)	Industrial Wastewater Discharge (10^4 tons)	Wastewater up to the Discharge Standards (10^4 tons)	Up-to-Standard Rate of Industrial Wastewater Discharge（%）
Nanjing	39.6	16.6	6.5	5.5	84.1
Wuxi	18.9	3.1	1.8	1.7	96.9
Xuzhou	20.3	1.7	0.9	0.9	91.9
Changzhou	4.2	1.7	1.5	1.4	96.0
Suzhou	26.1	20.1	3.4	3.3	96.0
Nantong	14.0	9.4	1.1	1.1	95.3
Lianyungang	6.1	1.3	0.5	0.4	95.1
Huaian	5.5	3.4	0.6	0.6	97.4
Yancheng	4.2	2.8	0.7	0.7	92.6
Yangzhou	11.2	7.1	0.9	0.8	93.8
Zhenjiang	20.9	18.4	0.8	0.7	98.9
Taizhou	3.5	2.4	1.1	1.1	97.2
Suqian	0.6	0.4	0.3	0.3	93.3
The Province	175.2	88.5	20.2	18.6	91.9

3.2 Main Pollutants in Industrial Wastewater

Industrial wastewater pollutions in Jiangsu mainly are mainly caused by organic pollutants. As to the 11 pollutants, which were taken into statistics, discharge volume of COD, volatile hydroxybenzene, sulfides, and petrolics is 240 thousand tons, 114.2 tons, 472.7 tons and 2204.2 tons, respectively. For more details, see table 3-2. These pollutants are the main pollutants in the industrial wastewater in Jiangsu, of which the standardized pollution load occupied 92.1% of the total. In terms of standardized pollution load, suspending substances occupied 4.8%; Plumbum occupied 0.3%; and other five virulent chemicals, namely cyanides, Arsenic, chromium (VI), Cadmium, and Hydrogyrum, jointly occupied 2.8% (See Figure 3-1).

Figure 3-1 Standardized Pollution Load Ratio of Main Pollutants in Wastewater



Standardized pollution load of industrial wastewater in Jiangsu province are mainly from chemical, textile and paper making industry. They are main wastewater discharges in Jiangsu, sharing 35.5%, 24.8% and 19.9% of the total standardized pollution load respectively in 2000. For details, see table 3-2.

3.3 Wastewater Discharge and Treatment in 4 Industries

Food & Beverage Industry

In 2000, total volume of wastewater discharge in this industry was 71.0815 million tons, or 3.5% of the total of the whole province. Yearly discharged pollutants included 0.04 ton hydroxybenzene, 14626.02 tons COD, 30.99 tons petrolics, 5282.62 tons suspending substances and 0.24 ton sulfides, occupying 0.05%, 6.05%, 1.4%, 0.5% and 0.05% of those of the whole province, respectively.

There were 316 sets of wastewater treatment facilities in this industry, costing 45.451 million Yuan, among which 302 sets were under normal operation, processing 46.2901 tons wastewater per year. Percentage of Industrial Wastewater Treated was 87.56%, and up-to-standard rate of the treatment is 96.2%. 87.23% of the hydroxybenzene, 89.47% of the COD, 99.04% of the petrolics, 91.30% of the suspending substances, and 99.5% of the sulfides were removed.

Textile & Dyeing Industry

In 2000, total volume of wastewater discharge in this industry was 245.8262 million tons, or 12.37% of the total of the whole province. Yearly discharged pollutants included 0.82 ton hydroxybenzene, 59877.14 tons COD, 40.02 tons petrolics, 14183.71 tons suspending substances and 161.62 ton sulfides, occupying 0.72%, 24.8%, 1.8%, 12.18% and 34.19% of those of the whole province, respectively.

There were 792 sets of wastewater treatment facilities in this industry, costing 950.906 million Yuan, among which 763 sets were under normal operation, processing 181.6059 tons wastewater per year. Percentage of Industrial Wastewater Treated was 91.58%, and up-to-standard rate of the treatment is 94.4%. 34.42% of the

hydroxybenzene, 69.42% of the COD, 6.6% of the petrolics, 69.56% of the suspending substances, and 60.59% of the sulfides were removed.

Paper Making Industry

In 2000, total volume of wastewater discharge in this industry was 152.6489 million tons, or 7.56% of the total of the whole province. Yearly discharged pollutants included 10.87 ton volatile hydroxybenzene, 46966.31 tons COD, 16.46 tons petrolics, 23096.92 tons suspending substances and 36.92 tons sulfides, occupying 9.5%, 19.46%, 0.73%, 19.84% and 7.8% of those of the whole province, respectively.

There were 156 sets of wastewater treatment facilities in this industry, costing 652.222 million Yuan, among which 146 sets were under normal operation, processing 142.9223 tons wastewater per year. Percentage of Industrial Wastewater Treated was 88.64%, and up-to-standard rate of the treatment is 82.04%. 75.28% of the hydroxybenzene, 68.56% of the COD, 45.18% of the petrolics, 79.7% of the suspending substances, and 97.38% of the sulfides were removed.

Chemical & Pharmaceutical Industry

In 2000, total volume of wastewater discharge in this industry was 761.9114 million tons, or 37.72% of the total of the whole province. Yearly discharged pollutants included 0.02 ton Stannum, 0.22 ton chromium (VI), 51.51 tons Arsenic, 52.23 ton volatile hydroxybenzene, 30202.19 tons COD, 928.73 tons petrolics, 31132.4 tons suspending substances and 205.66 tons sulfides, occupying 6.7%, 3.1%, 98.98%, 45.99%, 68.28%, 12.51%, 41.46%, 26.75% and 43.51% of those of the whole province, respectively.

There were 1221 sets of wastewater treatment facilities in this industry, costing 2026.658 million Yuan, among which 1181 sets were under normal operation, processing 729.5908 tons wastewater per year. Percentage of Industrial Wastewater Treated was 92.7%, and up-to-standard rate of the treatment is 57.82%. For more details, see table 3-3, 3-4, and 3-5.

Table 3-2 Industrial Wastewater Discharge in main industries, year 2000

Industry	Enterprise Number	Total Volume of Industrial Wastewater discharged (10,000 tons)	Volume of Wastewater up to the Discharge Standards	Volume of Waste Water Treated (10,000 tons)	The Volume of Industrial Wastewater Discharge (ton)										
					Hg	Cd	Cr(VI)	Ph	As	Volatile Hydroxybenzene	Cyanides	COD	Petrolics	Suspending Substance	Sulfides
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Food & Beverage	579	7108.15	6363.17	4453.09						0.06		14626.02	30.99	5282.62	0.24
Textile Industry	954	24582.62	21960.87	17238.07			0.02			0.82		59877.14	40.02	14183.71	161.62
Leather, Furs, Down and Related Products	62	425.04	283.15	245.32			0.07			0.19		3762.49	2.62	302.93	0.92
Paper making and Paper Products	165	14292.23	12051.83	11725.87						10.87		46966.31	16.46	23096.92	36.92
Petroleum Processing and Coking	33	1797.33	1777.89	1595.27						4.32	0.74	1510.80	76.37	493.10	1.09
Raw Chemical Materials and Chemical Products	953	71168.06	64031.24	27599.57		0.02	0.22	0.37	51.51	50.32	32.79	57602.05	858.08	28706.30	182.55
Medical and Pharmaceutical Products	173	5023.08	4671.06	1376.25						1.91	0.27	11945.81	70.65	2426.10	23.11
Chemical Fiber	44	4395.25	4352.43	3568.79								5995.62	0.39	2741.82	6.54
Nonmetal Mineral Products	784	2510.49	2411.41	885.39			0.09		0.03	0.50	0.09	1313.59	50.34	1381.31	1.12
Smelting and Pressing of Ferrous Metals	141	25987.11	24070.20	10236.90		0.27	0.38	11.47		6.83	9.16	12227.14	496.97	19281.76	19.78
Metal Products	587	1249.10	1196.22	883.35			4.83	0.06		0.11	2.01	1006.55	14.93	346.56	0.60

Machinery, Electrical Equipment and Electronic Equipment Manufacturing	1070	8894.96	8518.62	3242.88		1.28	0.63	0.06	0.65	0.86	7027.24	306.49	2981.86	15.03
Electric power, Gas and Water Production and Supply	132	28245.28	27981.67	9013.05				0.38	37.60	2.23	11710.23	73.60	9893.20	5.95

Table 3-3 Main Pollutants discharge in 4 Selected Industries, year 2000

Industry	Volume of Waste Water Discharge		Amount of Pollutants in Wastewater													
	10,000 tons	% of the total	As (ton)	% of the total	VH* (ton)	% of the total	Cyanides (ton)	% of the total	COD (ton)	% of the total	Petrolics (ton)	% of the total	SS** (ton)	% of the total	Sulfides (ton)	% of the total
Beverage & Food	7108.15	3.5			0.06	0.05			14626.02	6.05	30.99	1.4	5282.62	0.5	0.24	0.05
Textile & Dyeing	24582.62	12.37			0.82	0.72			59877.14	24.8	40.02	1.8	14183.71	12.18	161.62	34.19
Paper Making	15264.09	7.5			10.87	9.5			46966.31	19.46	16.46	0.73	23096.92	19.84	36.92	7.8
Chemical & Pharmaceutical	76191.14	37.7	51.51	99.0	52.23	45.99	33.06	68.28	69547.86	28.8	928.73	41.46	31132.4	26.75	205.66	43.51
Total	123146.8	61.0	51.51	99.0	63.98	56.0	33.06	68.3	151677.66	62.8	1016.2	45.4	73695.65	59.3	404.44	85.6
Total in the Whole Province	201923.33		52.64		114.23		48.42		24139.1		2240.25		116431.59		472.68	

* VH= Volatile Hydrobenzene; ** SS= Suspending Substances

Table 3-4 Operation of Wastewater Treatment Facilities in Jiangsu Province, year 2000

Industry	Wastewater Treatment Facilities (Sets)	Facilities under Normal Operation (Sets)	Cost of Facilities (10,000 Yuan)	Volume of Waste Water Treated (10,000 tons)	Volume of Reused Wastewater after Treatment (10,000 tons)	Percentage of Industrial Waste Water Treated (%)
Beverage & Food	316	302	4545.1	4629.01	88.86	87.56
Textile & Dyeing	792	763	95090.6	18260.59	77.55	91.58
Paper Making	156	146	65222.2	15264.89	3255.26	88.64
Chemical & Pharmaceutical	1221	1181	202665.8	72959.28	42242.08	92.7
Total	2485	2392	367523.7	111114.27	45663.69	91.72
Total in Whole Province	4761	4574	678131.1	240669.86	141229.86	95.18

Table 3-5 Removed Percentages and Processed Amounts of Main Pollutants in 4 Selected Industries

Industry	Removed Percentages and Processed Amounts of Main Pollutants													
	As		Volatile Hydrobenzene		Cyanides		COD		Petrolics		Suspending Substances		Sulfides	
	RA* (ton)	RP (%)	RA (ton)	RP (%)	RA (ton)	RP (%)	RA (ton)	RP (%)	RA (ton)	RP (%)	RA (ton)	RP (%)	RA (ton)	RP (%)
Beverage and Food			0.41	87.23			124244.64	89.47	3212.88	99.04	55470.85	91.3	50.02	99.5
Textile and Dyeing			0.4	34.42			135954.29	69.42	2.82	6.6	32411.71	69.56	248.45	60.59
Paper Making			33.1	75.28			102420.24	68.56	30.43	45.18	90670.64	79.7	1377.37	97.38
Chemical and Pharmaceu	103.56	66.78	633.93	92.39	327.51	90.83	153033.19	69,55	3217.27	77.6	80306.69	72.06	573.3	73.6
Total	103.56	66.78	667.84	91.26	327.51	90.83	515652.36	77.27	6463.4	86.41	258859.89	77.83	2249.14	84.76
Total in Whole Province	103.56	66.56	2546.8	95.7	646.47	93.03	641364.89	72.65	30868.54	93.23	3147604.6	96.43	8272.41	94.59

* RA= Removed Amount, RP=Removed Percentage

4. Main Controlling policies, actions and the results

In the 9th Five Year Plan period, environmental protection in Jiangsu Province made a breakthrough. By taking active pollution control actions, adding investment, and strengthening regional environmental comprehensive harness, Jiangsu has controlled its industrial pollution effectively. Deterioration of environmental quality was stopped, and even in some region, environmental quality was much better than before. This has benefited the economical and social development in Jiangsu. In this period, main environmental control policies and actions included:

4.1 Establish and Consummate the Four Basics of Environmental Management

The 6th and 7th Environmental Protection Meeting of Jiangsu Province was convoked in 1996 and 1998 respectively in order to stimulate the fulfillment of state environmental protection policies. In 1996, the provincial government issued *Several Opinions on Strengthening the Environmental Protection in Jiangsu Practically*, demanding that environmental quality goal be brought into the indicator system of full-scale comparatively well off and initially modernized society, and that operational mechanisms called *Director taking charge of environmental protection*, *Environmental protection being ranked in the first position when examining and approving projects*, and *Environmental prevention owning the veto right solely when choosing advanced persons or units* be established and popularized in the bound of the whole province. In 1997, the provincial government issued a file called *China Agenda 21: Program of Actions in Jiangsu*, in order to accelerate the implement of sustainable development policy. In 1999, the provincial government issued *Notification on Strengthening the Comprehensive Decision-making Ability on Environment and Development*, demanding that the four systems brought forward by President Jiang Zemin, namely *Comprehensive policy making on environment and development*, *Increasing investments on environmental protection*, *United monitoring*, and *Public participation*, be put into effect, and that decision making of environmental protection work be strengthened by identifying the 5 principles and 6 categories as well as establishing and consummating the 10 management systems.

In Jiangsu Province, uniform monitoring and management mechanism on environmental protection has formed, of which the features are "*Government taking charge, various department administrating, united monitoring, public participation, enterprises treating, and news monitoring* ". It played an active role in up-to-standard discharge control of pollutants and comprehensive harness in key drainage area. Through deepening the environmental protection goal liability system, and strengthening the review on political head for

his environmental protection duty, environmental protection work in Jiangsu has stepped into a new stage.

At the same time, more investments were put into environmental protection. A financing mechanism called "*polluters harness, users pay, developers protect, destroyer compensate, and government add investment*" was established.

Public participation mechanism is also forming. In *Environmental Impacts of Constructive Project*, public participation was listed and described. Provincial Woman's Union ever carried out a topic-advertisement activity called "Woman, Home, and Environment".

4.2 Legal construction on Environment.

During the period of the 9th Five Year Plan, 16 local environmental laws at provincial level, such as *Ordinances on Tai Lake Water Pollution of Jiangsu Province* and *Ordinances on Agricultural Environmental Protection of Jiangsu Province*, more than 20 environmental protection regulations, and more than 150 environmental protection criterion files made by provincial departments were issued, which will provide juristic accordance to environmental protection administration and environmental law's execution. Governments at all levels have taken different kinds of actions to promote the execution of environmental law, such as *closing 15-small action, zero clock action, focusing on Tai Lake action, and Protecting Mother River, Focusing on Yangtse River action*, etc. In 1997, provincial government approved a file called *Opinions on ulteriorly Strengthening Environmental Protection Management*, which was made by provincial environmental protection administration and provincial planning & economic commission. It demanded that all the construction, reconstruction and expansion projects be approved by environmental protection administration before their initiation. Projects must be forbidden if they bring heavy pollutions or pollutants discharged by them cannot be treated. So the appearance of new pollution source was under strict control.

4.3 Up-to-standard discharge control of pollutants and comprehensive harness in key drainage area.

During the 9th Five Year Plan period, Jiangsu defined "Three Battles" on water pollution control in the drainage basin of Tai Lake, Huai River and Yangtse River, where 1563 enterprises was informed to harness their pollutants discharge by the end of time limit. At the same time, the provincial government issued P*lan on the Amounts of Main Pollutants Discharge in Jiangsu Province during the 9th Five Year Plan Period* and *Assessment Method on the Accomplishment of Total Amount Control Goal*, prescribing that the indicator of control on total pollutants discharge amount be taken into the assessment contents of environmental protection

goal of governments at all levels. The provincial government also organized relative department to make a Trans-century Green Engineering Program.

4.4 Eco-Environment Construction

In the 9th Five Year Plan period, Jiangsu Province followed the principles with that the pollution control and eco-environmental protection are equally emphasized. There were 5 counties (or municipals) were approved to be experimental areas of ecological construction early or late, and were checked and accepted by State Environmental Protection Administration in May, 1999. At present, another 19 counties (or municipals) were also approved to be experimental areas of ecological construction. The province also accelerated the development of natural protection areas. Now Jiangsu own 21 such areas, of which the total area is about 580 thousand hectares. In this way, 1500 km^2 land with soil erosion was harnessed.

4.5 Developing Environmental Technologies, and Making Education Outreach

Jiangsu Province has fully taken the advantage of new technologies formed in university and research institutions, and defined an environmental protection strategy guided by technology. The province also funded a foundation for environmental protection technology development. 2% of the effluent charge was used to support research and demonstrative projects on regional environmental protection, or served as subsidies to the coordinative activities when tackling key treatment technologies. Existed achievements and practical technologies were filtered, and the best ones will be turned into real treatment ability. Clean production was popularized in order to reduce more pollutants discharge. From 1996, Jiangsu started clean production auditing. At first, 26 enterprises, which scattered in chemical, light and building material industry, were chosen to do this work as experimental ones at provincial level. Later, experimental enterprises at municipal and county level were also chosen, and now, clean auditing has been carried out all over the province. Another action is impelling enterprises to pass the ISO 14000 attestation. At present, there are over 60 enterprises and two areas (Suzhou, Wuxi) have passed the ISO 14000 attestation. The provincial government also took some actions to promote public attention on environmental issues. Departments in charge have jointly issued some related files, such as *Opinions on Strengthening Education Outreach on Environmental Protection*, demanding that the cultivation classes at all levels must take the cultivation course on and have the test of environmental protection, and that new selected leader must get an approval letter before he come to his position.

4.6 Capability Construction of Environmental Protection Branches

The province governmental attached importance to this effort. Files on standardized construction of environmental protection and environmental monitoring institutions, as well as on environmental monitoring has been issued, and to be taken into practice.

4.7 International Cooperation in Environmental Fields

Some international meetings have been held and some cooperative projects have made, such as *Sino-US Symposium on Management and Technologies in Wastewater Treatment, Sino-UK Symposium on Clean Production, Sino-Japan Ishikawa-Jiangsu Workshop on Tai Lake Pollution Comprehensive Control, Sino-Germany symposium on City Effluent Treatment, Sino-Germany Symposium on New Technologies of Wastewater Treatment in Textile Industry*, and Sino-Canada *Applicable Management and Environmental Protection Cultivation in Jiangsu's Small and Medium Enterprises* Project. Through these meetings and projects, industrial leaders, policy makers and researchers broadened their horizons, promoted their relationship and communication with their craft brothers in developed countries, and knew the latest trends and information in the whole world.

4.8 Results

Jiangsu has benefited much from taking these main controlling policies and actions. Firstly, it reached the so-called "one order, two goals" made by State Council. At the same time, Discharge of 12 main pollutants was also controlled at the levels demanded by the state, and 13 municipalities directly under the jurisdiction of the provincial government has all complete the missions assigned by provincial government in controlling pollutants discharge. 37709 enterprises, which have undertaken the mission, reached the goal.

The percentage of environmental protection investment in GDP climbed year after year, from 0.7 in 1996 to 1.75% in 1999, which has exceed what the provincial government have asked (1.5%). During the 9^{th} Five Year Plan period, 1904 Trans-century green engineering projects were arranged, and anticipated investment is about 22.08 billion Yuan. At the end of this period, 1311 projects were accomplished, and actual investment was 7.76 billion Yuan.

Jiangsu fulfilled its liability on water pollution harness, which was also described by central government. 558 key wastewater dischargers in Huai River drainage basin, 770 key wastewater dischargers in Tai Lake drainage basin, and 408 key wastewater dischargers in Yangtse River drainage basin has realized up-to-standard

discharge in 1997, 1998, and 1999 respectively, reducing COD discharge by 550 thousand tons. Among the 15 control sections of 13 rivers in Huai River drainage basin, which were listed in the state examination, water quality in 13 sections has been up to the standard made by the State Council. After the implement of *Zero Clock Action* in Tai Lake drainage area, over-standard discharge from industrial pollution source was basically under the control.

Clean production audit also brought visible environmental and economic benefits. According to statistics, just in the experimental enterprises, the direct economic benefits due to the enhancement of resource utilization rate have exceeded 260 million Yuan.

5. Installations and Usage of Wastewater Treatment Facilities in 100 Selected Enterprises

5.1 Basic Information of the Investigated Enterprises

The 100 selected enterprises scattered in food and beverage, dyeing, paper making and chemical & pharmaceutical industry, among which there are 16 in food and beverage industry, 31 in dyeing industry, 15 in paper making industry and 38 in chemical & pharmaceutical industry. Also, the 100 selected enterprises scattered in all 13 municipalities directly under the jurisdiction of the provincial government. There are 9 from Nanjing, 15 from Wuxi, 10 from Xuzhou, 9 from Changzhou, 21 from Suzhou, 5 from Nantong, 3 from Lianyungang, 1 from Huaian, 6 from Yancheng, 4 from Yangzhou, 9 from Zhenjiang, 5 from Taizhou, and 3 from Suqian. For more details, see table 5-1.

The 100 selected enterprises can be attributed to 13 categories by their ownership properties. State owned enterprises are the most, summing up to 31, then the collective enterprises and foreign funded enterprises, being 14 and 7 respectively. For more details, see table 5-2.

In the 100 selected enterprises, there are 44 enterprises whose fixed assets were over 100 million Yuan, 21 enterprises whose fixed assets were between 50 million and 100 million Yuan, 30 enterprises whose fixed assets were between 10 million to 50 million Yuan, and 5 enterprises whose fixed assets were below 10 million Yuan (There are 5 enterprises didn’t report their fixed assets). For more details, see table 5-3.

Table 5-1 Basic Information of the Investigated Enterprises: Numbers in Different Area

Area	Food & Beverage	Textile & Dyeing	Paper Making	Chemical & pharmaceutical	Total
Nanjing	2	2	0	5	9
Wuxi	3	6	1	5	15

Xuzhou	3	0	4	3	10
Changzhou	1	7	0	1	9
Suzhou	1	11	3	6	21
Nantong	0	2	0	3	5
Lianyungang	2	0	0	1	3
Huaiyin	0	0	1	0	1
Yancheng	0	0	2	4	6
Yangzhou	0	1	0	3	4
Zhenjiang	1	0	3	5	9
Taizhou	0	2	1	2	5
Suqian	3	0	0	0	3
The Province	16	31	15	38	100

Table 5-2 Basic Information of the Investigated Enterprises:

Numbers with Different Economical Type

Economical Type	Food & Beverage	Textile & Dyeing	Paper Making	Chemical & Pharmaceutical	Total
State Owned	7	11	2	11	31
Collective	1	5	4	4	14
Joint stock	1	0	2	3	6
Joint operated	0	1	0	1	2
Limited Co.	0	6	0	5	11
Stock Co., Ltd.	1	3	0	7	11
Private	0	1	1	1	3
Joint Venture with H, M and T	1	1	0	2	4
Cooperative Operation with H, M and T	0	0	0	0	0
Ventures Exclusively by H, M and T	0	0	0	0	0
Stock Co., Ltd. invested by H, M, and T	1	0	0	0	1
Joint Venture with foreign investment	2	1	5	2	10
Cooperative Operation with F	0	0	0	1	1
Ventures Exclusively by F	0	2	1	1	4

Stock Co., Ltd. invested by F	2	0	0	0	2

*H: Hong Kong, M: Macao, T: Taiwan, F: Foreign.

Table 5-3 Basic Information of the Investigated Enterprises: Numbers with different Scales

Scale (10^4 Yuan)		Food & Beverage	Textile & Dyeing	Paper Making	Chemical & Pharmaceutical	Total
Fixed Assets At Cost	>10000	9	11	7	17	44
	5000-10000	3	12	0	6	21
	1000-5000	4	7	7	12	30
	<1000	0	1	1	3	5
Industrial Production Value	>10000	10	20	10	19	53
	5000-10000	2	4	1	11	18
	1000-5000	3	6	3	8	20
	<1000	1	1	1	0	3
Pre-tax Profit*	>10000	2	0	1	2	5
	5000-10000	1	1	0	3	5
	1000-5000	7	9	5	5	25
	<1000	4	20	7	28	65

* 5 enterprises didn't report.

5.2 Raisons for choosing these enterprises

The consigner of this investigation has appointed the 4 industries and the number of enterprises to be investigated. A special list of the 100 selected enterprises was made by obeying the following rule:

(1) Industrial distribution of the selected enterprises should accord with that of the whole province. According to the data provided by Jiangsu Statistical Bureau, the numbers of enterprises in beverage, textile (dyeing), paper making, and chemical & Pharmaceutical industry occupied 20%, 34%, 6% and 40% respectively of the total number of enterprises in these 4 industries in the whole province. So when confirming the list, the distribution factor was taken into consideration. At the same time, we also considered the fact enterprises in food and beverage industry was large in number but small in scale as well as the suggestion by designer that the number of enterprises in paper making should be added. In the final, we selected the 100 enterprises, and their distribution was: 16 in food industry, 31 in dyeing industry, 15 in paper making industry, and 38 in chemical & Pharmaceutical industry.

(2) Enterprise's scale, ownership structure, and geographical distribution were also taken into our consideration. As to geographical distribution, predominant industries in some areas were given a priority. For example, textile & dyeing industry was very prosperous in Suzhou and Changzhou, so that we arranged more

investigation on this industry in these two areas.

To see the list of the selected enterprises, please refer to the Figure 1 in annex.

6. Analysis on the wastewater treatment facilities situation in the four industries

6.1 General Description

The 100 selected enterprises all owned wastewater treatment facilities and installed at a rate of 100%. Wastewater treatment degrees in the 4 industries were different. For food & beverage or dyeing industry, all enterprises were at Level II; for paper making industry, 1 was at Level I and 14 were at Level II, occupying 7% and 93% of the total enterprises in this industry, respectively; for chemical & Pharmaceutical industry, 1 was at Level I, 35 at Level II, and 2 at Level III, occupying 2.6%, 92%, and 5.4% of the total enterprises in this industry. We know form the above that water treatment degree in the four industries were mainly at Level II. As to equipment automation level, the rations of automated, semi-automated and non-automated equipments were 6: 81: 12.5 in food & beverage industry, 3:55:42 in dyeing industry, 13:47:40 in paper making industry and 3:71:26 in chemical & Pharmaceutical industry. For more details, see table 6-1.

Table 6-1 Installations of Wastewater Treatment Facilities in Investigated Enterprises

Number of Enterprises		Food & Beverage	Textile & Dyeing	Paper Making	Chemical & Pharmaceutical	Total
In this industry		16	31	15	38	100
With wastewater treatment facilities		16	31	15	38	100
Installed Rate（%）		100	100	100	100	100
Treatment Degree	Treatment at Level I	0	0	1	1	2
	Treatment at Level II	16	31	14	35	96
	Treatment at Level II	0	0	0	2	2
Automation Degree	With automated equipments	1	1	2	1	5
	With semi-automated equipments	13	17	7	27	64
	With non-automated equipments	2	13	6	10	31

6.2 Investments on industrial wastewater treatment facilities

The investigated enterprises totally invested 1.216 billion Yuan on wastewater treatment facilities. Total daily treatment capability of these facilities was 560.2 thousand tons, among which:

In food & beverage industry, the total investment was 136.033 million Yuan; the treatment capability of the facilities was 43.8 thousand tons; initial investment was 3103 Yuan/ton.day;

In dyeing industry, the total investment was 182.175 million Yuan; the treatment capability of the facilities was 135.1 thousand tons; initial investment was 1348 Yuan/ton.day;

In paper making industry, the total investment was 716.633 million Yuan; the treatment capability of the facilities was 271.2 thousand tons; initial investment was 2642 Yuan/ton.day;

In chemical & Pharmaceutical industry, the total investment was 180.739 million Yuan; the treatment capability of the facilities was 110.06 thousand tons; initial investment was 2170 Yuan/ton.day;

From above analysis, we can conclude that initial investment on wastewater treatment facilities in food & beverage industry is the highest one, then that of the paper making, chemical & Pharmaceutical, and dyeing industry. Main reason for this result is that investigated enterprises in food & beverage industry were mainly brewage enterprises. In the wastewater discharged by these enterprises, COD concentration was very high. So these enterprises, especially alcohol producer, need installed expensive anaerobic equipments. Another reason is that wastewater treatment technologies in these enterprises included biogas and dross recovery technique. This also added the cost on equipments. For more details, see Table 6-2

Table 6-2 Initial Investment of Wastewater Treatment Facilities in Investigated Enterprises: I

Industry Item	Food & Beverage	Textile & Dyeing	Paper Making	Chemical & Pharmaceutical	Total
Treatment Capability（t/a）	43800	13510	271200	110060	560160
Facilities Cost（10000 Yuan）	13603.3	18217.5	71663.3	18073.9	121558
Initial Investment	3103	1348	2642	2170	2170

The capital source of those investments all came from self-financing. For details, see Table 6-3.

Table 6-3 Initial Investment of Wastewater Treatment Facilities in Investigated Enterprises: II

Industry		Capital source of the investment on wastewater treatment facilities							
		EP investment in basic construction	EP investment in planned projects	Subsidies	Loan	Foreign Investment	Self-Financing	Others	Total
Chemical & Pharmaceutical	10^4 Yuan	2365.32	752.63	2221.22	1173.58	608.13	10738.04	215	18073.92
	%	13.09	4.16	12.29	6.49	3.36	59.41	1.19	100
Textile & Dyeing	10^4 Yuan	289.4	102.4	1257.88	692.6	2322	13487.6	65.54	18217.5
	%	1.59	0.56	6.90	3.80	12.75	74.04	0.36	100
Paper Making	10^4 Yuan	460	184	614.84	1254.5	15745.5	53404.4	0	7163.3
	%	0.64	0.26	0.86	1.75	21.97	74.52	0	100
Food & Beverage	10^4 Yuan	518	248.66	797.96	383	0	11655.6	0	13603.3
	%	3.81	1.83	5.87	2.82	0	85.68	0	100
Total	10^4 Yuan	3632.72	1287.69	4891.9	3503.68	18675.6	89285.8	280.54	121558.
	%	2.99	1.06	4.02	2.88	15.36	73.45	0.23	100

6.3 Sources of Wastewater Treatment Facilities

Sources of wastewater treatment facilities in investigated enterprises are: in food & beverage industry, percentage of all domestically produced equipment was 75%, and percentage of partly or all imported equipment (including those form Taiwan and Hong Kong) was 25%; in dyeing industry, percentage of all domestically produced equipment was 90%, and percentage of partly or all imported equipment was 10%; in paper making industry, percentage of all domestically produced equipment was 67%, and percentage of partly or all imported equipment was 33%; and in chemical & Pharmaceutical industry, percentages of all domestically produced equipment was 75%, and percentage of partly or all imported equipment (including those form Taiwan and Hong Kong) was 25%. For more details, see table 6-4.

Table 6-4 Sources of Wastewater Treatment Facilities in Investigated Enterprises

Source	Food & Beverage		Textile & Dyeing		Paper Making		Chemical & Pharmaceutical	
	Number of Enterprises	%	Number of Enterprises	%	Number of Enterprises	%	Number of Enterprises	%
Domestically Produced	12	75	28	90	10	7	3	7
Imported	4	25	10	0	5	3	1	3

6.4 Operation and Problems of Wastewater Treatment Facilities in Investigated Enterprises

According to the data of this investigation, up-to-standard rate of wastewater treatment was 100% in food & beverage industry, and cost for charging 1 ton wastewater was 1.8 Yuan. Existed problems are high operation cost, huge energy consumption, and trouble in maintenance and management, if listed by importance.

In dyeing industry, up-to-standard rate of wastewater treatment was 91.81%, and cost for charging 1 ton wastewater was 2.03 Yuan. Existed problems are high operation cost, huge energy consumption, and instable operation if listed by importance.

In dyeing industry, up-to-standard rate of wastewater treatment was 91.81%, and cost for charging 1 ton wastewater was 0.89 Yuan. Existed problems are high operation cost, huge energy consumption, and instable operation if listed by importance.

In chemical & Pharmaceutical industry, up-to-standard rate of wastewater treatment was 87.42%, and cost for charging 1 ton wastewater was 1.95 Yuan. Existed problems are high also operation cost, huge energy

consumption, and instable operation if listed by importance. For more details, see table 6-5 and 6-6.

Table 6-5 Operations of Wastewater Facilities in Investigated Enterprises

Item		Food & Beverage	Textile & Dyeing	Paper Making	Chemical Pharmaceutical
Volume of Wastewater Discharge Treated (10^4 tons)		705.26	2521.08	6048.97	2892.44
Volume of Wastewater up to the Discharge Standards (10^4 tons)		705.21	2314.56	5717.48	2528.65
Up-to-Standard Rate of Industrial Wastewater Treatment (%)		100	91.81	94.52	87.42
Operation Cost	Total Cost (10^4 Yuan)	1277.94	4329.28	5406.5	5631.68
	Unit Cost (Yuan)	1.8	1.7	0.89	1.95

Table 6-6 Existed Problems in the Operation of Wastewater Treatment Facilities

Problems	Enterprises Number in Food & Beverage	Enterprises Number in Textile & Dyeing	Enterprises Number in Paper Making	Enterprises Number in Chemical Pharmaceutical	Enterprises Number in Total
High Operation Cost	9	20	13	30	72
Huge Energy Consumption	7	14	4	18	43
Poor Treatment Technologies	1	5	1	6	13
Frequent failure	0	1	0	0	1
Instable Operation	2	7	2	5	16
Poor Treatment Efficiency	2	3	2	4	11
Hard to operate	0	4	0	1	5
Trouble in Maintenance and Management	5	5	0	4	14
Unskillful operators	0	3	0	0	4