Part 5: Wastewater Management

THE STUDY ON INTEGRATED MANAGEMENT FOR ECOSYSTEM CONSERVATION OF THE ANZALI WETLAND

FINAL REPORT
Volume III Supporting Report

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CHAPTER 1 INTRODUCTION

1.1 General

The wastewater management plan is one of the components of the Master Plan Study on Integrated Management for Ecosystem Conservation of the Anzali Wetland in the Islamic Republic of Iran. Due to lack of suitable wastewater management, water pollution become one of serious problems in the Anzali Wetland. The objective of the wastewater management plan is to improve and maintain the water quality of the Anzali Wetland at a level acceptable for its ecosystem.

1.2 Scope of the Study

The study area is the entire basin of the Anzali Wetland. The scope of the study on the wastewater management includes the followings:

- To describe and understand the present condition of wastewater management in the study area
- To evaluate the amount of COD, T-N and T-P pollution load to Anzali Wetland at present, and to predict the pollution load amount in future, 2019
- To propose the projects in the wastewater management plan up to 2019
- To estimate the project cost and O&M cost of the project proposed in the wastewater management plan
- To prepare the implementation program for the wastewater management plan up to 2019

CHAPTER 2 PRESENT CONDITION OF WASTEWATER MANAGEMENT

2.1 Pollution Sources in the Basin

The wastewaters discharged to the wetland are generated in the basin of the wetland. The water environment in the wetland has been degraded by continuous wastewater inflow from human activities, such as domestic, industrial and agricultural activities. Major water pollution sources are the urban population (743,000 residents), rural population (395,000 residents), industrial factories, livestock (860,000 head), and farmland (99,000 ha). In addition, the natural environment such as forest/grassland (198,000 ha) also generate water pollution. The composition of water pollution sources are as shown below.

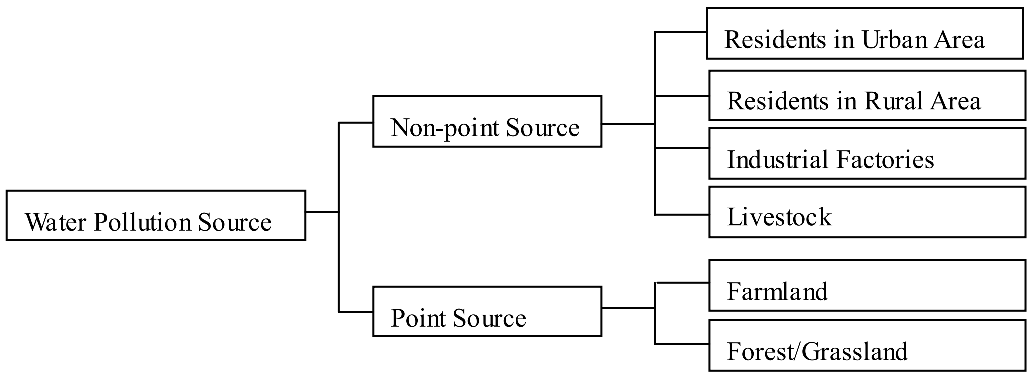


Figure 2.1.1 Type of Pollution Sources

Details of the pollution sources in the basin are described in Chapter 3.

2.2 Related Organizations and Regulations

2.2.1 Responsible Organizations for Wastewater Management

The various authorities such as DOE, MOJA, GWWC and RWWC take responsibility for management of the wastewater and pollution sources, and much effort has been put into their management. However, a large part of the wastewater is still discharged without any treatment, and no organization has taken the responsibility for overall management of wastewater in the basin of the wetland. Table 2.2.1 shows responsible organizations for management of each pollution source.

Table 2.2.1 Task of Organizations Responsible for Wastewater Management

Pollution Source	Task	Executing Organization
Urban Domestic Wastewater	1) New sewerage system development 2) Management of sewerage system	GWWC
Rural Domestic Wastewater	1) Development of rural wastewater treatment system	RWWC
Industrial Wastewater	1) Monitoring of Industrial Effluent 2) Permission for construction of industrial factories	DOE
	1) Development of industrial cites	MOIM
Livestock	1) Control of number of livestock in grazing land 2) Permission for engaging in of industrial animal husbandry.	MOJA DOE
Pollution from Farm Land	1) Control of agricultural chemical use 2) Control of chemical fertilizer use	MOJA

Source: JICA Study Team

2.2.2 Laws and Regulations related to Wastewater Management

The Regulation and Standard of Environment, 1999 describes the effluent standard. According to the standard, all of domestic and industrial wastewater shall be treated properly before discharging to surface water or absorption well. It will take so long time for all polluters to follow the standard. GWWC and RWWC have plans to increase the domestic wastewater treatment ratio, for which some projects have been carried out. DOE conducts control of industrial effluent even by using legal force. The effluent standard stipulates allowable concentrations of 52 water quality parameters in effluent. The major water quality items are as shown below. To follow the standard, Secondary Treatment Level is required.

Table 2.2.2 Summary of Effluent Standard

Item	Discharge to Surface Water	Discharge to Absorbent Well (Ground)	Using for Agriculture and Irrigation
BOD	30	30	100
COD	60	60	200
Ammonia (NH_4)	2.5	1	-
Nitrite (NO_2)	10	10	-
Nitrate (NO_3)	50	10	-
Total Phosphorous	6	6	-

Source: Regulation and Standard of Environment, 1999

(1) National Strategy for Wastewater Treatment

According to the National Strategy mentioned in the Draft Fourth 5 Years Development Plan prepared by DOE and the Coming 20 year Development Plan, the sewerage service ratio in urban area and the wastewater treatment ratios in rural area are planned to increase gradually as shown in Table 2.2.3.

Table 2.2.3 Target Wastewater Treatment Ration in Iran

Item	Present	Fourth 5 Years Development Plan	Coming 20 Years Development Plan
Sewerage Service Ratio in Urban Area	Almost 0%	20 %	60 %
Wastewater Treatment Ratio in Rural Area	Almost 0%	5 %	30 %
Industrial Wastewater Treatment	Not clear	Basically, all factories follow the effluent standard.	

Source: NWWEC, DOE

2.3 Domestic Wastewater Management in Urban Areas

2.3.1 Present Situation

GWWC is responsible for the management of domestic wastewater in the urban areas. At present about 762,000 people live in the urban areas of the basin and most of them are connected to the traditional drainage system. This system consists only of combined sewers for storm water and wastewater collection, without any treatment.

There are about 200 outlets from existing sewers along the rivers in Rasht, and about 100 outlets in Anzali. Effluent water quality from these outlets is completely out of compliance with the effluent standard, because of the lack of any treatment. Some parts of the urban area are not connected to the existing sewerage system. The households in these areas discharge wastewater directly to rivers, absorption wells, or surface drains along the streets. The traditional drainage system in Guilan Province is illustrated in Figure 2.3.1.

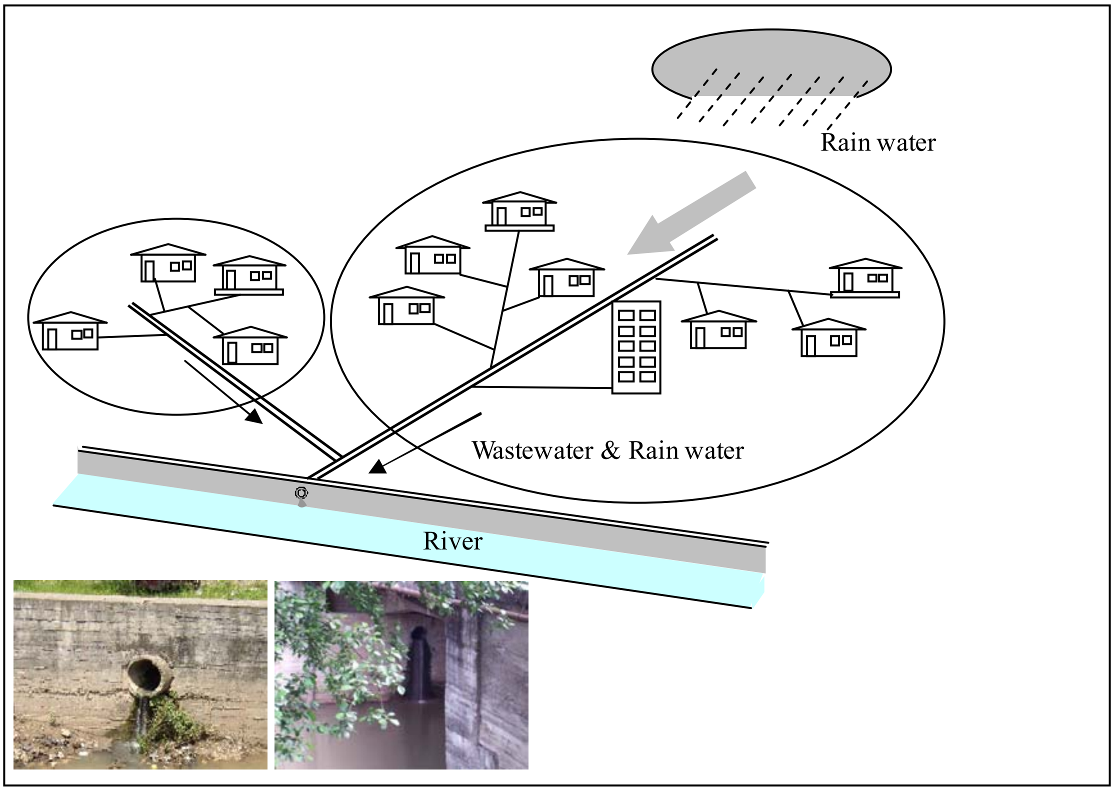
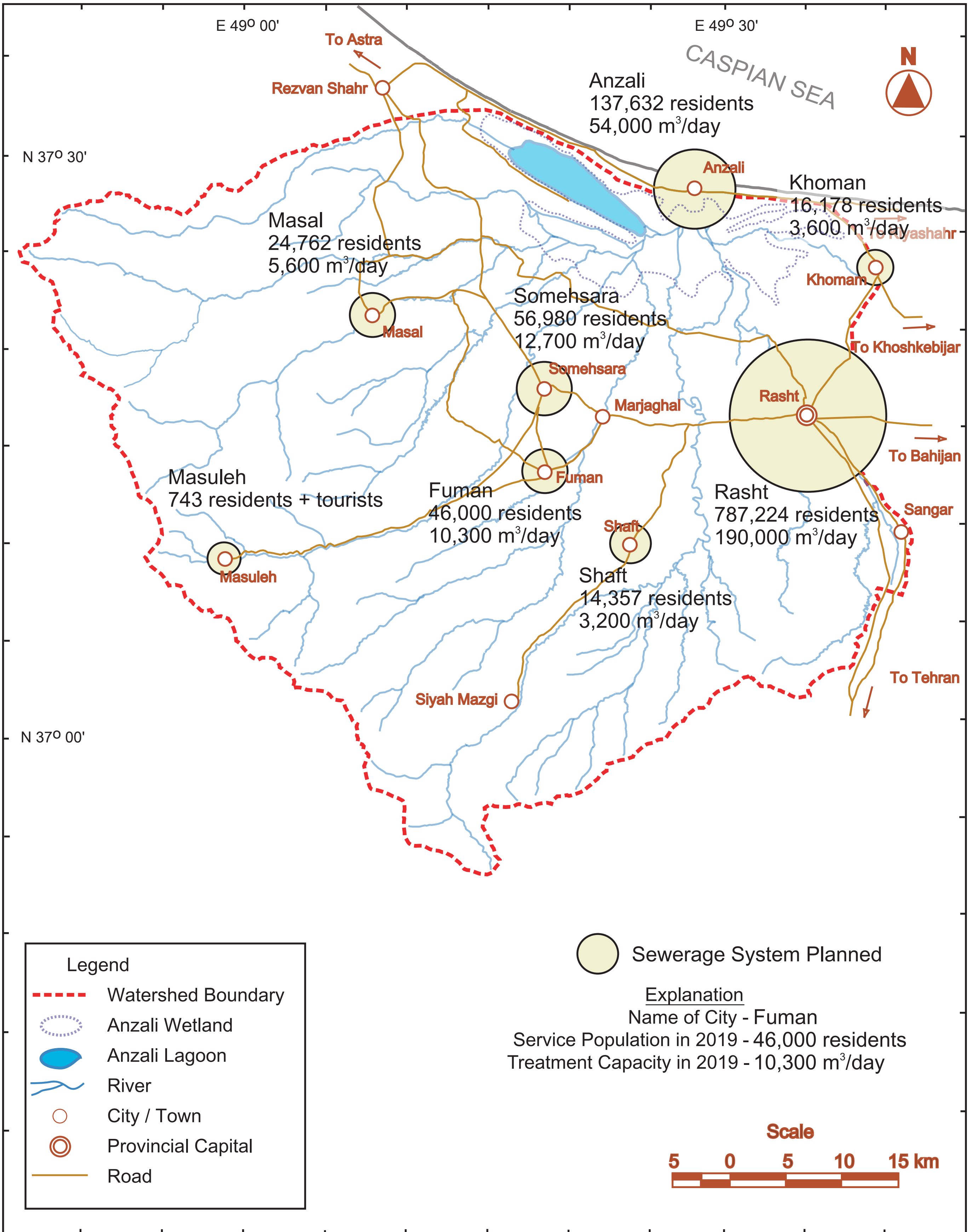


Figure 2.3.1 Traditional Drainage System

2.3.2 Sewerage Development Plan of NWWEC

GWWC has a general long-term goal to develop sewerage systems that meet the effluent standards in all urban areas. Figure 2.3.2 shows the location and the status of sewerage development projects in the cities for which GWWC is responsible. The construction of sewerage systems with secondary treatment (activated sludge process) in Rasht, Anzali and Somehsara has already commenced. Figure 2.3.2 shows location of the planned sewerage area and service populations. Figure 2.3.3 shows situation of the on-going construction works.



The Study on Integrated Management for Ecosystem Conservation of the Anzali Wetland in the Islamic Republic of Iran

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Figure 2.3.2
Populations and Capacities of Sewarage Systems Planned by GWWC (2019)

Installation of Sewer Pipe

Sewer Pipe

Manhole

Wastewater Treatment Plant (1)

Wastewater Treatment Plant (2)

Pump Station

Figure 2.3.3 Construction Site for Sewerage System

The service population and the project cost for the projects are described in Table 2.3.1.

Table 2.3.1 List of Planned Projects of Sewerage System Development

Basin	Sewerage Projects	Service Population	Project Cost (million Rial)	Progress
Eastern Part	Rasht (Phase 1)	253,816	478,880	Construction
	Rasht (Phase 2)	378,284	471,494	Basic Design
	Rasht (Phase 3)	93,600	285,874	Basic Design
	Anzali (Phase 1)	77,920	357,187	Construction
	Anzali (Phase 2)	51,000	101,130	Basic Design
	Anzali (Phase 3)	8,712	18,803	Basic Design
	Khomam	16,095	52,000	Basic Study
	Shaft	14,357	46,000	Basic Design
	Total	893,784	1,811,368	
Western Part	Somehsara	56,980	184,000	Construction
	Fuman	46,000	149,000	Basic Design
	Masal	24,762	80,000	Basic Study
	Total	127,742	413,000	

Source: JICA Study Team, based on Data from GWWC

The implementation of sewerage projects depends upon national investment managed by MPO. Although the projects are actually going on, the financial sources of the sewerage system development have not been clear. MPO is still negotiating loan arrangements for implementation of Rasht and Anzali sewerage projects with the World Bank. According to

GWWC official, the implementation schedule for sewerage development in the basin has been tentatively established as follows:

Table 2.3.2 Tentative Implementation Schedule for Sewerage Development

Cities	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
Rasht(Phase1)	—	—	—	—	—										
Rasht(Phase2)						—	—	—	—	—					
Rasht(Phase3)											—	—	—	—	—
Shaft											—	—	—	—	—
Somehsara	—	—	—	—	—	—	—	—	—						
Fuman						—	—	—	—	—	—	—	—	—	—
Masal						—	—	—	—	—	—	—	—	—	—
Anzali (Phase1)	—	—	—	—	—										
Anzali (Phase2)						—	—	—	—	—					
Anzali (Phase3)											—	—	—	—	—
Khoman											—	—	—	—	—

Source: JICA Study Team

Figure 2.3.4 shows the sewerage service population forecast related to Table 2.3.2 tentative implementation schedule proposed by GWWC.

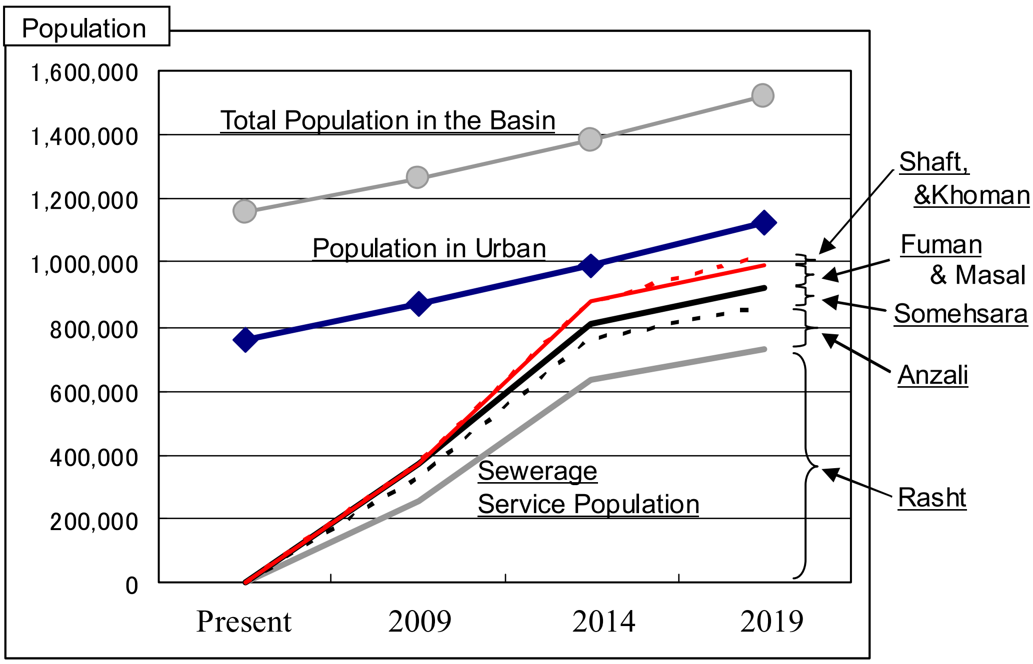

Figure 2.3.4 Forecast of Sewerage Service Population up to 2019

2.3.3 NWWEC Sewerage Development Plan

(1) Rasht

The Rasht sewerage development plan up to 2027 is described in “Rasht/Anzali Water Supply and Wastewater Collection and Disposal, March 2003” prepared by NWWEC. The sewerage development project in Rasht has already commenced, and the new sewerage system is planned to be completed in 2004. The progress of implementation of the project seems about one year behind schedule. It is assumed that planned project implementation up to 2019 will be delayed 2 years from the original schedule. The Rasht sewerage development plan up to 2019 is shown in Table 2.3.3. below.

Table 2.3.3 Sewerage Development Plan in Rasht City

Item	2004	2009	2014	2019
Project Phase		Phase 1	Phase 2	Phase 3
Population	520,741	597,667	685,979	787,224
Service Population * (Service Ratio)	0 (0%)	253,816 (42%)	632,100 (92%)	725,700 (92%)
Sewerage Volume (m^3/day)	-	59,269	151,641	178,341
Sewerage Volume per capita. (m^3/p/day)		233	240	246
Proposed Treatment Capacity (m^3/day)	65,000 under construction	80,000	160,000	190,000

(2) Anzali

The Anzali sewerage development plan up to 2027 is also described in "Rasht/Anzali Water Supply and Wastewater Collection and Disposal, March 2003" prepared by NWWEC. A part of the sewerage development project in Anzali has already commenced, and the new sewerage system is planned to be completed in 2004. The progress of implementation of the project seems to be about one year behind schedule. It is assumed that the planned project implementation up to 2019 will be delayed 2 years from the original schedule. The sewerage development plan for Anzali is shown in Table 2.3.4.

Table 2.3.4 Sewerage Development Plan in Anzali City

Item	2004	2009	2014	2019
Project Phase		Phase 1	Phase 2	Phase 3
Population	111,114	119,708	128,920	137,632
Western Part				
Service Population* (Service Ratio)	0 (0%)	44,113 (65%)	100,242 (100%)	112,531 (100%)
Sewerage Volume (m^3/day)	-	9,481	22,139	26,116
Sewerage Volume per capita.(m^3/p/day)	-	215	221	232
Proposed Treatment Capacity (m^3/day)	20,000 under constr uction	20,000	33,000	33,000
Eastern Part				
Service Population* (Service Ratio)	0 (0%)	33,808 (65%)	78,416 (100%)	89,706 (100%)
Sewerage Volume (m^3/day)	-	7,266	17,319	20,819
Sewerage Volume per capita. (m^3/p/day)	-	215	221	232
Proposed Treatment Capacity (m^3/day)	-	14,000	21,000	21,000

Note: Service Population includes number of tourists.

(3) Somehsara

Somehsara sewerage development plan up to 2021 has been prepared by NWWEC. Installation of the trunk main has just started. It is assumed that project implementation up to 2019 will be advanced 2 years from the original schedule. The development plan up to 2019 is presented in Table 2.3.5.

Table 2.3.5 Sewerage Development Plan in Somehsara City

Item	2004	2009	2014	2019
Population	40,417	49,145	59,621	72,449
Service Population (Service Ratio)	0 (0%)	43,230 (88%)	49,631 (83%)	56,980 (79%)
Sewerage Volume (m^3/day)	-	9,047		12,705

(4) Other Cities

Excluding the urban population of Rasht, Anzali and Somehsara, the remaining urban population of the basin is predicted to be about 129,546 in 2019, which is about 11% of the total urban population in the basin.

As shown in Table 2.3.1, NWWEC has started studies and planning on sewerage development for Fuman, Masal, Shaft and Khomam. The design works for Masal, Shaft and Khomam sewerage projects have not yet commenced. The basic design for the Fuman sewerage system has been completed.

2.4 Domestic Wastewater Management in Rural Areas

2.4.1 Present Situation

About 394,000 people live in the rural areas. The Rural Water and Wastewater Company, Guilan (RWWC) is responsible for water supply and domestic wastewater management in the rural areas of Guilan. However, RWWC has not conducted any work on wastewater treatment, except for the planning of wastewater treatment systems, because of financial constraints. Most of the houses in rural areas have absorption wells, into which wastewater is discharged directly. These wells, which are constructed by the residents themselves, are the traditional wastewater treatment facilities in Iran. Domestic wastewater in the absorption tank infiltrates the surrounding ground as shown in Figure 2.4.1

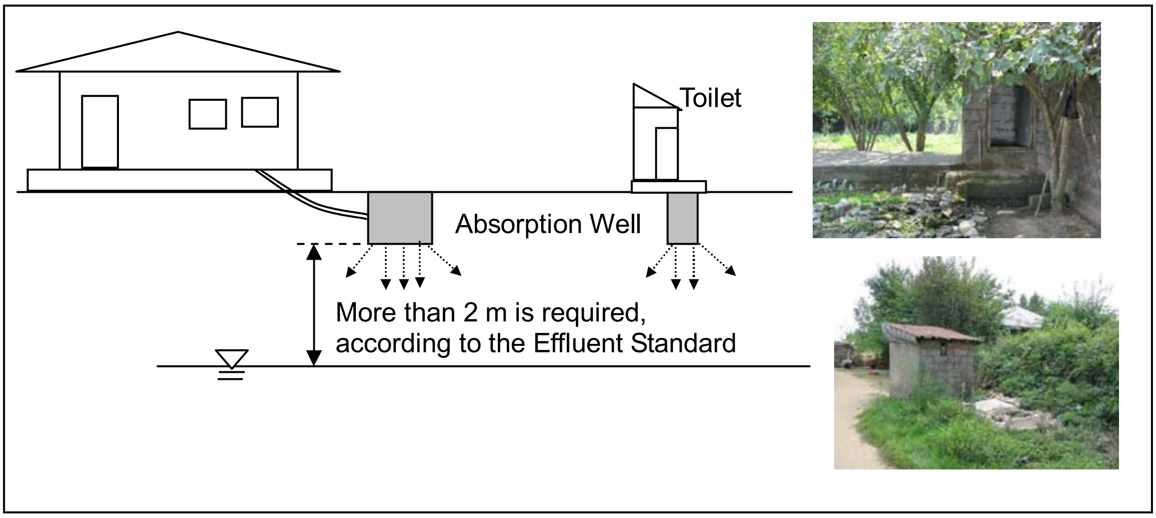

Figure 2.4.1 Absorption Tank in Rural Area

According to the effluent standard, wastewater discharged into absorption well should be treated to secondary treatment level. However, the wells usually receive wastewater directly from households without any treatment. In order to protect groundwater quality, the standard mentions that installation of an absorption tank is forbidden where the bottom of the tank is to be set less than 2 m above groundwater level. In a large part of Guilan, the groundwater level is generally high, especially in the winter season. In areas with high groundwater, absorption wells work poorly, because wastewater cannot be infiltrated to the ground, and it will overflow to the surface.

2.4.2 Development Plan for Community Wastewater Treatment System proposed by RWWC

According to RWWC, Guilan, the target of wastewater management in the rural areas up to 2022 is to provide wastewater treatment systems consisting of "septic tanks & a secondary treatment process" for 40% of villages that have more than 20 families. The main purpose of improvement of the rural wastewater treatment is to improve sanitary conditions for residents and it will also contribute to the reduction of pollution load on the wetland. This system will enable low-cost treatment of wastewater from rural communities, along with ease of operation.

RWWC has prepared detailed designs for rural wastewater treatment systems for sixteen villages, which include seven villages in the Anzali Wetland basin, Atashgah, Kheshtnasjed, Gasht, Loleman, Norgeston, Sheikhneshin and Aliabad. The service population in the seven villages is planned for 18,325 residents. These projects were planned to be implemented for the Third Five-Year Plan (2000-2004), but the construction works has not been commenced because no budget for the projects has been prepared by the central government.

2.5 Management of Industrial Effluent

2.5.1 Present Situation

According to DOE, Guilan, the amount of industrial effluent from major industries in 2002 is estimated as below.

Table 2.5.1 Water Consumption and Wastewater Discharges from Industrial Factories

(Unit: m^3/day)

Item	Number of Factories	Water Consumption	Wastewater from human activity	Wastewater from Process
Textile	11	3,757	555	2,852
Foods	15	2,836	87	1,389
Electrical Products	3	1,270	123	605
Ceramics	6	673	127	256
Metals and Machines	5	478	107	297
Chemical	1	320	17	200
Total	41	9,334	1,016	5,599
				6,615

Source: DOE

Owners of the factories have the responsibility to treat industrial effluent to meet the effluent standard and DOE has the responsibility for monitoring the effluent from the factories. The industrial factories are located in various places. It is therefore difficult for DOE staff to carry out effective monitoring of the effluent from all of the industrial factories.

As shown in Table 2.5.1, the total amount of industrial effluent discharged in the basin is roughly estimated to be less than 7,000 m^3/day. This is estimated to be about 3% of the total wastewater discharge by volume. The pollution load to the wetland from industrial activities, therefore, does not seem to be serious with respect to organics and nutrients. However, the industries may be important sources of heavy metals and other toxic materials.

2.5.2 Industrial City Development Plan

There are five existing industrial cities and one planned, in the basin. The management of industrial cities is as described as below.

Table 2.5.2 Management of Industrial Cities in the Basin

Industrial City	Area	Operating Factories	Management
Rasht	420 ha	125	Managed by Semi Private Company
Shaft	38 ha	2	Managed by MOIM, New construction
Somehsara	100 ha	15	Managed by MOIM
Fuman	14 ha	--	Managed by MOJA
Masal	-------	-------	(Planning stage) To be managed by MOIM
Anzali	50 ha	34	Managed by MOIM, To be expanded up to 85 ha

Source: MOIM, Gilan

Such centralization of industrial factories in certain places is effective for control of the industrial effluent. The Ministry of Industries and Mining is trying to transfer existing large-scale industrial factories and new planned industrial factories to these industrial cities. At present there are no wastewater treatment systems in the industrial cities, except Anzali Industrial City, where a small-scale wastewater treatment system is under construction.

2.6 Management of Livestock Waste

About 862,000 livestock are living in the basin. The livestock include about 309,000 cows, 417,000 sheep, 120,000 goats, 17,000 water buffaloes and 47,000 horses and donkeys. The livestock are divided into the following three types of livestock.

(1) Livestock fed by Individual Farmers

Out of 268,000 head of cows and buffalo in the basin, about 200,000 head of them are fed by individual farmers in the plain area. Usually one family feed two to ten cows or buffalo near their house or on their farmland. The farmers use livestock waste as manure on their farmland. The effective usage of the fertilizer for the farmland is the only measure for control of pollution, and a large number of the farmers have already carried out the manure use.

(2) Livestock in Rangelands in Mountain Area

Out of about 537,000 head of sheep and goats in the basin, most of the sheep and goats stay in 441 km^2 of rangelands in the mountain area. Waste from the sheep and goats are spreading over a wide area, because they are moving from place to place. Large parts of the potential pollution load are decomposed in the soil, and only a small amount of pollution load is discharged to the rivers. Under the rangeland management program by NRGO, about 250,000 head of livestock in the rangeland are planned to be removed. This will contribute to reduction of pollution load to the wetland. Livestock waste in the rangelands in the mountain area is not a serious problem to the wetland because the rangelands are far from the wetland.

(3) Livestock in Rangelands near the Wetland

About 20,000 head of cows and buffalo are fed in rangeland near the wetland. Wastes from these livestock are spread in the rangeland, and may be discharged to the wetland in rainy season. It may be a serious pollution sources, because it is easy for the waste to reach the wetland.

(4) Livestock in Industrial Animal Husbandries

There are about 17 industrial animal husbandries in the basin, where more than 20 head of cows each are kept. Dung from the cows is used as fertilizer in the farmland or feed in fishponds. Liquid waste are discharged to absorption tanks or ponds, and are not treated properly. DOE proposed that industrial animal husbandries to have suitable waste treatment facilities to meet the effluent standard.

Before authorizing construction of a new animal husbandry building, DOE should evaluate whether it will have a suitable waste management system in the building. For the waste management, the building is required to have a storage facility for livestock manure, and a wastewater treatment facility. However, there is no standard design for the waste management system for animal husbandry at present.

2.7 Management of Pollution from Farmland

In the Anzali Wetland basin, there are 98,700 ha of farmlands, which consist of 81,200 ha of paddy fields and 17,500 ha of other farmlands. A portion of the fertilizers, pesticides and manure used in the farmland is discharged into the wetland as a pollution load.

MOJA has an important role in guiding farmers on the control of pollution from agricultural activities. For the control of consumption of fertilizers, pesticides and herbicides, MOJA gives advice to farmers through the Agricultural Service Centers and Township Cooperative Offices as shown in Figure 2.7.1.

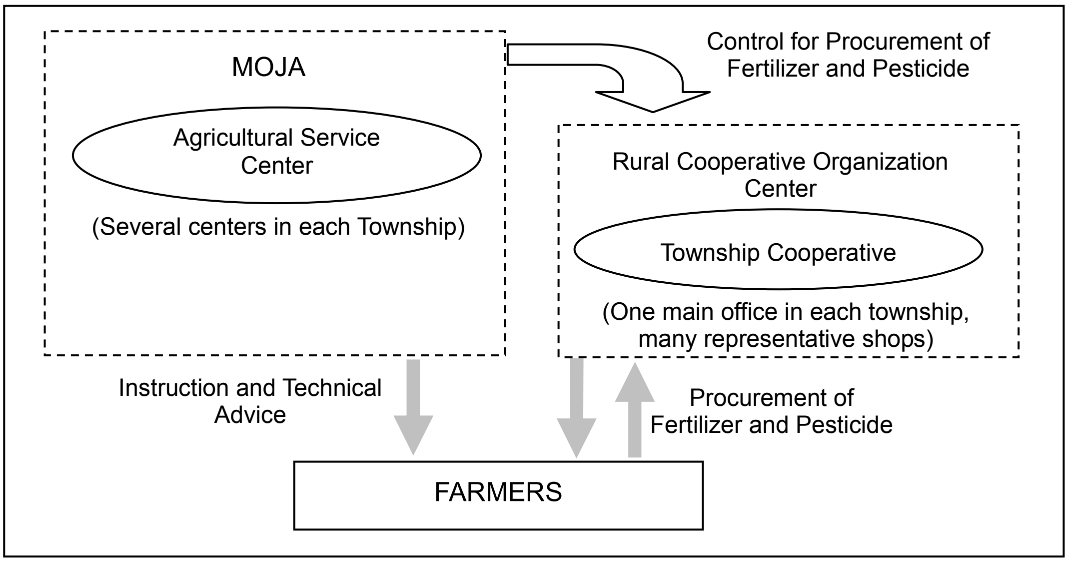

Figure 2.7.1 Organization for Control of Consumption of Fertilizer and Pesticide

(1) Chemical Fertilizers

On average, 75 kg of nitrogen, 4 kg of phosphorous and 26 kg of potassium were applied for one hectare of paddy fields in 2002 based on the data given by MOJA. The dosages for nitrogen and phosphorous are more or less equal with those recommended by MOJA, while that for potassium is significantly lower than the MOJA's recommendation[1]. The yield of rice has increased owing to stable application of fertilizer and improvement of rice varieties. At present, fertilizers are subsidized by the Government and provided to farmers through cooperatives. It is speculated that large quantities of fertilizers could be applied by farmers unless the agricultural extension work of MOJA functioned well.

[1] Recommended dosage per hectare for traditional rice is 55 kg of Nitrogen (N), 0 kg of Phosphate (P) and 60 kg of Potassium (K), while the recommendation for the improved variety is 83 kg (N), 0 kg (P), and 120 kg (K).

The soil laboratory of MOJA conducts soil analyses every year to determine the optimal dosage of fertilizers based on the soil analysis and give farmers recommendations on appropriate dosage to reduce the quantities applied. Through these activities, MOJA has been successfully in reducing average phosphorous consumption, from 36 kg/ha/year in 1992 to 4 kg/ha/year in 2002.as shown in Table 2.7.1.

Table 2.7.1 Chemical Fertilizer Use in the Paddy Field, 2002

(Unit: kg/ha)

Year	Average of Nitrogen	Average of Phosphate	Average of Potassium
1992	148	121	30
1999	149	36	59
2000	148	39	26
2001	135	13	66
2002	164	13	51

Source: Watershed Management Deputy in Guilan, MOJA

(2) Agricultural Chemical (Pesticide and Herbicide)

The kinds and the amount of the main agricultural chemicals used for rice farming in the study area are summarized in the following table. On average, 4.5 kg/ha of pesticide, 0.1 lit/ha of fungicide and 2.5 kg/ha of herbicide are used per cropping.

Table 2.7.2 Main Agricultural Chemicals Use in the Paddy Field, 2002

Township	Cultivated area (ha)	Insecticide			Fungicide		Herbicide
		Diazinon (kg)	Rident (kg)	Padan (kg)	Hinozan (liter)	Beem (kg)	(kg)
Anzali	4,200	10,000	10,450	2,200	450	50	10,500
Rasht *	15,500	67,500	20,000	17,500	1,875	500	38,750
Shaft	14,330	10,409	29,650	-	1,000	1,000	35,800
Fuman	13,870	38,325	3,825	12,150	500	500	34,400
Somehsara	27,150	86,369	29,004	12,430	1,500	1,500	67,800
Masal	6,150	15,000	2,000	-	300	500	15,300
Total	81,200	227,603	94,929	44,280	5,625	4,050	202,550

Source: Horticulture and Agriculture Organization in Guilan, MOJA (Data of Chemical Consumption), JICA Study Team, based on the data from Statistic Data Book in Gilan Province, 1997 (Data of farmland area)

Note: The value shown in the cell "Rasht" is chemical consumption in the part of Rasht, which is in the basin of the wetland. It is assumed that 25 % of chemical amount in Rasht is used in the basin of the wetland.

The agricultural minister mandated a reduction in the quantity of agricultural chemical use in 1994. Accordingly, MOJA has instructed farmers through cooperatives to reduce the frequency of chemical application and implemented the IPM (Integrated Pest Management) program to enable farmers to minimize their chemical use. In fact, the consumption of chemicals has decreased to one third of the previous levels over the last decade at the national level.

Biological control, which is an insect control technology that uses the natural enemy of insects, such as the egg parasitism bee, was introduced about 20 years ago in the country. MOJA has also promoted biological control since 1994 when the minister directed curtailment of agricultural chemicals. Through the efforts of MOJA, it has been spreading quickly in recent years and produced a certain effect to reduce agricultural chemical use.

Table 2.7.3 Chemical Control and Biological Control, 2002

Township	Farmland (ha)	Biological Control (ha)
Anzali	5,186	390
Rasht *	16,557	4,650
Shaft	14,677	3,565
Fuman	34,478	3,371
Somehsara	14,440	5,434
Masal	6,751	2,500
Total	141,759	19,910

Source: JICA Study Team, based on the data from Statistic Data Book in Gilan Province, 1997 (Data for Farmland Area), Horticulture and Agriculture Organization in Guilan, MOJA (Data of Biological Control Area)

Notes: The cell "Rasht" shows the values in the part of Rasht, which is in the basin of the wetland. The area of Rasht in the basin is assumed 25 % of overall Rasht.

CHAPTER 3 WATER POLLUTION LOAD TO ANZALI WETLAND

3.1 Introduction

3.1.1 Water Degradation in Anzali Wetland

It is generally believed that large pollution loads impact upon the ecosystem of Anzali Wetland. Certain phenomena in the wetland are reported, such as excessive growth of *Azolla* and *Phragmites*, and anaerobic conditions in the bed of the wetland. These phenomena may be related to the inflow of excessive amounts of COD, T-N and T-P. The mechanism of water quality degradation in the wetland is shown in Figure 3.1.1.

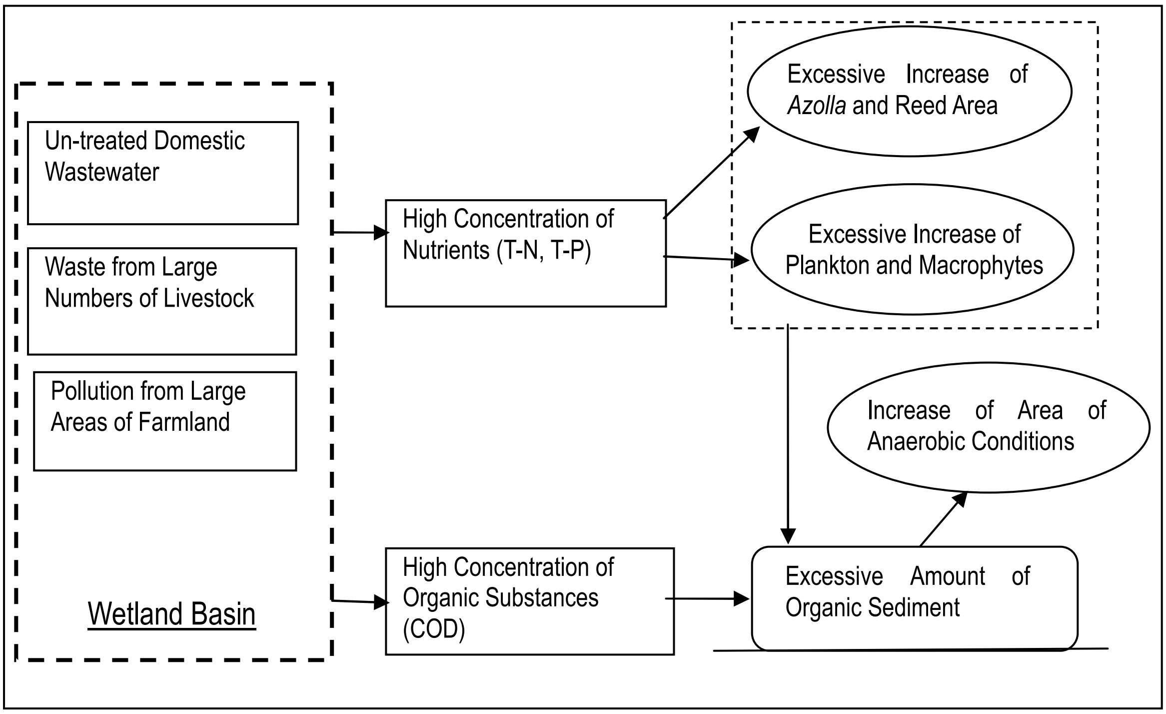

Figure 3.1.1 Mechanisms of Water Quality Deterioration and Ecosystem Degradation

(1) Cause of High Concentration of Nutrient

Comparing the concentrations of nutrients (T-N and T-P) with several eutrophication criteria, it can be said that water quality in Anzali Wetland is between the upper limit of the mesotrophic condition and the eutrophic condition. One of the potential problems associated with eutrophic conditions is the excessive growth of specific plankton and/or macrophytes. The recent spreading of *Azolla* and the luxuriant growth of reeds may be related to the eutrophication of the water.

(2) Causes of High Concentration of Organic Pollution

COD is an indicator of organic pollution, which is caused by the inflow of organic pollutants, and results in the excessive growth of plants. The US EPA water quality guidelines, indicates highly eutrophic conditions, or in this case, high organic pollution, with more than 30 mg/L of COD. As the organic pollution progresses, the level of dissolved oxygen generally decreases, and anaerobic conditions in the bottom water are reported in Siakisim, Anzali Port and downstream of Pirbazar River.

3.1.2 Water Quality in Anzali Wetland

(1) COD, T-N and T-P

Water quality surveys conducted in the wetland three times between September and December, 2003, indicate the distribution of COD, T-N and T-P concentrations shown in Figure 3.1.2.

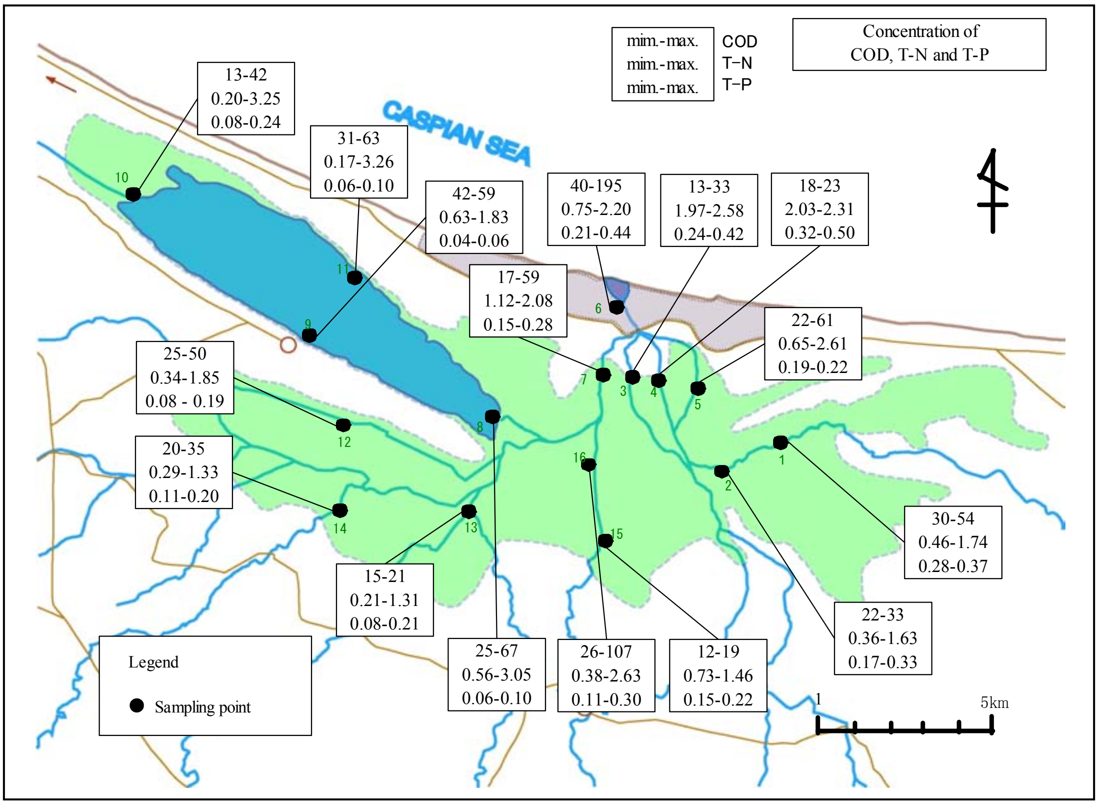

Figure 3.1.2 COD, T-N and T-P Concentrations (mg/l) in Wetland Water

High values of COD, T-N and T-P were recorded especially in eastern part of the wetland, although the recorded values differ from point to point.

(a) Organic Pollution

Table 3.1.1 shows the distribution of COD concentrations in the wetland, and US EPA eutrophication criteria for comparison. According to the criteria, most of the wetland except for Siahkesim can be classified as highly polluted water.

Table 3.1.1 Distribution of COD Concentrations in the Wetland

(Unit: mg/L)

Area	Eastern part of wetland	Central Part of wetland	Environs of Anzali city	Siahkeshim	Lagoon area	Average
Average	37	39	43	27	44	38
Range	22 - 61	12 - 107	13 - 195	15 - 50	13 - 67	12.9 – 67.2
Criteria of Eutrophic Condition (US EPA)	High: COD >30 mg/L, Moderate: COD 20 -30 mg/L Slight: COD 10 – 20 mg/L, Minimal: COD <10 mg/L					

Source: JICA Study Team

High COD values are recorded in the eastern part and in the environs of Anzali city, which have the highest recorded COD concentrations. According to DOE officials, there is an anaerobic zone at the bottom of Siahkesim, although the average recorded COD is relatively low.

(b) Nutrients

Table 3.1.2 shows the distribution of T-P concentrations in the wetland, and three international eutrophication criteria for comparison.

Table 3.1.2 Total Phosphate Concentrations in Wetland Water

(Unit: mg/L)

Area		Eastern part of wetland	Central Part of wetland	Environs of Anzali city	Siahkeshim	Lagoon area	Average
Average		0.28	0.20	0.32	0.17	0.09	0.20
Range		0.17 –0.42	0.11 – 0.30	0.15 – 0.50	0.08 – 0.29	0.04 – 0.24	0.04 – 0.50
Criteria of Eutrophic Condition	Vollenweider	0.03 – 0.1 mg/L					
	US EPA	> 0.02 mg/L					
	OECD[1]	0.035 – 0.1 mg/L					

Source: JICA Study Team

The environs of Anzali city are recorded as having the highest T-P values. The T-P concentrations in the western part are also high, whilst the values in Siahkesim and the Lagoon are recorded as being relatively low.

[1] Fixed Boundary System, OECD Trophic Terminology and Prediction, see http://lakes.chebuoto.org/TPMODELS/OECD/trophic.htm

(2) Heavy Metal and Other Toxic Materials

(a) Heavy Metals in Sediment

There is no significant difference in the concentrations of heavy metals in the sediments of the wetland and of the rivers, and those values are less than the international standards shown in Table 3.1.3. This means that there is not a heavy metal pollution problem in the wetland.

Table 3.1.3 Analytical Result of Heavy Metals in Sediment

(Unit: mg/kg)

Area	Cd	Pb	Cr^{6+}	As	Cu	Zn
Wetland	n.d. - 0.2	n.d. - 50.9	4.3. - 40.6	0.002 – 0.102	18.8 - 86.4	31.9 - 221.5
River	n.d. - 0.2	11.2 - 43.4	3.2. - 39.0	0.012 – 0.257	36.4 - 63.8	49.3 - 144.8
Canadian Criteria for aquatic life*	3.5	913.0	90.0	17.0	197.0	315.0

Source: JICA Study Team

Note: Probable Effect Level, Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, 1999

(b) Pesticide and Herbicide

Pesticides and herbicides, such as diazinon and paraquat, are widely used in the basin, though little is known about their environmental impacts. Apparently birds and fish are quite susceptible to diazinon[2], while the concentrations of diazinon at 16 points in the wetland were recorded as between 14 and 143 μg/L in the water quality survey of September, 2003. Paraquat is moderately toxic to birds and fish[3], and the concentration of paraquat was recorded as between 18 and 199 μg/L at the same points and time. The field survey results must therefore be suspect. It is not clear whether this is due to point sources of pollution or other reasons, such as analytical and reporting errors. Evaluation of the pesticide and herbicide results is still on-going. Meanwhile, a detailed monitoring of agricultural chemical use and environmental concentrations of such chemicals, both with chemical analysis of biological assay, should be established.

[2] Reported LD50 (lethal doze) of diazinon for birds rages of 2.8-41 mg/kg, and the reported LC50 (lethal concentration in water) for fish are 80-3,200 μg/L for rainbow trout, 52 μg/L for bluegill, 30 μg/L for loach (EXTOXNET, 1996; Kyoto Univ., 1997).

[3] Reported LD50 of paraquat for birds is 970-981 mg/kg (bobwhite, Japanese quail), and the LC50 for trout is 13-32 mg/L (EXTOXNET, 1996).

3.2 Situation of Pollution Sources in the basin

3.2.1 Pollution Load Discharged into Anzali Wetland

(1) Water Flows in Anzali Wetland

Pollution from the basin are discharged into the wetland through the nine rivers and drains. For the study on pollution load analysis, the basin of the wetland was divided into the five sub-basins shown in Figure 3.2.1. The mechanism of water flow in the wetland is considered to be as shown in Figure 3.2.2. This shows that the pollution load comes from five different sub-basins, and that Anzali Wetland can be divided into five areas. The present condition of pollution sources in each sub-basin is summarized below.

Table 3.2.1 Sub-basins in the Study Area

Sub-Basins	Condition of Sub-Basins
Sub-Basin A	Rasht, the biggest city in the basin, is located in this sub-basin, and most of the industrial factories are also located in this sub-basin. The river water is discharged to the Caspian Sea through the eastern part of the wetland. It does not go through Siahkeshim or the lagoon in the wetland.
Sub-Basin B	Population in this sub-basin is relatively low. This river water is also discharged to the Caspian Sea through the eastern part of the wetland. It does not go through Siahkeshim or the Lagoon.
Sub-Basin C	Fuman and Sumehsara, major cities in the basin, are located in this sub-basin. The river water is discharged to the Caspian Sea through eastern side of Siahkeshim and the Lagoon.
Sub-Basin D	Population in the sub-basin is relatively low. The river water is discharged to Siahkeshim.
Sub-Basin E	Wastewater generated in Anzali city is discharged into the wetland or the Caspian Sea through drains.

Source: JICA Study Team

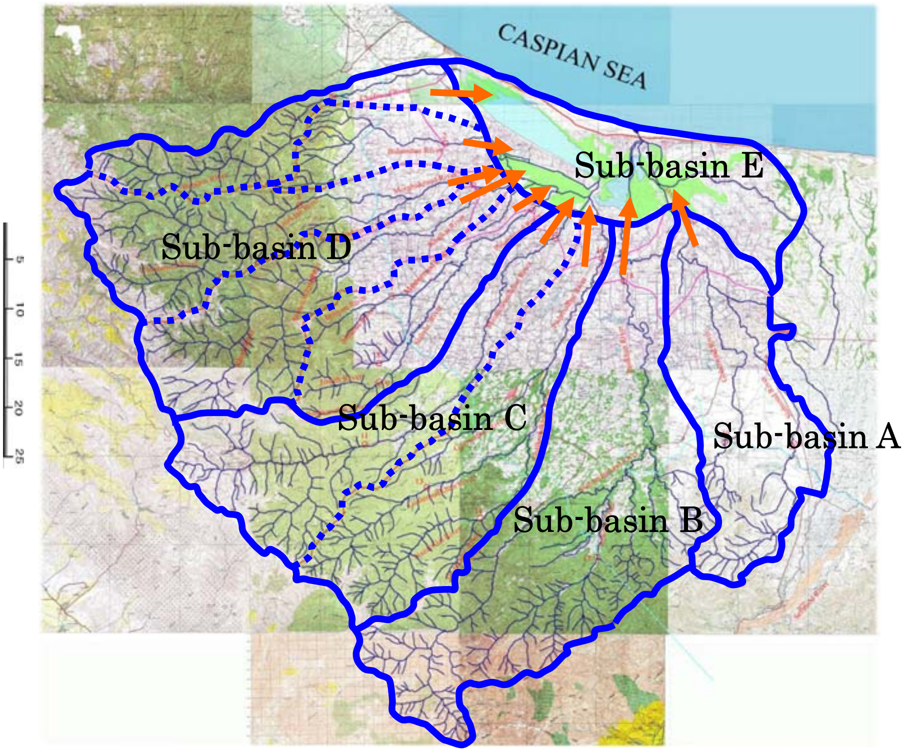

Figure 3.2.1 Sub-Basins in the Study Area

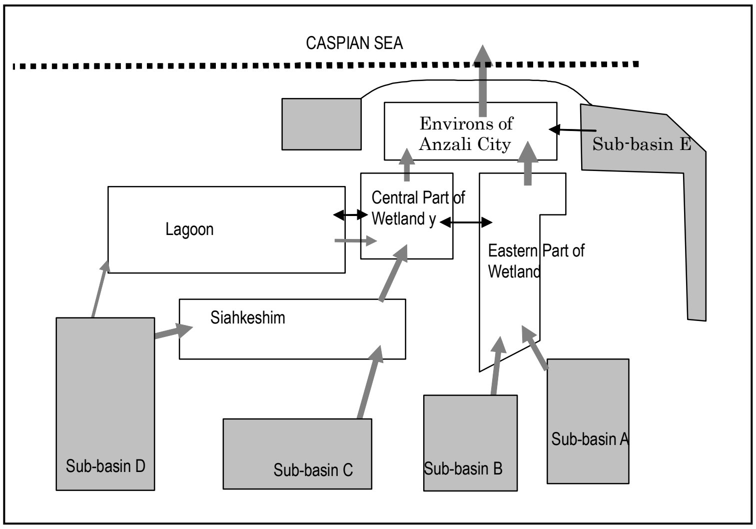

Figure 3.2.2 Pollution Load Discharged Mechanism in Anzali Wetland

The characteristics of each sub-basin are described below.

1) Sub-basin A includes the most urbanized area, the biggest city, Rasht, and several factories. More than half of the population (i.e. 569,697 people) of the basin live in this sub-basin.
2) Sub-basin B also discharges river water to the eastern part of the wetland. Only one small urban area, Shaft, and a large forest area are located in the basin. Only 10% of the total basin population lives in this sub-basin.
3) It is estimated that more than half of the pollution load in the basin is discharged from sub-basins A & B through the eastern part of the wetland to the northern part of the wetland. Anaerobic zones at the bottom are found at several points in the eastern part. Hosein Bekandeh Non-hunting Area and Chokam Non-hunting Area are located in eastern part of the wetland.
4) Urban area, Fuman and Somehsara are located in sub-basin C. It is estimated that 20 % of the basin residents and 28% of the livestock live in this sub-basin. The pollution load from sub-basin C is discharged directly to Sorkhankol Wildlife Refuge. Selke Wildlife Refuge is located near Sorkhankol Wildlife Refuge. Large amounts of *Azolla* occur in Selke all year.
5) Sub-basin D has only one small urban area, Masal. Most of the population lives in the rural areas. The number of livestock is greater than the human population of the sub-basin. Most of the pollution load is discharged directly to Siahkesim Protected Area. It is reported that anaerobic conditions are found in several parts of Siahkesim Protected Area. Only one small river in sub-basin D, the Chafrud River, discharges into the “Lagoon”. The lagoon seems to have a long water retention time.
6) Sub-basin E includes the second biggest city, Anzali. There is only a small land area in this sub-basin. Wastewater generated in Anzali city is discharged into the wetland or the Caspian Sea through drains. Owing to the direct discharge of untreated wastewater from Anzali, the water near Anzali Port is recognized as some of most polluted areas in the wetland.

3.2.2 Condition of Each Pollution Source

1) Domestic Wastewater

The pollution load from domestic wastewater depends on population. The 980,000 population in the basin is divided into five (5) sub-basins as shown below.

Table 3.2.2 Population Distribution by Sub-basin

Sub-Basin	Population Overall	Percentage	Urban Population	Non-urban Population
Sub-Basin A	489,000	50%	360,090	58,455
Sub-Basin B	87,000	9%	122,731	66,826
Sub-Basin C	197,000	20%	34,267	74,830
Sub-Basin D	89,000	9%	51,404	101,534
Sub-Basin E	120,000	12%	101,534	21,927
Total	982,000	100%	670,026	306,844

Source: JICA Study Team, based on the data from Statistic Data Book in Gilan Province, 1997

The condition of wastewater management is described in Chapter 2.

2) Industrial Wastewater

The total amount of industrial effluent discharged in the basin is roughly estimated to be less than 7,000 m^3/day. as shown in Table 2.5.1. Distribution of industrial activities is summarized as below.

Table 3.2.3 Distribution of Industrial Activity by Sub-basin

Sub-Basin	Industrial City	Area	Operating Factories
Sub-Basin A	Rasht	420 ha	125
Sub-Basin B	Shaft	38 ha	2
Sub-Basin C	Fuman	14 ha	-
Sub-Basin D	Somehsara	100 ha	15
Sub-Basin E	Anzali	50 ha	34

Source: MOIM, Gilan

The pollution load of industrial activities to the wetland therefore seems not to be serious with respect to organics and nutrients. However, the industries may be important sources of heavy metals and toxic materials. At present, there is not any monitoring activity for toxic substances like heavy metals in industrial effluent. The monitoring of these substances is required for protection of the wetland from toxic material pollution.

3) Livestock Wastewater

About 860,000 livestock (cows, sheep, goats, Buffalo and horses) are feeding in the basin. Based on the data in Statistic Year Book 1998, the numbers of livestock in the basin were as shown below.

Table 3.2.4 Numbers of Livestock in Each Township in the Basin

(Unit : head)

Township	Cows	Sheep	Goats	Buffalo	Horses and Donkeys	Total
Anzali	8,428	960	0	1,422	646	11,456
Rasht*	41,183	211	178	1,546	7,541	50,658
Shaft	47,283	67,845	32,819	590	3,426	151,963
Somehsara	66,074	120,787	6,231	9,228	11,854	214,174
Forman	60,182	86,348	58,346	1,097	7,993	213,966
Masal	45,028	141,125	22,333	1,200	8,289	217,975
Total	268,178	417,276	119,907	15,083	39,749	860,192

Source: Statistic Data Book in Gilan Province, 1997

Note: The value shown in the cell "Rasht" is number in the part of Rasht, which is in the basin of the wetland. It is assumed that 25 % of number in Rasht is living in the basin of the wetland.

The total number of livestock is almost the same as the human population in the basin. However, the unit pollution load of the livestock is much larger than the unit pollution load of human discharge. Though the pollution generation generated by livestock must therefore be much larger than human waste, the discharge flow rate of live stock wastewater must be much smaller, because of difference of drainage system. The distribution of livestock in each sub-basin is estimated as shown in the table below.

Table 3.2.5 Number of Livestock in Each Sub-basin

(Unit: head)

Sub-basin	Cows	Sheep	Goats	Buffalo	Horses and Donkeys	Total
Sub-Basin A	32,947	169	142	1,236	6,033	40,527
Sub-Basin B	55,520	67,887	32,855	899	4,934	162,095
Sub-Basin C	87,790	141,551	50,415	6,414	13,507	299.677
Sub-Basin D	83,494	206,709	36,495	5,111	14,629	346,438
Sub-Basin E	8,428	960	0	1,422	646	11,456
Total	268,178	417,276	119,907	15,083	39,749	860,192

Source: JICA Study Team, based on the data from Statistic Data Book in Gilan Province, 1997

Table 3.2.6 Number of Livestock in Each Sub-basin

(Unit: head)

<table>
<tr><th>Type</th><th>Caw</th><th>Sheep</th><th>Goat</th><th>Buffalo</th><th>Horses and Donkeys</th><th>Total</th></tr>
<tr><td>Fed by Farmers in the Plain Area</td><td>221,578</td><td rowspan="2">27,276</td><td rowspan="2">29,907</td><td>12,083</td><td>13,200</td><td>330,000</td></tr>
<tr><td>In Grazing Land of the Plain</td><td>26,800</td><td>3,000</td><td>13,200</td><td>37,000</td></tr>
<tr><td>In Grazing Land of the Mountain Area</td><td>6,800</td><td>390,000</td><td>90,000</td><td>0</td><td>13,349</td><td>500,000</td></tr>
<tr><td>Industrial Animal Husbandries</td><td>3,000</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3,000</td></tr>
<tr><td>Total</td><td>268,178</td><td>417,276</td><td>119,907</td><td>15,083</td><td>39,749</td><td>860,192</td></tr>
</table>

Source: JICA Study Team, based on questionnaire survey results

4) Non-point Pollution Source

The distribution of agricultural area in the basin is as shown below.

Table 3.2.7 Agricultural Area in Each Sub-basin

(Unit: ha)

Sub-basin	Rice	Tea	Others	Total
Sub-Basin A	12,196	299	7,373	19,868
Sub-Basin B	17,364	75	550	17,989
Sub-Basin C	27,360	1,975	2,904	32,239
Sub-Basin D	19,765	1,316	2,349	23,430
Sub-Basin E	4,200	0	986	5,186
Total	80,983	3,665	14,162	98,810

Source: JICA Study Team, based on the data from Statistic Data Book in Gilan Province, 1997

Unit pollution load of farming land depends on mainly consumption of fertilizer. MOJA, Gilan has announced the suitable amount of fertilizer use in order to avoid wasteful use of fertilizer. Because of the high concentration of phosphate in the soil in the basin, the consumption of phosphate fertilizer has been reduced in Gilan as shown in Table3.2.8.

Table 3.2.8 Average Use of Chemical Fertilizer in Gilan

(Unit: kg/ha)

Item	1992	1999	2002
Nitrogen	148	149	164
Phosphate	121	36	13
Potassium	30	59	51
Total	299	244	228

Source: MOJA, Gilan

3.3 Estimate of Amount of Pollution Load discharged into Anzali Wetland

3.3.1 Unit Pollution Load and Discharge Ratio

Based on the results of the water quality analysis and river flow surveys, the amount of pollution load to the wetland is calculated as show in Table 3.3.1. Detail of the water quality analysis are described in Databook 1 Water Quality and Bottom Sediment Survey.

Table 3.3.1 Estimate of Pollution Load discharged based on Survey Results

Item	Aug, 2003	Oct, 2003
1. Result of the Survey on a per Daily Basis		
1) Total COD Pollution Load	66,681 kg/day	71,449 kg/day
2) Total T-P Pollution Load	1,036 kg/day	1,446 kg/day
3) Total River Discharge	26.32 m^3/s	44.02 m^3/s
2. Evaluation of Yearly Amount		
1) Total COD Pollution Load	61,637 ton/year	39,485 ton/year
2) Total T-P Pollution Load	958 ton/year	799 ton/year
3) Total River Discharge	2,102 million m^3/year	

Source: JICA Study Team

Table 3.3.2 shows the values of units pollution loads for the total pollution load estimate in the Study. The values of units pollution loads are estimated by considering the above results and the unit pollution load adopted in Japan, which is also described in Table 3.3.2.

Table 3.3.2 Summary of Unit Pollution Load

Pollution Load	Case	COD_{Mn}	COD_{Cr}	T-N	T-P
Domestic Wastewater (g/person/day)	Typical Vales in Japan	26.0	(130)	11	1.20
	Vales in Lake Biwa	29.3	(146.5)	----	1.17
	Vales in the Study		130	11	1.80
Livestock, Cow (g/head/day)	Typical Vales in Japan	530.0	(2650)	290	50.00
	Vales in Lake Biwa	53.0	(265)	290	0.65
	Vales in the Study	----	26	2.9	0.50
Paddy Field (kg/ha/year)	Typical Vales in Japan	111.1	(555.5)	----	1.65
	Vales in Lake Biwa	43	(215)	14.3	0.98
	Vales in the Study	---	107	14.3	0.98
Forest & Grass Land (kg/ha/year)	Typical Vales in Japan	25.4	(127)	----	0.300
	Vales in Lake Biwa	18.8	(94)	7.57	0.142
	Vales in the Study		47	7.57	0.300

Source: JICA Study Team

Note 1: Discharge ratio of livestock waste in case of Lake Biwa adopted COD: 10%, T-N:10% T-P: 1.3 %. Discharge ratio of livestock waste in case of the Study adopted COD: 1%, T-N:1% T-P: 1%

2: Figures in brackets shows estimated COD Cr values which are 5 times of COD Mn.

Table 3.3.3 shows the pollution load reduction ratio adopted for the pollution load prediction in the Study.

Table 3.3.3 Pollution Load Reduction Ratio of Treatment Process

Case	Treatment Process	COD	T-N	T-P
In case of Lake Biwa	Sewerage in Rural Area	85%	60%	60%
	Gappei Jokasou	75%	50%	40%
Adopted in the Study	WWTP (Secondary Treatment Process)	90%	60%	60%
	WWTP (Advanced Treatment Process)	90%	60%	90%
	Preliminary Treatment in Rural	60%	60%	60%
	Community Wastewater Treatment	90%	60%	60%

Source: JICA Study Team

3.3.2 Estimate of Present Pollution Load Amount

The distribution of the pollution sources at present are summarized in Table 3.3.4.

Table 3.3.4 Present Condition of Pollution Sources

Pollution Source	Unit	Sub-Basin					Total
		A	B	C	D	E	
Population (Urban)	person	515,012	7,673	82,188	18,076	119,870	742,819
Population (Rural)	person	66,541	94,992	111,374	73,870	47,522	394,299
Industrial Activities	m^3/day	7,000	0	0	0	0	7,000
Live Stock (Cows & Buffalo)	head	40,216	63,170	107,711	103,234	10,496	324,827
Live Stock (Sheep & Goat)	head	311	100,820	191,966	243,204	960	537,261
Farming Land	ha	19,868	17,988	32,239	23,430	5,186	98,711
Forest & Pasturage	ha	29,700	63,360	43,560	59,400	1,980	198,000

Source: JICA Study Team

Based on the data in Table 3.3.2 and Table 3.3.4, the amounts of pollution loads of COD, T-N and T-P to Anzali Wetland at present are estimated as shown in Table 3.3.5, 3.3.6 and 3.3.7.

Table 3.3.5 Calculation of COD Pollution Load Discharged at Present

(Unit: ton/year)

COD Load	Unit Pollution Load		Sub-Basin					Total
			A	B	C	D	E	
Population (Urban)	g/p/day	130	24,437	364	3,900	858	5,688	35,247
Population (Rural)	g/p/day	40	971	1,387	1,626	1,079	694	5,757
Industrial Activities	mg/L	50	110	0	0	0	0	110
Live Stock (Cow & Baffallo)	g/p/day	26	382	599	1,022	980	100	3,083
Live Stock (Sheep & Goat)	g/p/day	6.5	1	239	455	577	2	1,275
Farming Land	kg/ha/year	107	2,126	1,925	3,450	2,507	555	10,562
Forest & Pasturage	kg/ha/year	47	1,396	2,978	2,047	2,792	93	9,306
Total			29,422	7,492	12,500	8,792	7,131	65,338

Source: JICA Study Team

Table 3.3.6 Calculation of T-N Pollution Load Discharged at Present

(Unit: ton/year)

T-N Load	Unit Pollution Load		Sub-Basin					Total
			A	B	C	D	E	
Population (Urban)	g/p/day	11.0	2,068	31	330	73	481	2,982
Population (Rural)	g/p/day	3.3	80	114	134	89	57	475
Industrial Activities	mg/L	30.0	66	0	0	0	0	66
Live Stock (Cow & Baffallo)	g/p/day	2.90	43	67	114	109	11	344
Live Stock (Sheep & Goat)	g/p/day	0.73	0	27	51	64	0	142
Farming Land	kg/ha/year	14.3	284	257	461	335	74	1,412
Forest & Pasturage	kg/ha/year	7.6	226	482	331	451	15	1,505
Total			2,766	978	1,421	1,122	639	6,925

Source: JICA Study Team

Table 3.3.7 Calculation of T-P Pollution Load Discharged at Present

(Unit: ton/year)

T-P Load	Unit Pollution Load		Sub-Basin					Total
			A	B	C	D	E	
Population (Urban)	g/p/day	1.8	338.4	5.0	54.0	11.9	78.8	488.0
Population (Rural)	g/p/day	0.5	13.1	18.7	22.0	14.6	9.4	77.7
Industrial Activities	mg/L	6.0	13.1	0.0	0.0	0.0	0.0	13.1
Live Stock (Cow & Baffallo)	g/p/day	0.50	7.3	11.5	19.7	18.8	1.9	59.3
Live Stock (Sheep & Goat)	g/p/day	0.125	0.0	4.6	8.8	11.1	0.0	24.5
Farming Land	kg/ha/year	0.98	19.5	17.6	31.6	23.0	5.1	96.7
Forest & Pasturage	kg/ha/year	0.3	8.9	19.0	13.1	17.8	0.6	59.4
Total			400.4	76.5	149.0	97.2	95.8	818.8

Source: JICA Study Team

The amounts of pollution load to Anzali Wetland are summarized as below.

Table 3.3.8 Total Amount of Pollution Load Discharged

Pollution Source	COD Load		T-N Load		T-P Load	
	Amount (ton/year)	Ratio	Amount (ton/year)	Ratio	Amount (ton/year)	Ratio
Urban Domestic Wastewater	35,247	53.9%	2,982	43.1%	488.0	59.6%
Rural Domestic Wastewater	5,757	8.8%	457	6.6%	77.7	9.5%
Industrial Effluent	219	0.2%	66	0.2%	13.1	1.6%
Livestock	4,358	6.7%	486	1.0%	83.8	10.2%
Farm Land	10,562	16.2%	1,412	20.4%	96.7	11.8%
Natural	9,306	14.2%	1,505	21.7%	59.4	9.3%
Total	65,338	100.0%	6,925	100.0%	818.8	100.0%

Source: JICA Study Team

3.3.3 Prediction of Pollution Load Amount

The social and economic condition in 2019 are predicted as below.

- Urban Population will increase from 762,000 in 2004, to 1,127,000 in 2019.
- Rural Population will decrease from 394,000 in 2004, to 393,000 in 2019.
- Industrial activities will be expanded by 2.75 times by 2019.
- Agricultural activities will be in almost the same condition by 2019.

Considering above condition, the situation of the pollution sources in 2019 is assumed as below.

Table 3.3.9 Prediction of Pollution Source in 2019

Pollution Source	Unit	Sub-Basin					Total
		A	B	C	D	E	
Population (Urban)	person	772,557	9,163	121,689	28,564	194,879	1,126,851
Population (Rural)	person	63,293	92,960	114,276	74,648	47,503	392,679
Industrial Activities	m3/day	17000	0	0	0	0	17,000
Live Stock (Cows & Buffalo)	head	40,216	61353	107711	103234	10,496	323,010
Live Stock (Sheep & Goat)	Head	311	100742	191966	243204	960	537183
Farming Land	ha	19,868	17,988	32,239	23,430	5,186	98,711
Forest & Pasturage	ha	29,700	63,360	43,560	59,400	1,980	198,000

Source: JICA Study Team

Based on the data in Table 3.3.2 and Table 3.3.9, the amount of pollution loads of COD, T-N and T-P to Anzali Wetland in 2019 are estimated as shown in Table 3.3.10, 3.3.11 and 3.3.12.

Table 3.3.10 Prediction of COD Pollution Load Discharged in 2019

(Unit: ton/year)

COD Load	Unit Pollution Load		Sub-Basin					Total
			A	B	C	D	E	
Population (Urban)	g/p/day	130	36,658	435	5,774	1,355	9,247	53,469
Population (Rural)	g/p/day	40	924	1,357	1,668	1,090	694	5,733
Industrial Activities	mg/L	600	3,723	0	0	0	0	3,723
Live Stock (Cows & Buffalo)	g/p/day	26	382	599	1,022	980	100	3,083
Live Stock (Sheep & Goats)	g/p/day	6.5	1	239	455	577	2	1,275
Farming Land	kg/ha/year	107	2,126	1,925	3,450	2,507	555	10,562
Forest & Pasturage	kg/ha/year	47	1,396	2,978	2,047	2,792	93	9,306
Total			45,209	7,533	14,417	9,301	10,690	87,151

Source: JICA Study Team

Table 3.3.11 Prediction of T-N Pollution Load Discharged in 2019

(Unit: ton/year)

T-N Load	Unit Pollution Load		Sub-Basin					Total
			A	B	C	D	E	
Population (Urban)	g/p/day	11.0	3,101.8	36.8	488.6	114.7	782.4	4,524
Population (Rural)	g/p/day	3.3	76.2	112.0	137.6	89.9	57.2	473
Industrial Activities	mg/L	30.0	186.2	0.0	0.0	0.0	0.0	186
Live Stock (Cows & Buffalo)	g/p/day	2.90	42.6	66.9	114.0	109.3	11.1	344
Live Stock (Sheep & Goats)	g/p/day	0.725	0.1	26.7	50.8	64.4	0.3	142
Farming Land	kg/ha/year	14.30	284.1	257.2	461.0	335.0	74.2	1,412
Forest & Pasturage	kg/ha/year	7.6	225.7	481.5	331.1	451.4	15.0	1,505
Total			3,917	981	1,583	1,165	940	8,586

Source: JICA Study Team

Table 3.3.12 Prediction of T-P Pollution Load Discharged in 2019

(Unit: ton/year)

T-P Load	Unit Pollution Load		Sub-Basin					Total
			A	B	C	D	E	
Population (Urban)	g/p/day	1.8	507.6	6.0	79.9	18.8	128.0	740.3
Population (Rural)	g/p/day	0.5	12.5	18.3	22.5	14.7	9.4	77.4
Industrial Activities	mg/L	10.0	62.1	0.0	0.0	0.0	0.0	62.1
Live Stock (Cows & Buffalo)	g/p/day	0.50	7.3	11.5	19.7	18.8	1.9	59.3
Live Stock (Sheep & Goats)	g/p/day	0.125	0.0	4.6	8.8	11.1	0.0	24.5
Farming Land	kg/ha/year	0.98	19.5	17.6	31.6	23.0	5.1	96.7
Forest & Pasturage	kg/ha/year	0.3	8.9	19.0	13.1	17.8	0.6	59.4
Total			617.8	77.1	175.6	104.2	145.0	1,119.7

Source: JICA Study Team

Table 3.3.13 shows the amount of pollution load and increase ratio of the pollution load from2003 to 2019.

Table 3.3.13 Comparison of Pollution Load Amount Discharged in 2003 and 2019

(Unit: ton/year)

Area	COD Load Discharged			T-P Load Discharged		
	2003	2019	Increase Ratio	2003	2019	Increase Ratio
Urban Domestic	35,247	53,469	51.6%	488.0	740.3	51.6%
Rural Domestic	5,757	5,733	-0.5%	77.7	77.4	-0.5%
Industrial	219	621	183.6%	13.1	37.2	183.6%
Livestock	4,358	3,765	-13.6%	83.8	72.4	-13.6%
Farm Land	10,562	10,562	0.0%	96.7	96.7	0.0%
Natural	9,306	9,306	0.0%	59.4	59.4	0.0%
Total	65,448	83,455	27.5%	818.8	1,095	33.7%

Source: JICA Study Team

CHAPTER 4 WASTEWATER MANAGEMENT PLAN

4.1 General

As discussed in Chapter 2, water pollution is one of the serious environmental problems in the Anzali Wetland, and it is affecting the entire ecosystem of the wetland. In order to control water pollution, the various organizations like DOE, MOJA and GWWC are making efforts in managing wastewater generated from domestic, industrial and agricultural activities. However, the greater part of the wastewater is still discharged without any treatment. Though the effluent standard for wastewater discharged are established, it seems to take a long time to achieve the level of the standard for most of the polluters in the basin.

Moreover, there is no overall plan for wastewater management in the basin, and the tasks and duties of the related organizations have not been clarified. The target water level of Anzali Wetland has not been established, and the target for pollution load reduction has not been identified either. Therefore, to mitigate the environmental impact of water pollution on the eco-system of the wetland, a comprehensive wastewater management plan is needed with the co-operation of various authorities. In addition, it is important that the related organizations understand and complete their own tasks and duties in order to achieve the targets.

Though there are numerous ways to reduce pollution loads from the basin, practical measures are limited because such measures should satisfy a number of requirements to be sustainable. For example, they have to be (i) cost effective to control environmental pollution and sanitation problems, (ii) implemented within reasonable initial investment and O&M cost limits, (iii) easy to maintain, and (iv) socially and environmentally acceptable. Tables 4.1.1 and 4.1.2 show examples of typical measures of wastewater control widely accepted in the world.

Table 4.1.1 Typical Measures of Organic and Nutrient Pollution Load

Source of Pollution	Type of Pollution	Measures to treat wastewater	Measure to reduce pollution load at source	Other
Urban Domestic Wastewater	Organic	1) New sewerage system development 2) Installation of individual treatment facilities	1) Control of population increase	1) Direct wastewater discharge to Caspian sea
	Nutrient	1) Installation of advanced treatment system	2) Use of detergent with low phosphorous contents	
Rural Domestic Wastewater	Organic	1) Installation of individual treatment facilities 2) Community wastewater treatment system development	1) Control of population increase	
	Nutrient	1) Installation of advanced treatment system	2) Use of detergent with low phosphorous contents	
Industrial Effluent	Organic	1) Centralized wastewater treatment system 2) Individual wastewater treatment facility	1) Restriction of number of factories in the basin	1) Centralization of factories in industrial cities
	Nutrient	1) Installation of advanced treatment system		
Livestock Waste	Organic Nutrient	1) Installation of wastewater treatment facilities and storage tanks for manure	1) Decrease of number of livestock	1) Measures to protect river from ingress of livestock waste
Pollution from Farmland	Organic	1) Dilution	1) Decrease of agricultural area	1) Improvement of irrigation system
	Nutrient		2) Control of consumption of chemical fertilizer	

Table 4.1.2 Typical Measures of Wastewater including Toxic Material and Heavy Metals

Source of Pollution	Measures to treat wastewater	Measure to reduce pollution load at source	Other
Industrial Effluent	1) Individual wastewater treatment facilities	1) Restriction of construction of factories that discharge toxic material or heavy metals into the basin	1) Centralization of factories in industrial cities
Pollution from Farmland	1) Dilution	2) Decrease of consumption of agricultural chemical	1) Improvement of irrigation system

4.2 Objective and Strategies

4.2.1 Objectives

The objectives of the wastewater management plan are as follows:

- To improve and maintain the water quality of the Anzali Wetland at a level acceptable for its ecosystem by implementing affordable and effective wastewater management,

4.2.2 Strategy

(1) Setting of Targets

For the wastewater management plan, the targets on ambient water quality in Anzali Wetland and amount of pollution load reduction to the wetland are set up as below.

1) Target of Ambient Water Quality and Sediment Quality

For the management of the wetland conservation, the tentative targets of ambient water quality in Anzali Wetland are set as COD 30 mg/L, T-N 2.0 mg/L and T-P 0.20 mg/L for organic and nutrient pollution considering prevention of eutrophication. The targets of sediment quality are set as Cd: 3.5 mg/kg, Pb: 91 mg/kg, Cr: 60 mg/kg, Cu: 197 mg/kg, Zn: 315 mg/kg for environmental risk management of heavy metal pollution, which are based on Canadian Environmental Quality Guidelines, 2002.

It should be noted that the wetland ecosystem is influenced by various factors and it is not easy to know the water quality level acceptable to a given species or ecosystem. The selected parameters are COD, T-N, T-P and heavy metals as these are the most relevant to the water pollution of the Anzali Wetland, i.e., organic pollution, eutrophication[1], and environmental risks of heavy metals to the wetland ecosystem.

Table 4.2.1 shows the target values and actual water quality records on COD T-N and T-P.

Table 4.2.1 Target of Water Quality in the Wetland

Parameter	Target to 2019	Records in 2004
COD (mg/L)	30	Eastern Area (Eastern Part): Average 37 (22-61) Western Area (Siahkeshim): Average 27 (15-50)
T-N (mg/L)	2.0	Eastern Area (Eastern Part): Average 2.2 (1.4-3.7) Western Area (Siahkeshim): Average 1.8 (1.1-2.3)
T-P (mg/L)	0.20	Eastern Area (Eastern Part): Average 0.28 (0.17 – 0.42) Western Area (Siahkeshim): Average 0.17 (0.08-0.29)

[1] Phosphorous is believed to be one of the main determining factors of eutrophication in the wetland.

Regarding the eastern side of Anzali Wetland, the average values of COD exceeded the target by about 20 %, the average values of T-N exceeded the target by about 10 %, and the average of T-P values exceed the target by 40 %. On the other hand, the average values of COD T-N and T-P in the western side of Anzali Wetland do not exceed the target. Table 4.2.2 shows that the values of heavy metals do not exceed the target.

Table 4.2.2 Targets of Sediment Quality in the Wetland

Parameter	Targets	Records in 2004
Heavy Metals (mg/kg)	Cd: 3.5, Pb: 91, Cr: 60, Cu: 197, Zn: 315	Cd: n.d. – 0.2, Pb: n.d. – 51, Cr^{6+}: 4 – 41 Cu: 19 – 86, Zn: 32 - 222

2) Target of Pollution Load Reduction on COD, T-N and T-P

In order to achieve the target of ambient water quality overall the wetland, the targets of pollution load reduction in the eastern part of the basin are set up as 20% reduction in COD, 10% reduction in T-N and 30% reduction in T-P from the 2003 level, which are equivalent to as 44% reduction in COD (28,196 ton/year), 32% reduction in T-N (1,893 ton/year) and 52% reduction in T-P (439 ton/year) from the forecast 2019 level. Regarding the west side, the tentative targets have been achieved, and the target in 2019 is to make some improvement from the present condition in 2003, which is 1,945 ton/year, 205 ton/year and 25 ton/year for COD, T-N and T-P respectively from the forecast 2019 level.

Table 4.2.3 Target of Sediment Quality in the Wetland

(Unit: ton/year)

Item		Western Side	Eastern Side	Total
COD	Future Prediction	23,718	63,433	87,151
	Target Level	21,292	35,237	56,529
	Required Reduction	1,945	28,196	30,141
T-N	Future Prediction	2,748	5,838	8,586
	Target Level	2,543	3,945	6,488
	Required Reduction	205	1,893	2,098
T-P	Future Prediction	271	840	1,111
	Target Level	246	401	647
	Required Reduction	25	441	466

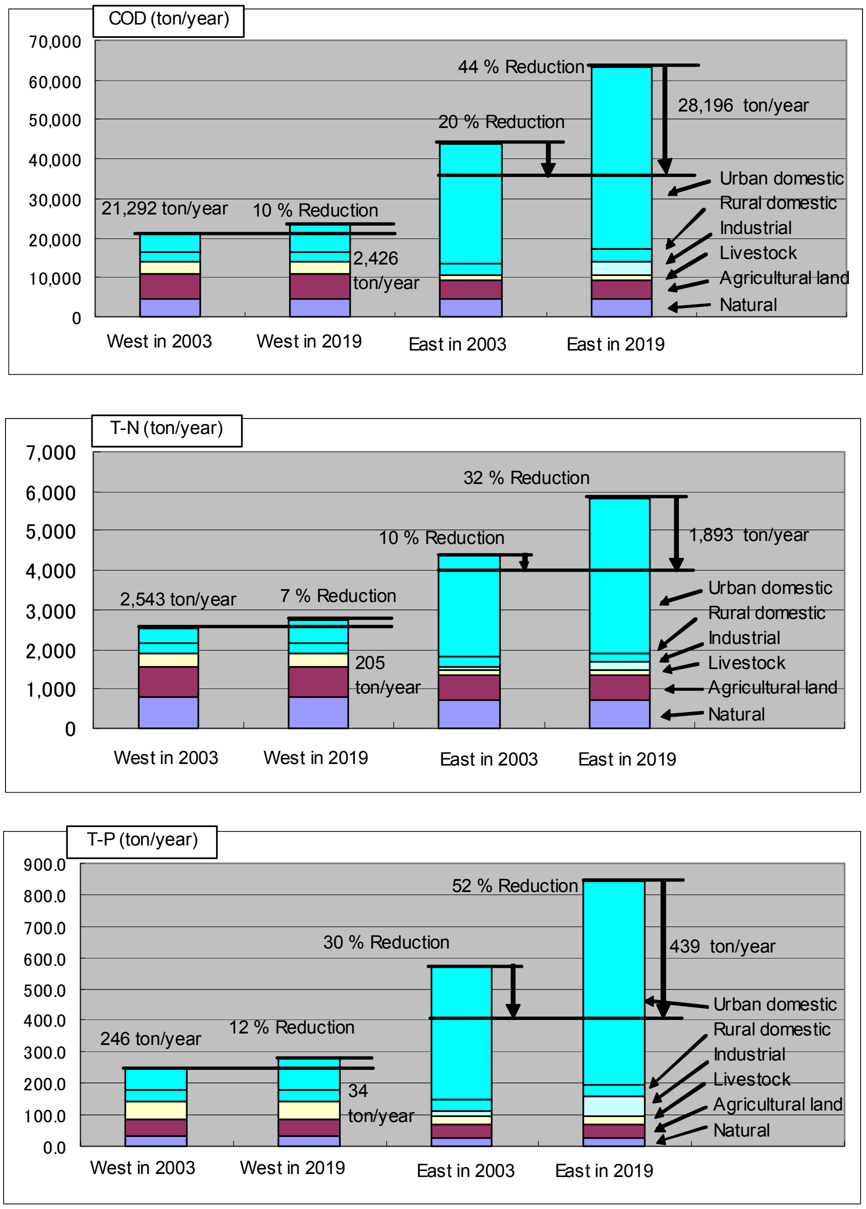

Figure 4.2.1 COD T-N and T-P Pollution Load to Wetland in West and East

3) Targets for Heavy Metals

The sources of heavy metals are limited to industrial activity. For management of heavy metals, only measures at the pollution sources (industrial factories) are required.

Based on the results of the water quality surveys in the study, it is evaluated that there is no serious pollution from heavy metals at present, and the current level of heavy metal concentration seems acceptable for the eco-system in Anzai Wetland. All of the industrial factories are required to meet the effluent standard in order to keep the present condition in Anzali Wetland.

(2) Measures for Each Pollution Source

In order to improve and maintain the water quality of Anzali Wetland, it is required to implement suitable wastewater management for all pollution sources in the basin. The management shall be considered for each pollution source. The following five sub-components of the management plans are prepared separately in the wastewater management plan, because required measures are different depending on the pollution sources and responsible organization.

1) Management of Domestic Wastewater in Urban Area

Domestic wastewater in the urban areas is the biggest pollution source of COD, T-N and T-P to the wetland. Drastic decreases in the pollution loads are therefore required in order to achieve the targets. Existing plans for sewerage system development in the basin are highly appreciated for Anzali Wetland Conservation. The measures for wastewater treatment shall be considered separately for application with inside the sewerage service area and outside of the service area. In addition to the wastewater treatment, measures for pollution source control shall be considered for phosphorous reduction, because conventional wastewater treatment is not effective for phosphorus removal.

2) Management of Domestic Wastewater in Rural Area

The pollution load in the rural area is not expected to have a serious impact on the wetland. Even if the measures for the rural wastewater are not necessary to achieve the target values, expansion of wastewater treatment in the rural area is required for continuous pollution load reduction to the wetland and for improvement of living condition in the basin. Wastewater treatment shall be developed within affordable financial parameters.

3) Management of Industrial Effluent

Industrial activities are expected to develop rapidly in the future. Even if all of the industrial factories meet the effluent standard in 2019, pollution load of the industrial activities is expected to increase by 2.75 times the current level. If the measures are not implemented, the pollution load will be increased by more than 20 times, and may include large amount of heavy metals and toxic materials. The basic strategy of the management of industrial effluent is that all industrial factories should take necessary measures to keep the effluent standard.

4) Management of Livestock

There are about 860,000 head of livestock in the basin. These animals are kept in four ways, i.e., fed: by Individual Farmers in the Plain, in the Grazing Land of the Mountain Area, in the Grazing Land of the Plain and in Industrial Animal Husbandries. The measures shall be considered on livestock for each category.

5) Management of Pollution from the Farmland

Although the present application rates of chemical fertilizers and agricultural chemicals in the study area seem low, there is a possibility that applied fertilizers and agrochemicals could be discharged into the wetland with drainage water due to improper application and/or improper water management. Therefore, the aims of this master plan are to minimize as many pollution loads from farmlands as possible by letting farmers adopt proper and environmentally-friendly farming practices. As described in sub-section 2.7, the present extension works (programs) of MOJA have a certain effect on reducing the uses of farm inputs (fertilizers and agricultural chemicals). Hence, the proposed measure focuses on further strengthening the present extension activities of MOJA and improving the coordination between monitoring of pollution loads from farmlands and extension activities at the field level to avoid irretrievable damage to the wetland environment.

4.3 Management of Domestic Wastewater in Urban Area

4.3.1 Introduction

It is estimated that urban domestic wastewater is the biggest pollution source and will account for 60 - 70 % of the total pollution load in 2019. Measures for urban domestic wastewater should be considered as a high priority. If reduction of pollution load on the wetland is the only goal, measures such as “diverting and discharging wastewater directly to the Caspian Sea”, are potential alternatives. However, such measures are not environmentally acceptable from the view point of protecting the Caspian Sea from pollution. NWWEC have several sewerage development plans in seven cities, which can treat wastewater generated by more than 90 % of the urban population in 2019. However, it seems difficult to implement all of the projects, because of financial constrain. To achieve the target on COD and T-N, it is required to implement some of the projects. To achieve the target on T-P, it is required to add other measures, such as introduction of advanced wastewater treatment process to wastewater treatment plant and introduction of use of low phosphorous detergent, because conventional treatment process of the sewerage system can hardly reduce enough phosphorous to achieve the target.

The following measures are proposed for management of domestic wastewater in the urban area.

1) Implementation of some of the sewerage development projects planned by NWWEC, and introduction of advanced treatment process.
2) Other measures for outside of the sewerage service area
3) Promotion of use of low phosphorous detergent

4.3.2 Sewerage System Development

(1) Structural Development Plan

The target amounts of pollution load reduction up to 2019 are 28,196 ton/year of COD, 1,893 ton/year of T-N and 439 ton/year of T-P for the eastern part of the wetland, and 2,469 ton/year of COD, 205 ton/year of T-N and 24 ton/year of T-P for the western part.

As the design criteria of the sewerage development plan, water quality of raw wastewater and treated wastewater through secondary treatment process and advanced treatment process (A2/O Process: One of Biological Nutrient Removal Process) are assumed in Table 4.3.1.

Table 4.3.1 Water Quality of Raw Wastewater and Treated Wastewater for Design

(Unit: mg/L)

	Raw Wastewater	Treated Wastewater		Effluent Standard
		Secondary Treatment Process	Advanced Treatment Process (A2/O Process)	
BOD	290	30	30	30
COD	650	60	60	60
T-N	55	33	22	62
T-P	9.0	3.6	0.9	6.0

Source: JICA Study Team

Based on the above figures, it is estimated that the sewerage system with secondary treatment process can reduce pollution load of 43 kg/p/year of COD, 4.4 kg/p/year of T-N and 0.39 kg/p/year of T-P, and sewerage system with the advanced treatment process can reduce pollution load of 43 kg/p/year of COD, 3.6 kg/p/year of T-N and 0.59 kg/p/year of T-P.

Even if all of the projects in the NWWEC plan are implemented and cover more than 90 % of the urban population in 2019, the sewerage system with secondary treatment process can not reduce phosphorous enough to achieve the target. The advanced treatment process is therefore required.

To achieve the target of pollution load reduction, it is proposed to implement sewerage system development with advanced treatment process, which can treat wastewater from 70 % of the urban population, which are more than 43,000 service population in the eastern area and more than 748,000 service population in the eastern area. The achievement to the target for T-P is critical in the eastern part. It is easy to achieve the target on COD and T-N even through a conventional secondary treatment process.

As shown in Table 4.3.2, all of sewerage projects planned by NWWEC can cover more than 120,000 service populations in the western area and more than 890,000 service populations in the eaestern area. To achieve to the target, Rasht Sewerage Project (Phase 1 & 2), Anzali Sewerage Project (Phase 1 & 2) and Somehsara Sewerage Project are selected for proposed projects in the master plan by 2019. The service population of each sewerage projects is shown in Table 4.3.2.

Table 4.3.2 List of Planned Projects for Sewerage System Development

Basin	Sewerage Projects	Status	Service Population (Unit: persons)	
			Planned by GWWC	Proposed in the Study
Eastern Part	Rasht (Phase 1)	Construction	253,816	253,816
	Rasht (Phase 2)	Basic Design	378,284	378,284
	Rasht (Phase 3)	Basic Design	93,600	
	Anzali (Phase 1)	Construction	77,920	77,920
	Anzali (Phase 2)	Basic Design	51,000	51,000
	Anzali (Phase 3)	Basic Design	8,712	
	Khomam	Basic Study	16,095	
	Shaft	Basic Design	14,357	
	Sub-total		893,784	761,020
Western Part	Somehsara	Construction	56,980	56,980
	Fuman	Basic Design	46,000	
	Masal	Basic Study	24,762	
	Sub-total		127,742	56,980
Total			1,021,526	818,000

Source: JICA Study Team

To achieve the target of phosphorous reduction, an advanced treatment process should be installed in wastewater treatment plants in all of the proposed projects. However, two new wastewater treatment plants under construction in Rasht and Anzali cities do not have advanced treatment process to remove phosphorous. Additional construction works are required for them.

The outline of the proposed sewerage system in Rasht is described in Figure 4.3.1. The service area is divided into the central area, the eastern area and the western area. Some parts of the sewerage system in the central area are under construction, and the sewerage systems in the eastern and western areas are planned to be developed by the World Bank fund.

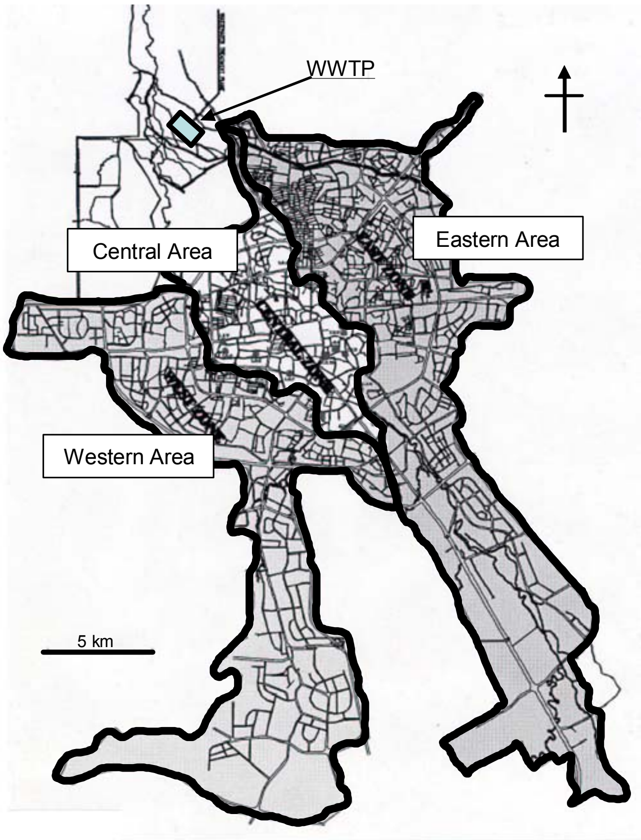

Figure 4.3.1 Outline of Rasht Sewerage System

The outline of the proposed sewerage service system in Anzali is described in Figure 4.3.2. The service area is divided into the eastern area and the western area. Some parts of the sewerage system in the western area are under construction, and the sewerage system in the eaestern area is planned to be developed by the World Bank fund.

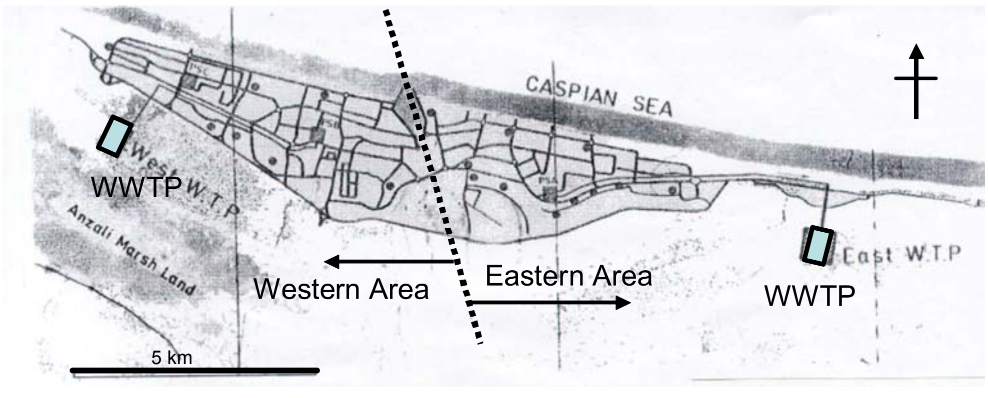

Figure 4.3.2 Outline of Anzali Sewerage System

(2) Institutional Development Plan

For sustainable operation and development of new sewerage system, the followings measures should be carried out by GWWC.

- Expansion of wastewater management section responsible for operation of new sewerage system
- Establishment of sewerage tariff setting system to cover O&M cost for new sewerage system
- Public awareness to get residents to understand necessity of new sewerage system development

Details of the above measures are described as below.

1) Expansion of Wastewater Management Section

For the proper operation and maintenance of the new sewerage systems, a number of operation and maintenance staff will be required. However, GWWC do not have any operation staff for the sewerage system at present. The required staffs for the new sewerage systems of Rasht, Anzali and Somehsara up to 2019 are proposed as below. Training programs, which include programs to be prepared by the contractors for construction of the WWTP, are also required for new employee staff.

Table 4.3.3 Required O&M Staff for New Sewerage System

Staff	Rasht		Anzali		Somehsara		Total
	WWTP	WCS	WWTP	WCS	WWTP	WCS	
Engineer	9	5	7	5	2	2	30
Technician	28	12	15	4	5	2	66
Clerk	8	0	6	0	2	0	16
Semi-skilled Worker	8	10	6	10	2	5	41
Unskilled Worker	24	60	16	20	6	8	134

Source: JICA Study Team, based on data from GWWC
Note: WWTP: Wastewater Treatment Plant, WCS: Wastewater Collection System

2) Establishment of Sewerage Tariff Setting System

As sewerage service population will increase, O&M cost for the sewerage system will increase also. Table 4.3.4 shows O&M cost and service population of each sewerage project. It is estimated that O&M cost is 38,136 million Rials/year, and average sewerage tariff is required at 46,966 Rial/person/year after completion of proposed sewerage projects.

Table 4.3.4 Service Population and O&M Cost of New Sewerage Systems

Project	Service Population	O&M Cost (million Rials/year)	O&M cost per person (Rials/year)
Rasht Sewerage System (Phase 1&2)	632,000	25,617	40,533
Anzali Sewerage System (Phase 1&2)	129,000	8,443	65,450
Somehsara Sewerage System	57,000	4,076	79,921
Total	818,000	38,136	46,966

Source: JICA Study Team, based on data from GWWC

Table 4.3.5 shows average sewerage tariff and annual revenue of GWWC from sewerage tariff in 2004. Total revenue from the sewerage tariff is 17,668 million Rials/year. Average expenditure to sewerage tariff is estimated at 23,506 Rials/person/year (200 L/p/day , 73 m3/p/year). It is required to increase sewerage tariff by about 2 times unitl 2009, except for consideration of price escalation.

Table 4.3.5 Sewerage Tariff and Sales Revenues from Sewerage Tariff in 2004

Consumer	Average Tariff (Rials/m^3)	Revenue from Sewerage Tariff (million Rials/year)	Ratio
Domestic	322	11,926	67.5%
Commercial	1,587	2,495	14.1%
Industrial	1,602	217	1.2%
Government	1,572	2,005	11.3%
Other	399	1,026	5.8%
Total		17,668	100.0%

Source: JICA Study Team, based on data from GWWC

GWWC makes a plan increase the sewerage tariff by about 30%, which is from 70 % of water tariff to 90%, after commencement of operation of the WWTP. It is reasonable as first step of the sewerage tariff increase.

1) Public Awareness

The sewerage system operation will depend on revenue of sewerage tariff from residents, and raising the sewerage tariff will be required to cover O&M cost for new sewerage system. It is therefore necessary to get the residents to understand necessity of new sewerage system development. Public awareness program is required. WWTP Site visit with lecture seems one of effective program.

4.3.3 Promotion of Individual Wastewater Treatment Facilities outside of Sewerage Service Areas

Since proposed sewerage service area is not expected to cover the whole urban area, some wastewater will continue to be drained out without treatment. A regulation requiring the installation of individual wastewater treatment facilities may, therefore, be valuable for areas outside the wastewater treatment service areas. It is not only for the wetland conservation but also for improvement of living conditions. It is estimated thatof the urban population, about 5%, which will be 113,000 residents in 2019, will not be in the wastewater treatment service area. Assuming one individual wastewater treatment facility for five residents, about 22,600 sets of treatment facilities need to be installed in the urban area up to 2019.

4.3.4 Promotion of Low Phosphorus Detergent Use

Eutrophication is a major problem in the Anzali Wetland, and it is therefore important to control the inflow of nutrients. The removal of phosphorus as a stage of wastewater treatment is possible using advanced treatment process such as the Biological Nutrient Removal Process, and this is considered in the sewerage plan proposed by NWWC. However, it is well-known that the removal of phosphorus in wastewater treatment is costly. In many countries, such as EU countries, USA and Japan, the pollution load of phosphorus was reduced by promoting phosphorus-free detergents, and this approach is recommended for Guilan Province, also.

According to the results of the water quality survey between September and December 2003, it is estimated that most of the phosphorus pollution load is derived from domestic wastewater. Phosphorus in detergent seems to be one of the major sources. The wastewater treatment plants in Rasht and Anzali cities are expected to reduce the phosphorous content after installation of the advanced treatment process. In addition to sewerage system development, research and development of “Low Phosphorus Detergent” is proposed for the reduction of phosphorus discharged into the wetland.

It is expected to takes a long time to promote use of the low phosphorous detergent, because the low phosphorous detergent has not been manufactured in Iran, and has not been distributed on the market. Moreover, the importance and effectiveness of use of the low phosphorous detergent have not been considered in Iran. As first step of the procedure, research works on the low phosphorous detergent is proposed, and a campaign of trial sales and use of the detergent is proposed as second step of the procedure. Finally, before introduction of the law to forbid sale and use of detergent with high contents of phosphorous, it is proposed to promote voluntary use of the detergent with low phosphorus.

4.4 Management of Domestic Wastewater in Rural Area

4.4.1 Introduction

For improvement of living conditions in the rural area, the development plans for wastewater treatment systems were prepared by RWWC. The plan seems effective for pollution control also. Households in rural area usually have absorption tanks. The absorption tanks cause the following problems that deteriorate living conditions.

- Seepage wastewater from the absorption tanks flows into groundwater.
- In case of high groundwater level, the wastewater cannot infiltrate into underground and overflows to the surface from the absorption tank.

To solve the above problems, wastewater in the rural area shall be collected, treated and discharged out of the residential area. One of possible measures is development of sewerage systems. However it seems be unaffordable in the rural area from the financial point of view. Considering these constraints, development of low-cost community-level wastewater treatment systems based on a sewer network, septic tanks and secondary treatment process is recommended for rural communities. Currently, there is no such community wastewater treatment facility in the rural area, but designs of community wastewater treatment systems have been prepared for seven villages.

4.4.2 Community Wastewater Treatment System Development

(1) RWWC Plan

RWWC has prepared detailed designs for the community wastewater treatment systems of sixteen villages in the Guilan Province to be developed during the period of the Fourth Five Year Plan (2005-2009). Out of the sixteen villages, seven villages are located in the Anzali Wetland basin as shown in Figure 4.4.1. The corresponding service population comes to 18,325 and that corresponds to 5 % of the rural population of 393,000 in the Anzali wetland basin.

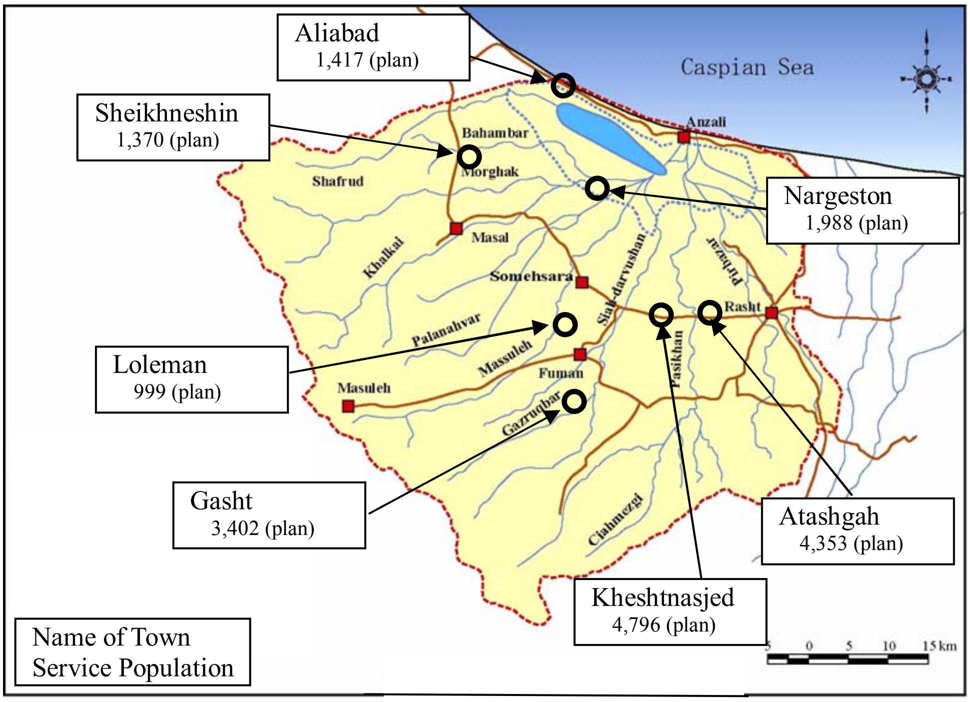

Figure 4.4.1 Locations of Community Wastewater Treatment Systems Proposed by RWWC

The type of wastewater treatment system proposed by RWWC is illustrated in Figure 4.4.2.

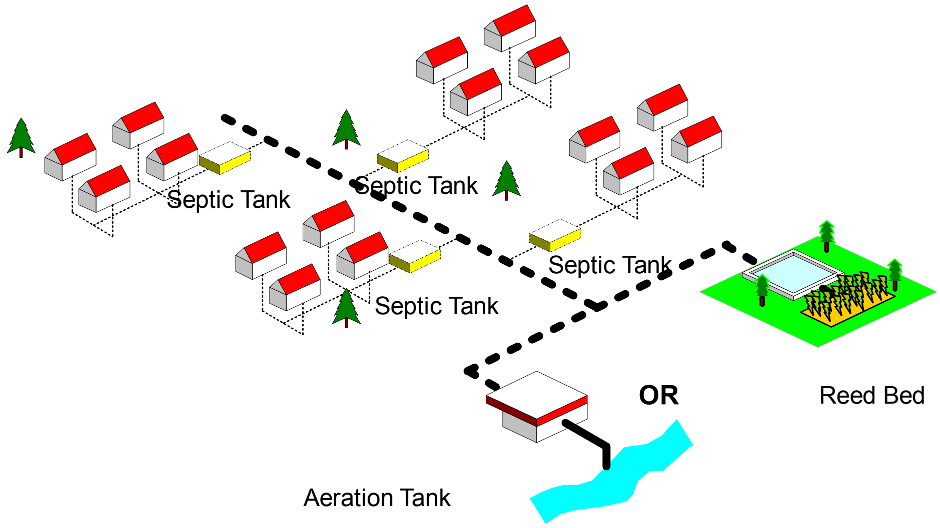

Figure 4.4.2 Image of Community Wastewater Treatment System Proposed by RWWC

Table 4.4.1 List of Projects for Community Wastewater Treatment in Seven Villages

Sub-basin	Village	Township	Service Population	Number of Septic Tank	Pipe Line (m)	Required Land for Additional Treatment	Type
A	Atashgah	Rasht	4,353	339	9,200	2.7ha	SDGS
B	Kheshtnasjed	Rasht	4,796	-	10,900	2.7ha	SS
C	Gasht	Fuman	3,402	470	23,000	1.2ha	SDGS
	Loleman	Fuman	999	25	3,700	1.2ha	SDGS
D	Norgeston	Somehsara	1,988	246	8,900	1.2ha	SDGS
	Sheikhneshin	Masal	1,370	138	12,700	1.3ha	SDGS
E	Aliabad	Anzali	1,417	-	5,300	1.2ha	SS

Source: RWWC
Notes: SDGS: Small Diameter Gravity System, SS: Simplified System

(2) Proposed Plan

As mentioned in Chapter 2, RWWC's target is to achieve the service coverage ratio of 40% by 2022. However, due to financial constraints, RWWC's plan to construct community wastewater treatment systems in sixteen villages could not be commenced within the Third Five Year Plan (2000-2004) and is expected to be started in the period of the Fourth Five Year Plan (2005-2009). To attain the original target of RWWC, the service coverage ratio has to be increased by more than 15% for every 5-years. Considering the financial conditions of RWWC and the delay of the commencement of the RWWC's plan, it may be unrealistic for RWWC to meet the original target. Therefore, the present master plan employs 5% increase for every Five Year Plan. The service population by 2019 will increase as shown in Table 4.4.2.

Table 4.4.2 Service Population by Community Wastewater Treatment System

Item	2004	up to 2009	up to 2014	up to 2019
Population	394,128	393,230	392,726	392,679
Service Population (Service Ratio)	0 (0%)	19,000 (5%)	38,000 (10%)	57,000 (15%)
Number of Village	-	7	14	21

Source: JICA Study Team

From the view point of Anzali Wetland conservation, it is proposed to develop community wastewater treatment systems in the villages located in the Buffer Zone, Transition Zone and the areas near the rivers in the Fifth and Sixth Five Year Development Plan.

4.5 Management of Industrial Effluents

4.5.1 Introduction

The industrial production will increase by 2.75 times current level by 2019, and the amount of industrial effluent is expected to increase to 21,000 m^3/day in the same period assuming proportional increase in the amount of industrial effluent with the industrial production. Even if all of the industrial factories keep the effluent standard in 2019, pollution load of the industrial activities is expected to increase by 2.75 times. In case of no measures being implemented, the pollution load will be increased by more than 20 times.

In addition to the rapid increase in the amount of industrial effluent, industrial effluent may include heavy metal and toxic material. Serious environmental impact is expected in case of no measure being implemented. The management plan proposes not only construction of wastewater treatment systems, but strict monitoring and effective control systems also.

Basically, the Polluter Pay Principle (PPP) is to be adopted for the wastewater management of industrial effluent. Owners of industrial factories have the responsibility to keep the effluent standard at their own cost. To make it easy to control and manage the industrial effluent in the basin, the measures for management of industrial effluent in the basin are as proposed below:

- Centralization of factories in industrial cities,
- Construction of Centralized wastewater treatment in the industrial cities,
- Strengthening of monitoring activities by DOE.

One of the alternatives is a restriction of the number of industrial factories in the basin, in order to limit industrial pollution load generation in the basin. Because industrial development is planned in order to create job opportunities for the expected population to be increased in the basin, this alternative can hardly be accepted.

4.5.2 Centralization of Industrial Factories

There are five existing industrial cities, and one planned, in the basin as shown in Figure 4.5.1. DOE and MOIM have already considered transferring major industrial factories to these industrial cities. For an effective procedure for the centralization, a guideline for centralization is proposed. First of all, criteria for the industrial factories to be transferred to the industrial cities should be clear. It is not necessary to transfer all industrial factories as some may have no effluent and no emission. The following process is recommended for the transfer of factories to the industrial cities.

- Basically new industrial factories, which have an environmental impact such as discharging effluent and emission, should be constructed in the industrial cities,
- Existing factories, which have the environmental impact, should be transferred to the industrial cities within a certain period to be fixed, such as 5-10 years, or should have a complete wastewater treatment system.

In the case of Japan, industrial factories that meet the criteria of industrial factory in, by law, cannot be constructed near residential areas. This provides environmental protection for living, and centralization of industrial factories is promoted for effective development of industrial activities and environmental conservation. The criteria in Japan are defined for each industrial factory by “Type of manufacture”, “Floor area”, “Type of material to be used for factories”, etc.

For promotion of the centralization some incentives need to be prepared. The following privileges have already been prepared for factories to be constructed in the industrial cities.

- Four year exemption of municipality taxes,
- Installment payments for land acquisition,
- Financial assistance from the government.

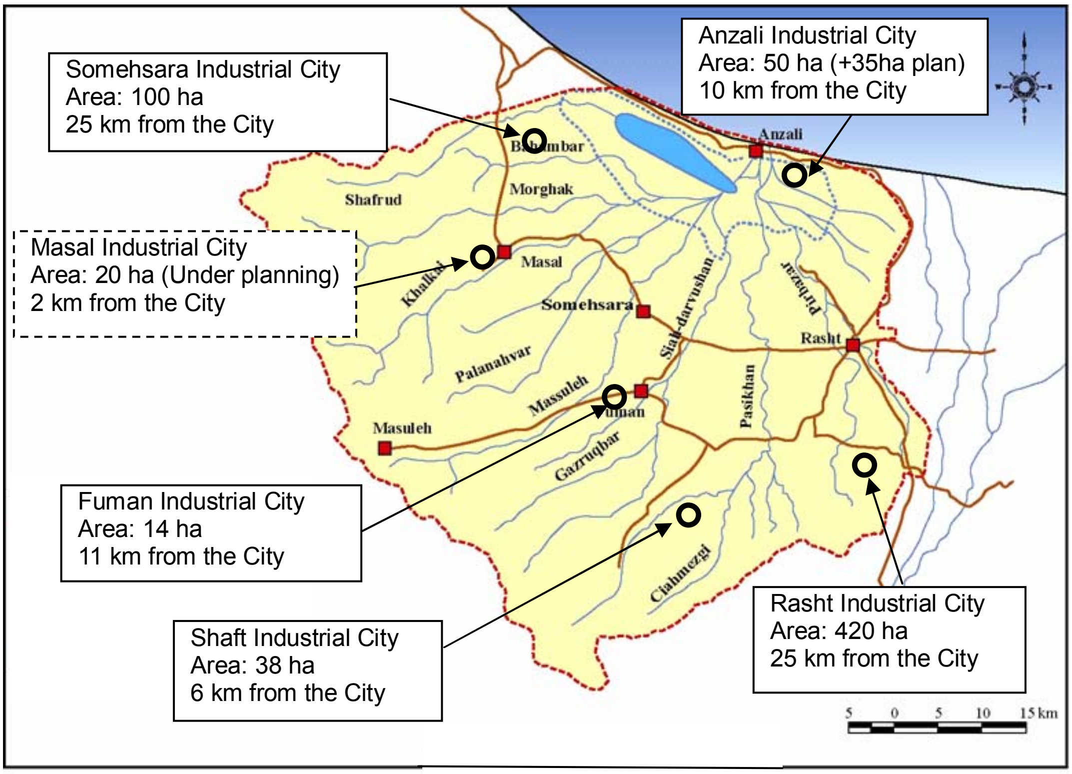

Figure 4.5.1 Location of Existing and Planned Industrial Cities

4.5.3 Construction of Centralized Wastewater Treatment Systems

Central wastewater treatment systems are proposed for the effective management of wastewater in the industrial cities. In the wastewater management plan, it is proposed to construct centralized wastewater treatment systems with treatment capacity to meet 21,000 m^3/day of the total industrial effluent predicted in the basin. At present, there are no wastewater treatment systems in the industrial cities, though as a first step, a small-scale wastewater treatment system with a treatment capacity of 100 m^3/day is under construction in Anzali Industrial City. Rasht Industrial City Company is considering a plan for construction of a wastewater treatment system. Based on discussions with relevant organizationss, the proposed wastewater treatment capacity for each industrial city is tentatively estimated as shown in Table 4.5.1. At present, there is no plan to construct any wastewater treatment systems except for the Rasht and Anzali industrial cities.

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Table 4.5.1 Wastewater Treatment Systems in Industrial Cities in the Basin

Industrial City	Treatment Capacity by 2019	Owner	Present Situation
Rasht	14,000 m^3/day	Rasht Industrial City Company	There is a plan for construction of the treatment system. Rasht Industrial City Company is looking for funds for design and construction of a wastewater treatment system.
Shaft	500 m^3/day	MOIM	No plan
Somehsara	500 m^3/day	MOIM	No plan
Fuman	500 m^3/day	MOIM	Noplan
Masal	500 m^3/day	MOIM	No plan
Anzali	5,000 m^3/day	MOIM	A treatment plant with a treatment capacity of 100 m^3/day is under construction. Expansion of the treatment capacity is required, but no plan for the expansion is prepared.

The image of the centralized wastewater treatment system is as shown in Figure 4.5.2.

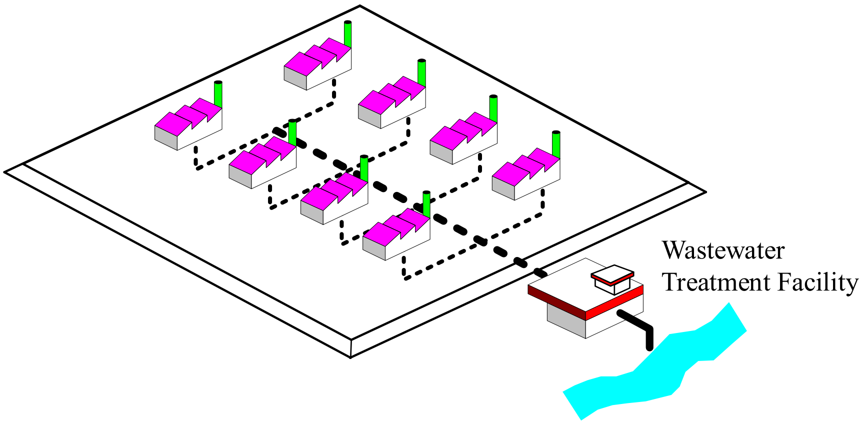


Figure 4.5.2 Image of Centralized Wastewater Treatment System

4.5.4 Strengthening of Monitoring Activities by DOE

DOE, Human Environmental Department is expected to play an important role to improve condition of industrial effluent from each industrial factory. The following activities are proposed for strengthening of DOE activities for industrial effluent control

(1) Expansion of Monitoring Activity

Current monitoring of DOE is only carried out on major industrial factories several times per year. If any problem is found from the monitoring, DOE Guilan issues an order to improve the effluent system in the factory. There are about 50 water quality parameters in the effluent standards, including heavy metals and other toxic materials. However, monitoring by DOE Guilan only covers 30 parameters, and those do not include heavy metals or other toxic materials. Monitoring including these substances is proposed for all of industrial factories in the basin. As mentioned in section 4.8.2, it is proposed to monitor activities of the industrial factories in the basin and make a data base. The data base shall be revised once a year based on new monitoring data.

(2) Expansion of Human Environmental Department

For expansion of industrial monitoring activities, a new water quality laboratory with an atomic absorption spectrophotometer is under construction for heavy metal analysis in DOE, Guilan headquarters. It is also proposed to increase technical staff for environmental monitoring and inspection of industrial factories.

4.6 Management of Livestock Waste

4.6.1 Introduction

There are about 860,000 head of cows, buffaloes, sheep and goats overall the basin. These animals are kept in four ways, i.e., .fed by Individual Farmers in the Plain, in Grazing Land of the Mountain Area, in Grazing Land of the Plain and in Industrial Animal Husbandry. It is evaluated that livestock fed by Individual Farmers in the Plain and in Grazing Land of the Mountain Area have no serious impact of Anzali Wetland, because waste from livestock fed by the farmers have been managed, and waste from livestock in the grazing land of the mountain area can hardly reach to the wetland. With the removal of 250,000 heads of livestock under the rangeland management by NRGO, about 13 % of the pollution load from the livestock is expected to be eliminated without any futher measures. The following measures are proposed for management of livestock waste.

Table 4.6.1 Measures for Management of Each Group of Livestock

Group	Measures
1) Livestock in Industrial Animal Husbandries	Installation of treatment facilities for waste from industrial animal husbandry
2) Livestock Grazing in Plain Area	Installation of Water Points and dykes to prevent livestock waste discharging directly to rivers

4.6.2 Treatment of Waste from Industrial Animal Husbandry

A building for industrial animal husbandry is a point source like an industrial factory. Waste from industrial animal husbandry should be managed same as industrial effluent, according to the bylaw. As shown in Figure 4.6.1, a building for industrial animal husbandry is required to install storage for livestock manure and a wastewater treatment facility. A re-use plan for livestock manure shall be prepared.

Industrial animal husbandries, which feed more than 20 head of cows, feed about 3,000 heads at seventeen sites in the basin. At present there is not any wastewater treatment facility for industrial animal husbandry in the basin. Wastewater treatment system and storage for livestock manure shall be installed in all the industrial animal husbandry facilities.

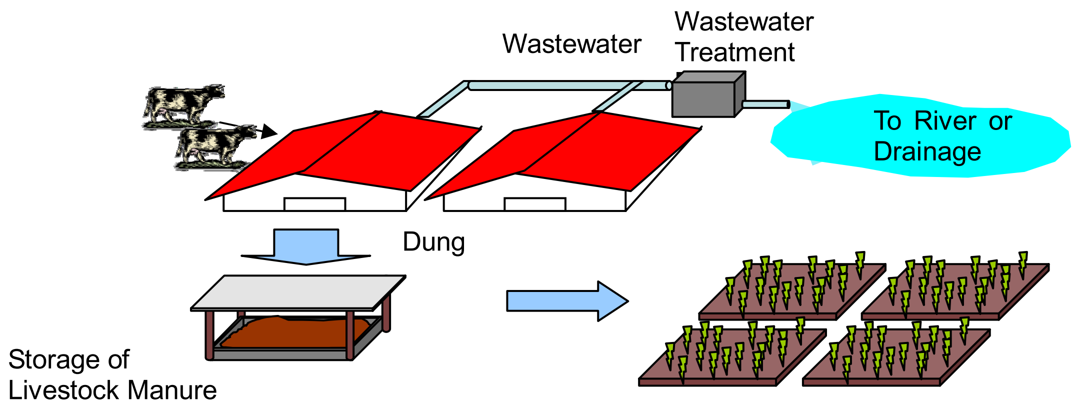


Figure 4.6.1 Image of Management of Livestock Waste in Industrial Animal Husbandry

At present, a new building for industrial animal husbandry, which feed not less than 20 heads of cows, is required to have a suitable wastewater treatment facility and storage for livestock manure. Before issuance of construction permit for a new building for industrial animal husbandry, DOE, Human Environmental Department evaluate the treatment system for livestock waste in it.

4.6.3 Control of Livestock Waste in Grazing Lands in the Plain Area

About 20,000 heads of cows and buffalos are feed in the grazing land in the plain area, which is located near the wetland and the rivers. This may be a serious pollution source, because livestock waste may discharge directly to the wetland and the rivers. Because it is not possible to collect and treat the livestock waste in the grazing land, installation of water points and dykes is proposed to prevent livestock waste from discharging to the wetland and the rivers as below.

- Installation of water points for livestock far from rivers and installation of fences along the river, in order to prevent livestock from going to the river. Any livestock tend to excrete when they drink water, and when livestock drink water in a river, it may a serious situation for river pollution caused by livestock.
- Installation of dyke to prevent drainage water in the rangeland from discharging into rivers.

It is one of the popular measures for pollution control of livestock waste in Japan. The locations required for the proposed measures are grazing areas in the Buffer Zone and Transition Zone and along the wetland and the rivers. The proposed dykes consist of a grass zone and trees between the plain and the rivers. The measure is illustrated in Figure 4.6.2.

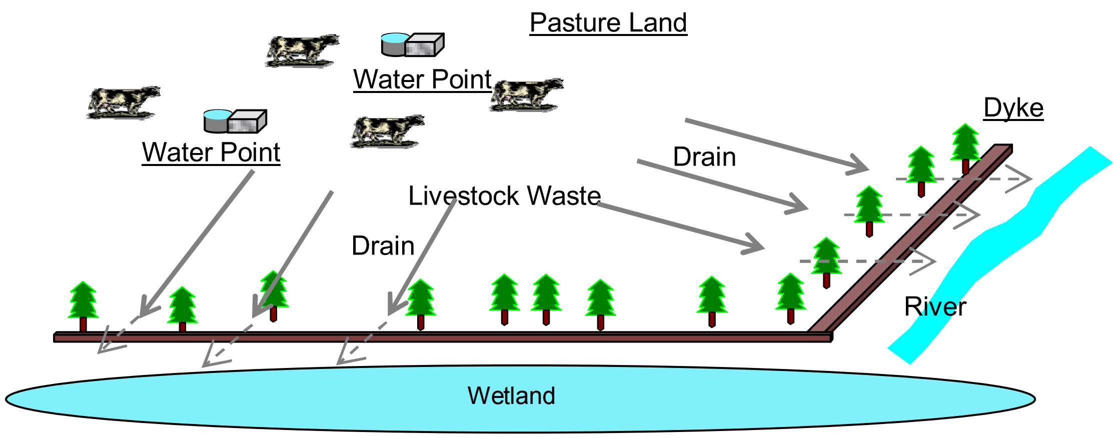


Figure 4.6.2 Image of Water Points and Dykes

4.7 Management of Pollution from Farmland

4.7.1 Introduction

The Agricultural Support Center of MOJA has been implementing programs to reduce the uses of chemical fertilizers and other agricultural chemicals. As a result, the application rate of phosphorous in the area has been reduced to almost 1/10 of previous level in the last 10 years, and as many as 20,000 ha or some 22% of the agricultural areas received biological pest management in 2002. According to extension service specialists and farmers, about 80% of the farmers in the study area follow instructions of agricultural extension specialists, and the purchase of farm inputs (chemical fertilizers and other agrochemicals) is controlled through the cooperatives. Overall, substantial efforts have already been made to control applications of chemical fertilizers and other agricultural chemicals.

According to MOJA, it is estimated that about 6,000 ton of nitrogen and 324 ton of phosphate were used in the area last year. Although the average application level of fertilizer for rice farming in the area is not high, the total quantities of fertilizers used are rather large since the paddy fields extend widely over the study area. Likewise, the application level of agricultural chemicals seems low, but the total quantity of agrochemicals used in the study area amounts to 500 ~ 600 ton /ha as a whole.

At this point, it is difficult to evaluate whether further reduction of fertilizers and other agricultural chemicals is practical, as such decisions could affect the livelihood of local farmers, and more discussions and researches are needed. Nevertheless, there are many reasons to at least tighten the control of fertilizes and other agrochemicals, if not reduce their uses.

- Pesticides and herbicides potentially have detrimental impacts on the wetland ecosystem. Even though many species may have significant tolerance to such chemicals, there are susceptible species[2], and loss of these species could affect the entire ecological balance of the region.

- It is generally desirable to minimize the amounts of agrochemicals in agricultural products from the perspective of food safety.
- Groundwater pollution by nitrate has been reported in the plain areas of the northern provinces, which may be partially attributed to excessive use of chemical fertilizers.

Considering the need to balance the production and environmental conservation, the master plan proposes the following programs.

4.7.2 Promotion of Farming with Less Input

(1) Promotion of use of compost such as livestock manure and/or Azolla

Traditionally, farmers use livestock waste as one of farm inputs in the study area. Although it might possibly cause water pollution by COD, T-N and T-P if it is excessively dosed, livestock waste-based compost should be further promoted to minimize the use of chemical fertilizers, especially nitrogen-based ones (e.g., urea, ammonium sulfate, etc.). Application of organic materials can make soil healthy and help to minimize an outbreak of diseases and pest infestation if it is properly treated. The Agricultural Service Center needs to disseminate information regarding proper application of organic materials as well as appropriate application levels of chemical fertilizers based on the dosage of organic materials.

The following actions should be considered to promote the use of compost.

- to provide subsidy for using organic materials
- to give added value to products organically grown (e.g., promotion of the product brand “Organic Rice from Guilan Province”)
- to develop a network with industrial livestock raisers to encourage recycling livestock waste

As discussed in Chapter 4, the use of compost/organic materials should first focus on the buffer zone to minimize the pollution load to the wetland.

(2) Expansion of Integrated Pest Management through Farmer Field School

Integrated pest management (IPM) has been promoted by MOJA as one of their extension programs. The main principle of IPM is to increase the profit of individual farmers by reducing the expenses for external farm inputs while maintaining the productivity. Major practices taken under IPM are i) identification and predition of pests, ii) determination of whether pest populations will reach a level that could cause economic damage, iii) application of agricultural chemicals in case the situation is severe, and iv) maintenance of crop health. The Farmer Field

[2] For example, crustaceans and some fish species are sensitive to diazinon, a pesticide widely used in the area. The reported PNEC (predicted no effect concentration) for aquatic species is as low as 0.00026 ug/L (Ministry of Environment, Japan, 2003).

School (FFS), which is a training course composed of guidance and practical sessions in the field, has been a major tool for the promotion of IPM. Since all the practices from identification to chemical application should be done by farmers themselves, the capacity development of farmers is essential for the implementation of IPM. In general, the FFS for rice farming organizes a field session per week and lasts for one cropping season.

Although MOJA has conducted the IPM program since 1999, the coverage of the activity is limited and the IPM practices seem unfamiliar to farmers in the study area. It is, therefore, proposed that two groups of two experts on IPM conducts 10 FFSs every year at different sites, and give guidance to about ten families of farmers at each school for several months. The experts on IPM need to keep close relation with the farmers and give technical guidance to farmers to enable them to use the proposed practices. As a result of 10 FFSs, about one hundred families of farmers can get guidance for about 200 ha of farmland every year. The farmers who get the guidance are expected to be trainers and disseminate their knowledge to their neighbors. FFS includes the following guidance:

- Guidance on identification and prediction of insects / pests to be controlled
- Guidance on methods of pesticide use with suitable types and amounts of pesticide to meet the site conditions
- Guidance for biological control of insect pests in order to reduce pesticide consumption
- Guidance for methods of herbicide reduction

The proposed IPM program should be concentrated on the buffer zone at the beginning of the master plan, and thence, it will expand its activity to the transition zone gradually.

(3) Promotion of proper farming practice

Farming practices on farm input application and water management are crucial for the control of pollution loads from farmlands. Draining irrigation water soon after application of farm inputs (fertilizers / agricultural chemicals) results in the discharge of highly polluted water with nitrogen, phosphorous or toxic materials to rivers as well as the wetland. Needless to say, over-dosage can easily cause contamination of drainage water.

As shown in Section 2.7.2, Diazinon is the main agricultural chemical presently used in the area. Since it has the property of being easily hydrolyzed and reduced in paddy fields, the water retention for a certain period after application is very important. Due attention should be paid to water management to minimize the discharge of pollution loads to river systems. Therefore, the Agricultural Service Center should also emphasize water management at the field level in addition to the extension works on the uses of agricultural chemicals and fertilizers.

4.7.3 Coordination between Monitoring and Agricultural Extension

The polluted level of river water caused by farm inputs should be monitored periodically, especially in the months when farmers apply agricultural chemicals and fertilizers on their farms. It is also important to feed back the findings of monitoring to decision makers for remedial actions to prevent further environmental degradation of the wetland.

Monitoring of water quality will be undertaken by DOE and MOE as described in the succeeding section 4.8 "Environmental Monitoring for Wastewater Management". Therefore, the close coordination between them (DOE and MOE) and MOJA, who are responsible for agricultural extension works, is necessary to improve and maintain the wetland environment.

4.8 Environmental Monitoring for Wastewater Management

4.8.1 Introduction

The wastewater management plan was prepared based on available data on the environmental condition of Anzali Wetland and the situation of pollution sources in the basin. During development of the wastewater management plan, the management plan shall be revised to meet actual future situation regarding the following items.

1) Changing water quality in Anzali Wetland and the rivers following to the wetland
2) Changing amount of pollution load generation in the basin
3) Progress of implementation of proposed projects in the wastewater management plan
4) Operational condition of proposed projects in the wastewater management plan

It is proposed that every 5 years the wastewater management plan should be revised based on the monitoring data showing the above situation.

4.8.2 Monitoring Programs

Since monitoring on Ambient Water Quality in Anzali Wetland is proposed in the Wetland Ecological Management Plan, the following 6 programs are proposed for monitoring of wastewater management.

Table 4.8.1 Proposed Monitoring Program for Wastewater Management

Monitoring	Organization	Purpose
1) On Domestic Wastewater Treatment	GWWC, RWWC	- Preparation of data for revising the management plan for domestic wastewater in urban area and rural area
2) On Industrial Factories	DOE	- Preparation of data for revising the management plan for industrial effluent
3) On Agricultural Activity	MOJA	- Preparation of data for revising the management plan for livestock waste and pollution from farmland
4) On pollution load to the wetland	DOE	- Preparation of data for revising the overall the wastewater management plan
5) On Ambient Water Quality	DOE and MOE	- Preparation of data for revising the overall the wastewater management plan

The details of the above 6 programs are as described as below.

Table 4.8.2 Monitoring of the Sewerage System

Objective	To monitor the condition of domestic wastewater treatment
Organization	GWWC, RWWC
Monitoring Program - Influent/Effluent	General Parameters (discharge rate, Temp., BOD, COD, T-N, T-P, SS), each Wastewater Treatment Plant, One time/day Toxic Parameters (heavy metals, pesticides), 1 time/month
- Development of Sewerage System	Length of Sewer Pipes by each diameter, once a year Total Operational Capacity of Wastewater Treatment
- Condition of Wastewater Treatment	Sewerage Service Population, once a year Service Population of Individual Wastewater Treatment Facility, once a year Service Population of Community Wastewater Treatment System, once a year
Analysis and Storage of Information	Every year, GWWC compiles the findings into a report.

Table 4.8.3 Monitoring of Industrial Factories

Objective	To inspect compliance of industries with effluent standards.
Organization	DOE and IMO
Monitoring Program - Industrial Activity	Basic Data (Type of industry, production amount, water consumption, number of employees, location, etc.), all industrial factories, updated once a year
- Industrial Wastewater	General Parameters (discharge rate, Temp., BOD, COD, TDS, T-N, T-P, SS), 40 locations, 1 time/year, Toxic Parameters (heavy metals, pesticides); 40 locations; 1 time/year
Analysis and Storage of Information	Every year, DOE compiles the finding into a technical report.

Table 4.8.4 Monitoring on Agricultural Activity

Objective	To monitor the condition of pollution sources in agricultural activities
Organization	MOJA
Monitoring Program - Livestock	 Number of cows, buffalo, sheep and goats, once a year Information of Industrial Animal Husbandry (location, number of livestock, situation of management of livestock waste), once a year, updated
- Activity in Farmland	Total area of agricultural land Total consumption of chemical fertilizers, Total consumption of pesticides and herbicide and other agricultural chemicals, once a year
- Analysis and Storage of Information	Every year, MOJA compiles the finding into a technical report.

Table 4.8.5 Ambient Water Quality Survey

Objective	To monitor ambient water quality of rivers and groundwater. The water quality of the wetland is monitored under a different program.
Organization	DOE and MOE
Monitoring Program - Water Quality	 General Parameters (Temp., DO, BOD, COD, T-N, T-P, SS, transparency), 20 locations, 4 times (spring, summer, fall, winter) Toxic Parameters (heavy metals, pesticides, herbicides); 20 locations; 3 times/year
- Sediment Quality	General parameters (depth, texture, organic carbon, T-N, T-P), Toxic parameters (heavy metals, pesticides); 10 locations; 1 time/year
- Groundwater	General Parameters (Temp., MnO_2 demand, NO_3, NH_4, T-P, turbidity, TDS, others), 10 locations, 4 times (spring, summer, fall, winter) Toxic Parameters (heavy metals, pesticides); 10 locations; 1 times/year
Analysis and Storage of Information	DOE compiles the findings into a technical report. A database of river water quality should be developed by DOE.

Table 4.8.6 Water Pollution Load Discharged to Rivers

Objective	To monitor ambient water quality of rivers and groundwater. The water quality of the wetland is monitored under a different program.
Organization	DOE and MOE
Monitoring Program - Water Quality and River Discharge	 General Parameters (Flow rate, BOD, COD, T-N, T-P, SS), 7 locations, 4 times/year (spring, summer, fall, winter)
Analysis and Storage of Information	DOE compiles the findings into a technical report. A database of river water quality should be developed by DOE.

For dissemination of all information from the above monitoring, the report will be distributed to DOE, MOE, GWWC, RWWC and other interested parties.

4.9 Institutional Arrangement

In order to effectively implement the proposed wastewater management plan, the following institutional arrangement is proposed.

(1) Revision of Regulations related to Effluent Standard

There appear to be conflicting regulations about the effluent standard, pollution charges related to effluent, pollution tax on industry, and fines and punitive measures associated with pollution. These regulations should be clarified and unified under a clear legal framework for pollution control.

(2) Establishment of Ambient Water Standard

Iran has no standards or guidelines for ambient water quality. It is recommended that ambient water quality standards should be established for different water bodies (rivers, lakes, coastal wetlands, etc.) taking into consideration the ideal water quality, the current situation and uses of the water bodies.

CHAPTER 5 COST ESTIMATE

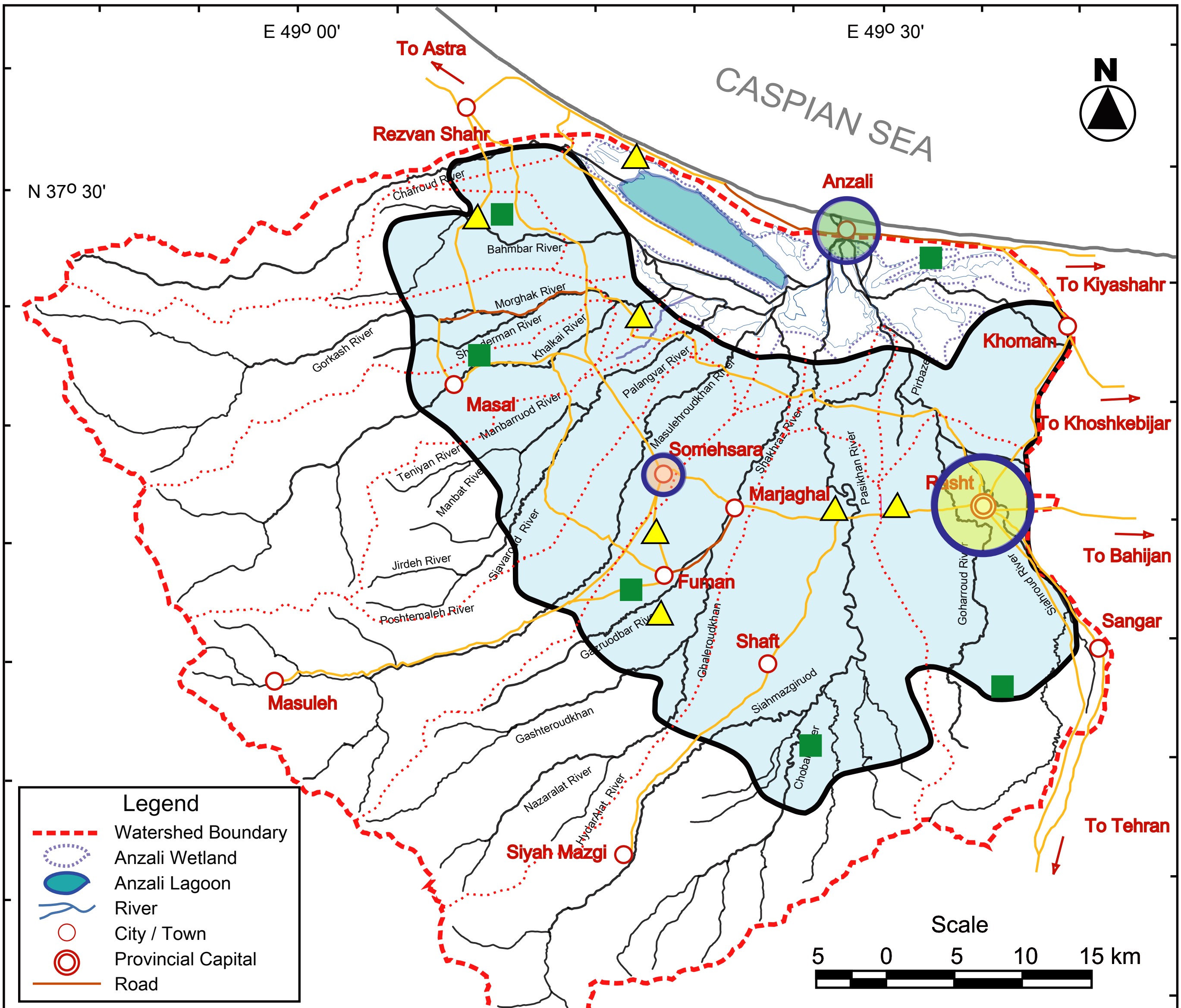
5.1 Summary of Proposed Wastewater Management Plan

The summaries of the proposed projects in the wastewater management plan are as shown in Table 5.1.1 and Figure 5.1.1.

Table 5.1.1 List of Proposed Projects and Executing Organizations

Sub-Components		Proposed Projects/Measures	Executing Organizations
Management of Domestic Wastewater in Urban Area	(1)	Rasht Sewerage System Development Project Phase 1 Service Population: 253,816 residents Treatment Capacity: 80,000 m^3/d Phase 2 Service Population: 378,284 residents Treatment Capacity: 80,000 m^3/d	GWWC
	(2)	Anzali Sewerage System Development Project Phase 1 Service Population: 77,920 residents Treatment Capacity: 34,000 m^3/d Phase 2 Service Population: 51,000 residents Treatment Capacity: 20,000 m^3/d	GWWC
	(3)	Somehsara Sewerage System Development Project Service Population: 56,980 residents Treatment Capacity: 12,700 m^3/d	GWWC
	(4)	Promotion of Individual Wastewater Treatment Facilities outside of Sewerage Service Area Target Population: 113,000 residents Number of Septic Tank Installation: 22,600 units	DOE
	(5)	Promotion of Low Phosphorous Detergent Use	DOE
Management of Domestic Wastewater in Rural Area	(1)	Community Wastewater Treatment System Development Service Population: 57,000 residents Sites: 21 villages	RWWC
Management of Industrial Effluent	(1)	Centralization of Industrial Factories Sites: Six Industrial Cities (Anzali, Rasht, Somehsara, Fuman, Shaft and Masal)	DOE/MOIE
	(2)	Construction of Centralized Wastewater Treatment System Sites: Six Industrial Cities (Anzali, Rasht, Somehsara, Fuman, Shaft and Masal) Total Treatment Capacity: 21,000 m^3/day	DOE/MOIE/ Private company
	(3)	Strengthening of Monitoring Activities by DOE	DOE
Management of Livestock Waste	(1)	Treatment of livestock waste from industrial animal husbandry Sites: 17 sites of existing industrial animal husbandries	DOE
	(2)	Control of livestock waste in grazing lands in the plain area	DOE
Management of Pollution from Farmland	(1)	Promotion of farming with less input 1) Promotion of use of compost such as livestock manure and/or Azolla 2) Expansion of Integrated Pest Management through Farmer Field School 3) Promotion of Proper Farming Practice	MOJA

Source: JICA Study Team



Proposed Projects/Measures

1. Management of Domestic Wastewater in Urban Area
   - (1) Rasht Sewerage System Development Project ( )
   - (2) Anzali Sewerage System Development Project ( )
   - (3) Somehsara Sewerage System Development Project ( )
   - (4) Promotion of Individual Wastewater Treatment Facilities outside Sewerage Service Area
   - (5) Promotion of Low Phosphorous Detergent Use
2. Management of Domestic Wastewater in Rural Area
   - (1) Community Wastewater Treatment System Development The designs for seven villages ( ) were completed.
3. Management of Industrial Effluent
   - (1) Centralization of Industrial Factories ( )
   - (2) Construction of Centralized Wastewater Treatment System
   - (3) Strengthening of Monitoring Activities by DOE
4. Management of Livestock Waste
   - (1) Treatment of Livestock Waste from Industrial Animal Husbandry
   - (2) Control of Livestock Waste in Grazing Lands in the Plain Area
5. Management of Pollution from Farmland ( )
   - (1) Promotion of Farming with Less Input
   - (2) Coordination between Monitoring and Agricultural Extension
6. Environmental Monitoring for Wastewater Management
   Monitoring of Domestic Wastewater Treatment, Industrial Factories, Agricultural Activity, Pollution Loads to the wetland, and Ambient Water Quality

The Study on Integrated Management for Ecosystem Conservation of the Anzali Wetland in the Islamic Republic of Iran

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 5.1.1

Wastewater Management Plan

5.2 Basic Conditions for Cost Estimate

Rough project costs for the proposed projects are estimated in principal under the following conditions:

(1) Construction Cost

The cost estimates for the following projects are calculated based on the following data. The breakdowns of each project costs are described in Table 5.3.2.

Table 5.2.1 Data Source for Construction Cost Estimation

Project	Data Source
Rasht Sewerage System Development	Based on Rasht Water Supply and Wastewater Collection and Disposal, Feasibility Studies (Final Report) in August 2004
Anzali Sewerage System Development	Based on Rasht/Anzali Water Supply and Wastewater Collection and Disposal, Feasibility Studies (Draft Report) in March 2003, the units prices were modified considering price escalation up to 2004. The cost of WWTP is estimated by JICA Study Team.
Somehsara Sewerage System Development	Based on the data from GWWC
Development of Community Wastewater Treatment System	Based on the data from RWWC, Gilan,

Source: JICA Study Team

(2) Operation and Maintenance Cost

The O & M cost estimates for the following projects are calculated based on the following data. The breakdowns of O&M cost of the project costs are described in Table 5.3.2.

Table 5.2.2 Data Source for O&M Cost Estimation

Project	Data Source
Rasht and Anzali Sewerage System Development	Based on Rasht/Anzali Water Supply and Wastewater Collection and Disposal, Feasibility Studies (Draft Report) in March 2003, the units prices were modified considering price escalation up to 2004. The cost of WWTP is estimated by JICA Study Team.
Somehsara Sewerage System Development	Based on the data in 2004 from GWWC.
Development of Community Wastewater Treatment System	Based on the data prepared by RWWC, Gilan in 2001, the unit prices were modified based on RWWC suggestions.

Source: JICA Study Team

The following unit costs are used for the O & M cost estimations.

Table 5.2.3 Unit Costs for O&M Cost Estimation

Items	Unit Cost
Staff Expenditures	Engineer: 36 million Rial/p/y, Technical/Clerk: 24 million Rial/p/y Semi-skilled Workers: 17 million Rial/p/y, Laborers: 15 million Rial/p/y
Electricity	500 Rial/KWH
Chemical	Chlorine: 1,500 Rial/kg, Lime: 400 Rial/kg, Polyelectrolutes: 25,000 Rial/kg
Repair and Maintenances	1 % of Construction Cost per year

Source: JICA Study Team

5.3 Cost Estimate

Table 5.3.1 shows the estimate of total investment cost and O&M cost of the proposed projects. Total investment cost is estimated about 2,449,866 million Rials, and average annual O&M cost for the proposed projects are estimated 42,634 million Rials/year.

The cost breakdowns are described from Table 5.3.2 to Table 5.3.11.

Table 5.3.1 Cost Estimate of Physical Measures for Wastewater Management

Proposed Projects/Measures	Project Cost (million Rials)	O&M Cost	
		Overall (million Rials)	Average Annual (million Rials/year)
1. Management of Domestic Wastewater in Urban Areas			
(1) Rasht Sewerage System Development Project			
1) Rasht sewerage (Phase 1), for 253,816 residents	741,088	274,218	25,810
2) Rasht sewerage (Phase 2), for 378,284 residents	588,426		
(2) Anzali Sewerage System Development Project			
1) Anzali sewerage (Phase 1), for 77,920 residents	510,018	90,161	8,443
2) Anzali sewerage (Phase 2), for 51,000 residents	177,633		
(3) Somehsara Sewerage System Development Project for 56,980 residents	214,380	33,984	4,076
(4) Promotion of Individual Wastewater Treatment	28,250	283	283
(5) Promotion of Low Phosphorous Detergent	0	1,940	194
Sub-total	2,259,795	400,586	38,806
2. Management of Domestic Wastewater in Rural Areas			
(1) Community Wastewater Treatment System Development			
1) Initial Stage for Seven Villages	19,830	8,349	1,089
2) Second Stage	19,830		
3) Third Stage	19,830		
Sub-total	59,490	8,349	1,089
3. Management of Industrial Effluent			
(1) Centralization of Industrial Factories	1,330	0	0
(2) Construction of Centralized Wastewater Treatment System			
1) Rasht industrial city	67,500	17,249	2,052
2) Anzali, Somehsara, Fuman and other industrial cities	60,750		
(3) Strengthening of Monitoring Activities by DOE	0	4,095	273
Sub-total	129,580	21,344	2,325
4. Management of Livestock Waste			
(1) Treatment of Livestock Waste from Industrial Animal Husbandry	500	260	20
(2) Control of Livestock Waste in Grazing Lands in the Plain Area	500	300	84
5. Management of Pollution from Farmland			
(1) Promotion of Farming with Less Input			
1) Expansion of use of compost such as livestock manure and/or Azolla	0	3,960	402
2) Expansion of integrated pest management through farmer field school			
3) Promotion of Proper Farming Practice			
6. Environmental Monitoring	0	5,250	350
Total	2,449,866	439,766	42,634

Source: JICA Study Team

Table 5.3.2 Project Cost of Sewerage System Development in Rasht (Phase1)

(Unit: Million Rials)

Cost Item	Unit	Unit Price	Quantity	Amount
1. Construction Cost				
1.1 Sewer Pipes (Dia. 200mm)	km	415.8	104.1	43,286
1.2 Intercepter (Dia. 250-500mm)	km	424.7	408.5	173,483
1.3 House Connection (Dia. 160mm)	km	427.6	341.9	146,190
1.4 Trunk Main (Dia. 600-1400mm)	km	1,606.3	31	49,796
1.5 Pumping Station (15 stations)	ls	96,199	1	96,199
1.6 Advanced Traetment for WWTP	ls	40,000	1	40,000
Sub-Total				548,954
2. Land Acquisition	m2			0
3. Compensation				0
4. Administration Cost (5% of 1.)	ls			27,448
5. Engineering Cost (10% of 1.)	ls			54,895
6. Physical Contingency	ls			109,791
(20% of 1. to 3.)				
Total of 1. to 6.				741,088

Source: JICA Study Team

Table 5.3.3 Project Cost of Sewerage System Development in Rasht (Phase2)

(Unit: Million Rials)

Cost Item	Unit	Unit Price	Quantity	Amount
1. Construction Cost				
1.1 Sewer Pipes (Dia. 200mm)	km	300.4	104.1	31,268
1.2 Intercepter (Dia. 250-500mm)	km	274.4	408.5	112,100
1.3 House Connection (Dia. 160mm)	km	196.3	341.9	67,110
1.4 Trunk Main (Dia. 600-1400mm)	km	721	31	22,350
1.5 Pumping Station (15 stations)	ls	32,043	1	32,043
1.6 Advanced Traetment for WWTP	ls	20,000	1	20,000
1.7 WWTP (Capa. 80,000 m3/day)	ls	150,000	1	150,000
1.8 Power Transmission	ls	1,000	1	1,000
Sub-Total				435,871
2. Land Acquisition	m2			0
3. Compensation				0
4. Administration Cost (5% of 1.)	ls			21,794
5. Engineering Cost (10% of 1.)	ls			43,587
6. Physical Contingency	ls			87,174
(20% of 1. to 3.)				
Total of 1. to 6.				588,426

Source: JICA Study Team

Table 5.3.4 Project Cost of Sewerage System Development in Anzali (Phase1)

(Unit: Million Rials)

Cost Item	Unit	Unit Price	Quantity	Amount
1. Construction Cost				
1.1 Sewer Pipes (Dia. 200mm)	km	372	171	63,612
1.2 Intercepter (Dia. 250-500mm)	km	704.4	132	92,981
1.3 House Connection (Dia. 160mm)	km	274.8	65.5	17,999
1.4 Trunk Main (Dia. 600-1400mm)	km	2187.6	18.1	39,596
1.5 Trunk Main (Dia. 1400mm) in Wes	km	3429.6	3.5	12,004
1.6 Pumping Station	ls	4800	18	86,400
1.7 Advanced Treatment for WWTP	ls	10000	1	10,000
1.8 WWTP (Capa. 14,000m^{3}day)	ls	54000	1	54,000
1.9 Power Trasmission Line for Plant	ls	1200	1	1,200
Sub-Total				377,791
2. Land Acquisition	m2			0
3. Compensation				0
4. Administration Cost (5% of 1.)	ls			18,890
5. Engineering Cost (10% of 1.)	ls			37,779
6. Physical Contingency	ls			75,558
(20% of 1. to 3.)				
Total of 1. to 6.				510,018

Source: JICA Study Team

Table 5.3.5 Project Cost of Sewerage System Development in Anzali (Phase2)

(Unit: Million Rials)

Cost Item	Unit	Unit Price	Quantity	Amount
1. Construction Cost				
1.1 Pipes (Dia. 160-500mm)	km	300	176	52,800
1.4 Trunk Main (Dia. 600-1400mm)	km	2400	2.2	5,280
1.6 WWTP (Capa. 13,000m^{3}day)	Units	49500	1	49,500
1.8 WWTP (Capa. 7,000m^{3}day)	Unit	24000	1	24,000
Sub-Total				131,580
2. Land Acquisition	m2			0
3. Compensation				0
4. Administration Cost (5% of 1.)	ls			6,579
5. Engineering Cost (10% of 1.)	ls			13,158
6. Physical Contingency	ls			26,316
(20% of 1. to 3.)				
Total of 1. to 6.				177,633

Source: JICA Study Team

Table 5.3.6 Project Cost of Sewerage System Development in Somehsara

(Unit: Million Rials)

Cost Item	Unit	Unit Price	Quantity	Amount
1. Construction Cost				
1.1 Pipes (Dia. 225-600mm)	km	500	87	43,500
1.2 Trunk Main (Dia. 800mm)	km	2200	2	4,400
1.3 House Connection (Dia. 160mm)	km	350	78	27,300
1.4 Pumping Station	Units	15000	1	15,000
1.5 WWTP (Capa. 12,700m^{3}day)	Unit	39600	1	39,600
1.6 Miscellaneous				29,000
Sub-Total				158,800
2. Land Acquisition	m2			0
3. Compensation				0
4. Administration Cost	ls			7,940
(5% of 1.)				
5. Engineering Cost	ls			15,880
(10% of 1.)				
6. Physical Contingency	ls			31,760
(20% of 1. to 3.)				
Total of 1. to 6.				214,380

Source: JICA Study Team

Table 5.3.7 Project Cost of Community Wastewater Treatment System (Phase1)

(Unit: Million Rials)

Cost Item	Unit	Unit Price	Quantity	Amount
1. Construction Cost				
1.1 Atashgah				
a. Septic tanks	units	3	339	1,017
b. Pipes	m	0.1	9200	920
c. Additional Treatment	residents	0.2	4353	871
Sub-total				2,808
1.2 Kheshtnasjed				
a. Septic tanks	units	3	0	0
b. Pipes	m	0.1	10900	1,090
c. Additional Treatment	residents	0.2	4796	959
Sub-total				2,049
1.3 Gasht				
a. Septic tanks	units	3	470	1,410
b. Pipes	m	0.1	23000	2,300
c. Additional Treatment	residents	0.2	3402	680
Sub-total				4,390
1.4 Loleman				
a. Septic tanks	units	3	25	75
b. Pipes	m	0.1	3700	370
c. Additional Treatment	residents	0.2	999	200
Sub-total				645
1.5 Nageston				
a. Septic tanks	units	3	246	738
b. Pipes	m	0.1	8900	890
c. Additional Treatment	residents	0.2	1988	398
Sub-total				2,026
1.6 Sheikhneshin				
a. Septic tanks	units	3	138	414
b. Pipes	m	0.1	12700	1,270
c. Additional Treatment	residents	0.2	1370	274
Sub-total				1,958
1.7 Aliabad				
a. Septic tanks	units	3	0	0
b. Pipes	m	0.1	5300	530
c. Additional Treatment	residents	0.2	1417	283
Sub-total				813
Total of 1.				14,689
2. Land Acquisition	m2			0
3. Compensation				0
4. Administration Cost	ls			734
(5% of 1.)				
5. Engineering Cost	ls			1,469
(10% of 1.)				
6. Physical Contingency	ls			2,938
(20% of 1. to 3.)				
Total of 1. to 6.				19,830

Source: JICA Study Team

Table 5.3.8 Annual Operation and Maintenance Cost of Rasht Sewerage System in 2019

(Unit: Million Rials)

Cost Item	Unit	Unit Price	Quantity	Amount
1. Personnel Cost				
1.1 Engineer	person	36	14	504
1.2 Technicial/Cleark	person	24	48	1,152
1.3 Semi-skilled Workers	person	17	18	306
1.3 Labours	person	15	84	1,260
				3,222
2. Expenses				
2.1 Electric Power	kWH	0.0005	24,550,764	12,275
2.2 Chemical				
a. Chlorine	ton	1.8	451	811
b. Lime	ton	0.5	2,669	1,335
c. Polyelectrolytes	ton	30	30	890
2.3 Maintenance and Repair Cost	ls			7,276
(1% of Costruction Cost)				
Total of 1. to 2.				25,809
		Annual Cost per Person (Rials/year):		40,831

Source: JICA Study Team

Table 5.3.9 Annual Operation and Maintenance Cost of Anzali Sewerage System in 2019

(Unit: Million Rials)

Cost Item	Unit	Unit Price	Quantity	Amount
1. Personnel Cost				
1.1 Engineer	person	36	12	432
1.2 Technicial/Cleark	person	24	25	600
1.3 Semi-skilled Workers	person	17	16	272
1.3 Labours	person	15	36	540
				1,844
2. Expenses				
2.1 Electric Power	kWH	0.0005	4,543,141	2,272
2.2 Chemical				
a. Chlorine	ton	1.8	90	162
b. Lime	ton	0.5	534	267
c. Polyelectrolytes	ton	30	6	178
2.3 Maintenance and Repair Cost	ls			3,720
(1% of Costruction Cost)				
Total of 1. to 2.				8,443
		Annual Cost per Person (Rials/year):		65,488

Source: JICA Study Team

Table 5.3.10 Annual Operation and Maintenance Cost of Somehsara Sewerage System in 2019

(Unit: Million Rials)

Cost Item	Unit	Unit Price	Quantity	Amount
1. Personnel Cost				
1.1 Engineer	person	36	4	144
1.2 Technicial/Cleark	person	24	9	216
1.3 Semi-skilled Workers	person	17	7	119
1.3 Labours	person	15	14	210
				689
2. Expenses				
2.1 Electric Power	kWH	0.0005	2,213,103	1,107
2.2 Chemical				
a. Chlorine	ton	1.8	42	75
b. Lime	ton	0.5	246	123
c. Polyelectrolytes	ton	30	3	82
2.3 Maintenance and Repair Cost	ls			2,000
(1% of Costruction Cost)				
Total of 1. to 2.				4,076
		Annual Cost per Person (Rials/year):		71,505

Source: JICA Study Team

Table 5.3.11 Annual Operation and Maintenance Cost of Community Wastewater Treatment System (Phase1)

(Unit: Million Rials)

Cost Item	Unit	Unit Price	Quantity	Amount
1. Personnel Cost				
1.1 Engineer	person	36	1	36
1.2 Technicial/Cleark	person	24	1	24
1.3 Semi-skilled Workers	person	17	0	0
1.3 Labours	person	15	7	105
				165
2. Expenses				
2.1 Electric Power	kWH	0.0005	0	0
2.2 Chemical				
a. Chlorine	ton	1.8	0	0
b. Lime	ton	0.5	0	0
c. Polyelectrolytes	ton	30	0	0
2.3 Maintenance and Repair Cost	ls			198
(1% of Costruction Cost)				
Total of 1. to 2.				363
		Annual Cost per Person (Rials/year):		20,167

Source: JICA Study Team

CHAPTER 6 IMPLEMENTATION PROGRAM

6.1 General

The proposed projects for the wastewater management are described in Chapter 4. The priority of the proposed projects and the implementation schedule are described in this chapter.

6.2 Evaluation of Proposed Measures for Prioritization

6.2.1 Criteria for Prioritization

The proposed projects are evaluated by the following criteria to prioritize the projects. Each criterion was scored by using "A", "B" and "C" (Ranked as A is the superior), as shown in Table 6.2.1. The ranking of "A", "B" and "C" were given scores of 1, 2 and 3, and the scores were totaled considering criterion weights.

Table 6.2.1 Evaluation of Proposed Measures for Prioritisation

Rank	1. Effect		2. Efficiency	3. Urgency	4. Cost	5. Capacity of Executing Organization	6. Conformity with National Policy	7. Environmental Impact	8. Social Impact	9. Other
	Reduction Amount of Organic Pollution	Reduction Amount of Heavy Metal & Toxic Material	Quickness of Response						Improvement on Public Health	Difficulty on Technical Point
A	Large More than COD: 200t/y or T-P: 1.0t/y	Large	Quick	High	Low Not more than 10 billion Rials	Excellent	Coincident	Low	High	Easy
B	Medium More than COD: 100t/y or T-P: 0.5t/y	Medium	Medium	Middle	Middle More than 10 billion Rials	Enough	Harmonized	Middle	Middle	Normal
C	Negligible Not more than COD: 100t/y or T-P: 0.5t/y	Negligible	Slow	Low	High More than 100 billion Rials	To be trainned	No conformity	High	Low	Difficult

(1) Effect

Effects of the projects are evaluated as a level of reduction of organic and nutrient pollution, and heavy metal and toxic material as below.

a) Reduction of organic and nutrient pollution

The main purpose of the projects is to reduce pollution load into Anzali Wetland. The evaluation was carried out on two items, "Reduction of organic and nutrient pollution" and "Reduction of heavy metal and toxic material"

As described in Chapter 4, the target of organic and nutrient pollution levels is set on COD, T-N and T-P respectively. The proposed projects are evaluated on the amount of pollution load reduction of COD and T-P, which are major pollution parameters in Anzali Wetland.

b) Reduction of heavy metal and toxic material

The effectiveness of pollution control of heavy metals and toxic materials are also evaluated. Various kinds of heavy metals and toxic materials are generated in specified pollution sources, which are some kinds of industrial effluent and agricultural chemicals. Only a few projects are effective for them.

(2) Efficiency/Speed of Response

If the results of the projects will appear quickly, the project will a have high score. Soft components such as capacity development are given a relatively low score.

(3) Urgency

If the projects are required to commence urgently for improvement of present serious situations, the project will have high score.

(4) Investment Cost

The amount of project cost is also an important factor for evaluation of the possibility of implementation of the projects. The projects that required less than 10 billion rials were ranked ”A”, and the projects that required more than 100 billion rials were ranked ”C”.

(5) Capacity of Executing Organization

For successful implementation of the projects, capacity of executing organization shall be evaluated. If it is evaluated that executing organizations do not have enough capacity to implement the project, the projects are ranked “C”.

(6) Conformity with National Policy

The projects are preferable if they are in line with the national policies. The Coming 20 Years Development Plan and the 4th Development Plan are typical indicators of the policies. If the project conforms to the national policy, a high score will be given to the project.

(7) Environmental Impact

Basically, if the project has serious negative impacts, such as resettlement of residents or deterioration of the natural environment, the project will have a low score.

(8) Social Impacts/Improvement on Public Health

The pollution load reduction may contribute to improvement of public health. If the project is expected to contribute a great improvement to public health, the project will have a high score.

(9) Other/Difficulties on Technical Points

If the project involves difficulties on technical points during construction or the operation and maintenance period, the project will have a low score.

6.2.2 Evaluation of Proposed Measures for Prioritization

The results of the evaluation for prioritization are described in Table 6.2.2.

Table 6.2.2 Evaluation of Proposed Measures for Prioritization

Criteria / Proposed Projects/Measures	1		2	3	4	5	6	7	8	9	Overall Evaluation
	a	b	a						a	a	
1.Management of Domestic Wastewater in Urban Areas											
(1)Rasht Sewerage System Development Project	A	C	A	A	C	B	A	A	A	B	A (21)
(2)Anzali Sewerage System Development Project	A	C	A	A	C	B	A	A	A	B	A (21)
(3)Somehsara Sewerage System Development Project	B	C	A	B	C	B	A	A	A	B	A (17)
(4)Promotion of Individual Wastewater Treatment	B	C	B	C	C	C	C	A	B	C	C (6)
(5)Promotion of Low Phosphorous Detergent	A	C	A	B	B	C	C	A	C	C	B (11)
2.Management of Domestic Wastewater in Rural Areas											
(1)Community Wastewater Treatment System Development	B	C	B	B	B	B	A	A	A	B	A (17)
3.Management of Industrial Effluent											
(1)Centralization of Industrial Factories	B	B	C	B	B	B	A	A	A	A	A (19)
(2)Construction of Centralized Wastewater Treatment System											
1)Rasht	A	B	A	A	B	B	B	A	B	B	A (21)
2)Others	B	B	B	C	B	B	B	A	B	B	B (14)
(3)Strengthening of Monitoring Activities by DOE	B	A	B	A	A	B	B	A	B	B	A (21)
4.Management of Livestock Waste											
(1)Treatment of Livestock Waste from Industrial Animal Husbandry	B	C	B	A	B	B	B	A	B	B	A (16)
(2)Control of Livestock Waste in Grazing Lands in the Plain Area	B	C	B	C	B	C	C	A	B	A	C (9)
5.Management of Pollution from Farmland											
(1)Promotion of Low External Input Farming	B	B	B	B	A	A	B	A	B	B	A (19)
Weight	2	2	1	2	1	2	2	1	1	1	-

Note: Criteria 1= Effect, a. Reduction of organic pollution, b. Reduction of heavy metals and toxic materials
2= Efficiency, a. speed of response, 3= Urgency, 4= Cost, 5= Capacity of executing organization,
6= Conformity with national policy, 7= Environmental impact, 8= Social impact, a. Improvement of public health
9= Other criteria, a. technical difficulty
Score A=2, B=1, C=0, Overall Evaluation, A: more than 30, B: 20-30, C: less than 20
Source: JICA Study Team

(1) Effects

Sewerage system development projects are given high scores, because it is evaluated that urban domestic wastewater is the highest pollution source for the wetland, and a sewerage system is most effective measure to reduce the pollution load. Promotion of low phosphorous detergent has also a high score for phosphorous reduction. Regarding to control of toxic materials and heavy metal pollution, Strengthening of DOE, Human Environmental Department and measures for agricultural activities is ranked high,

(2) Conformity with National Policy

Sewerage system development projects, and strengthening of DOE are also evaluated as high priorities. However, promotion of low phosphorous detergent is ranked low score.

(3) Environmental and Social Impact

It is evaluated that none of the proposed projects have serious negative environmental impacts, and most of the projects are expected to contribute to improvement of public health.

6.3 Implementation Schedule for Master Plan

It is proposed that the wastewater management plan be implemented by 2019, as shown in Figure6.3.1. However, the implementation will be dependent upon national budget preparation.

Figure 6.3.1 Proposed Implementation Schedule for Wastewater Management

6.3.1 Management of Urban Domestic Wastewater

(1) Sewerage System Development

The sewerage system development proposed in the master plan consists of five components, the Rasht sewerage project (Phase 1 and Phase 2), the Anzali sewerage project (Phase 1 and Phase 2) and the Somehsara sewerage project.

Some parts of the Rasht sewerage project (Phase 1), Anzali sewerage project (Phase 1) and Somehsara sewerage project are under construction. Rasht sewerage project (Phase 1) and Anzali sewerage project (Phase 1) are planned to be completed in the 4th Development Plan, and Somehsara sewerage project is planned to be completed in the 5th Development Plan. Some parts of Rasht sewerage project (Phase 1) and Anzali sewerage project (Phase 1) are planned to be financed by WB. According to the original plan prepared by NWWEC, Rasht sewerage project (Phase 2), and Anzali sewerage project (Phase 2) were planned to be completed in the 5th Development Plan. However, from a financial point of view, it is proposed in the master plan that both the Phase 2 projects be implemented in the 5th and 6th Development Plans.

In order to operate the sewerage system properly, capacity development of GWWC is also required to facilitate sewerage system development.

(2) Individual Wastewater Treatment

Outside of sewerage service areas, installation of individual wastewater treatment facilities with secondary treatment process is required to meet the effluent standard. However, individual wastewater treatment is expensive comparing with sewerage system. Installation of individual wastewater treatment in urban area is proposed to commence in 6th Development Plan, because the priority is relatively low as shown in Table 6.2.2.

(3) Promotion of Low Phosphorous Detergent

For reduction of the amount of phosphorous discharged to Anzali Wetland, the promotion of low phosphorous detergent is evaluated to be a very effective measure. However, the measure can not commenced soon, because of following reasons

- At present, no organization has considered a plan for this measure.
- No manufacturers in Iran have produce the low phosphorous detergent.

First of all, the residents should know why low phosphorous detergent is good for Anzali Wetland conservation, and should have the opportunity to use low phosphorous detergent which may be imported. In case in Japan, NGOs played an important role in the promotion. In the master plan, an environmental education program shall contribute to these activities in the 4th Development Plan

In the 5th Five Year Development Plan, DOE will promote consumption of low phosphorous detergent. After the low phosphorous detergent becomes popular, it will be possible to establish a regulation and law on usage of low phosphorous detergent. After that, it will be required to construct new industrial factories for manufacture of low phosphorous detergent or to import them with private funds. It is proposed that promotion of low phosphorous detergent will be commenced in the Fifth Five Years Development Plan.

6.3.2 Management of Rural Domestic Wastewater

(1) Community Wastewater Treatment System

According to the National Plan up to 2024, 30 % of residents in rural area shall have wastewater treatment systems that meet the effluent standard. Because of financial considerations, the target level for the treatment ratio is proposed to be 15 % in 2019. The treatment of rural wastewater is not expected to have a great impact on the pollution load reduction to the Anzali Wetland. The community wastewater treatment system shall be constructed continuously during the master plan period. As a first stage, community wastewater treatment systems in seven villages, for which design reports are available, shall be implemented in the 4th Development Plan. Development of the treatment systems shall continue through the 5th and 6th Development Plan, respectively.

6.3.3 Management of Industrial Effluent

(1) Centralization of Industrial Factories

Centralization of industrial factories has already been promoted by DOE and MOIM. Some privileges have been prepared including tax exemptions, payments for land acquisition and financial assistance from the government. The establishment of regulations shall be completed in the 4th Development Plan. After establishment, new industrial factories and existing industrial factories which have negative environmental impacts shall be moved to the industrial cities gradually.

(2) Centralized Wastewater Treatment System

Rasht Industrial City is owned by a private company named Rasht Industrial City Company. Other industrial cities in Anzali, Somehsara, Fuman and Shaft are owned by government organizations.

A centralized wastewater treatment system in Anzali Industrial City is under construction. A centralized wastewater treatment system in Rasht Industrial City is just under consideration, and Rasht Industrial City Company is looking for a financial source to finance the treatment system. The both treatment systems are proposed be implemented in the 4th Development Plan. Centralized wastewater treatment systems in the other four industrial cities are proposed to be implemented by government funding in the 5th and 6th Development Plan.

(3) Strengthening of DOE

Strengthening of DOE, Human environmental section is indispensable for suitable management of industrial effluent. Some activities for strengthening of DOE have already commenced.

6.3.4 Management of Livestock Waste

(1) Industrial Animal Husbandry

Industrial animal husbandry is one of the pollution sources regulated in the effluent standard as well as industrial factories. Compared with livestock in grazing land or owned by individual farmers, the treatment system for waste from industrial animal husbandry is more important. At present, there are only about only 3,000 cows in 16 sites of industrial animal husbandry sites in the Study Area. Installation of wastewater treatment facilities and storage of livestock manure shall be completed for all of Industrial Animal Husbandry sites in the Study Area in the 4^{th} Development Plan.

(2) Livestock in Grazing Land

Measure for handling livestock waste in grazing land is a low priority, because of the low effect it would have on the pollution load and the difficulty of implementation. In addition, the number of livestock in the grazing land is expected to decrease. However, the pollution load is still not negligible. This measure is to be implemented in the 6^{th} Development Plan.

6.3.5 Management of Pollution from Farmland

For management of pollution from farmland, the promotion of farming with low input is proposed. The program for the low external input farming consists of 1) Expansion of use of compost such as livestock manure and/or Azolla, 2) Expansion of integrated pest management through farmer field school and 3) promotion of proper farming practice.

The MOJA extension system has advised farmers on the suitable use of chemical fertilizers, and suitable use of livestock manure and suitable use of pesticide and herbicides. The system has worked effectively to reduce consumption amount of chemical fertilizers and agricultural chemicals in the last ten years, and is expected to operate continuously. The program is proposed to be commenced in the 4^{th} Development Plan.

6.4 Next Five Years Plan for Each Organization

As a results of section 6.3, the following eight (8) projects are proposed to commence in the 4^{th} Development Plan. Table 6.4.1 shows the executing organizations for the projects. Action plans in the Next Five Years Plan (4^{th} Development Plan) for the organizations are described in this section.

Table 6.4.1 Proposed Projects in the 4th Development Plan and Executing Organization

Executing Organization	Implementation of Proposed Project in the 4th Development Plan
1) GWWC	1) Rasht Sewerage Project (Phase 1)
	2) Anzali Sewerage Project (Phase 1)
	3) Somehsara Sewerage Project
2) RWWC	4) Community Wastewater Treatment System (First Stage)
3) DOE	5) Installation of Wastewater Treatment Facilities for Industrial Animal Husbandry
	6) Strengthening of Monitoring Activities by DOE
3) MOJA	7) Introduction of integrated pest management and farmer field schools
4) Others	8) Centralized Wastewater Treatment (Rasht and Anzali)

6.4.1 Next Five Years Plan for GWWC

(1) Tasks and Duties of GWWC in the 4th Development Plan

Tasks and duties of GWWC in the 4th Development Plan are proposed as below

- Completion of construction works of Rasht Sewerage Project (Phase 1) and Anzali Sewerage Project (Phase 1)
- Commencement of successful operation of sewerage system to be constructed under Rasht Sewerage Project (Phase 1) and Anzali Sewerage Project (Phase 1)
- Implementation of part of construction works of Somehsara Sewerage Project
- Establishment of sewerage sector in GWWC for suitable operation of the sewerage systems

(2) Action Plan for the Next Five Years

GWWC action plan for implementation of the proposed projects is described in Table 6.4.2.

Table 6.4.2 GWWC Action Plan in Next Five Years

Action Plan	Status	05	06	07	08	09
1. Rasht Sewerage System Development (GWWC)						
Central Area						
a) Completion of WWTP Construction Works that are under construction	On-going					
b) Installation of Advanced Treatment Process	No Detail Plan					
b) Sewer Pipe Installation in Zone 19	On-going					
c) Sewer Pipe Installation in Zones 7, 11, 2, 14, 15 and 20	On-going					
d) Pipe Connections for Temporary Combined System	No Detail Plan					
e) House Connections in Central Area						
East and West (to be financed by World Bank)						
a) Sewer Pipe Installation in East & West Area	Under negotiation					
b) House Connections in East and West Area						
2. Anzali Sewerage System Development (GWWC)						
West						
a) Completion of on-going WWTP Construction	On-going					
b) Installation of Advanced Treatment Process	No Detail Plan					
c) Sewer Pipe Installation	On-going					
d) Pipe Connections for Temporary Combined System	No Detail Plan					
e) House Connections in West Area						
East (to be financed by World Bank)						
a) Construction of new WWTP (East)	Under negotiation					
b) Sewer Pipe Installation in East Area						
c) House Connection in East Area						
3. Somehsara Sewerage System Development (GWWC)						
a) Construction of WWTP	No Financial Plan					
b) Sewer Pipe Installation	On-going					
4. Capacity Development of GWWC						
a) Expansion of Wastewater Management Section	On-going					
b) Establishment of Sewerage Tariff Setting System	No Detail Plan					
c) Human Resources Development for Sewerage O&M Experts (Training Program)	On-going					
d) Public Awareness Program	On-going					

Source: JICA Study Team

(3) Urgent Issues to be considered

Sewerage system developments in the central area in Rasht, the western area in Anzali and Somehsara have commenced using Iranian government finance. Sewerage system development in the western and eastern area in Rasht and the eastern area in Anzali are waiting for World Bank finance. According to GWWC officials, the World Bank has basically agreed to prepare loan for implementation of Rasht Sewerage Project (Phase 1) and Anzali Sewerage Project (Phase 1). If the loan agreement is signed in this year, the construction works will be commenced in 2007.

Wastewater treatment plants for the central area in Rasht and the western area in Anzali will be completed in 2005. For successful operation of the sewerage systems, the sewage collection systems and house connection systems should be completed. The following problem should be solved for suitable operation.

- For transport of wastewater to the WWTP, the house connection works with sewer pipes are indispensable. However, no financial arrangement has been planned for the implementation of the house connection works.
- Phosphorous reduction is one of the most effective measures to prevent eutrophication of Anzali Wetland. However, the two WWTPs in Rasht and Anzali under construction do not have advanced treatment processes to reduce phosphorous load. The installations of advanced treatment processes are planned by GWWC. However, financial arrangement has not been planned.
- After completion of the WWTP, the contractor will take the responsibility to operate the WWTPs for one year and train GWWC staff on technical. One year after the completion, GWWC will have full responsibility for the operation. GWWC should expand O&M staff for sewerage system now.

To solve the above problems, the priority projects should include the following works.

- House connection works in the central area in Rasht, and the western area in Anzali.
- Installation of advanced treatment system in the WWTPs under construction in Rasht and Anzali as "Mitigation Measures for Environmental Impact of Discharge of Treated Wastewater in Anzali Wetland"

6.4.2 Next Five Years Plan for RWWC

(1) Tasks and Duties in 4th Development Plan

Tasks and duties of RWWC in 4th Development Plan are as below

- Completion of construction works for community wastewater treatment systems in seven villages, of which detailed design reports have already been prepared.
- Commencement of successful operation of the community wastewater treatment systems.
- Preparation of a master plan and detailed design for the 5th Development Plan for community wastewater treatment systems
- Establishment of a wastewater treatment sector in RWWC

(2) Action Plan for the Next Five Years

The RWWC action plan for implementation of the proposed projects is described in Table 6.4.3.

Table 6.4.3 RWWC Action Plan for Next Five Years

Action Plan	Status	05	06	07	08	09
1. Development of Community Wastewater Treatment Systems (RWWC)						
a) Construction of the treatment systems in 7 villages	No Financial Plan					
b)Preparation of a Master Plan	No Plan					
c) Execute of D/D for other 7 more Villages						
2. Capacity Development of RWWC						
a) Expansion of Wastewater Management Section	No Plan					
b) Establishment of Tariff Setting System						
c) Public Awareness Program						

Source: JICA Study Team

6.4.3 Next Five Years Plan for Industrial Wastewater Management

(1) Tasks and Duties of DOE, MOIE and Others in 4th Development Plan

Tasks and duties of DOE in the 4th Development Plan are as below

- Establishment of a control system of Industrial Effluent (including industrial animal husbandries)
- Execution of EIA for sewerage system development
- Research on low phosphorous detergent

Management of industrial effluent shall be carried out by MOIM, DOE and Others. In addition duties of DOE in the 4th Development Plan are as below also.

- Promotion of centralization of industrial factories
- Completion of wastewater treatments system in Anzali and Rasht Industrial Cities

(2) Action Plan for the Next Five Years

The implementation schedule for proposed projects to be carried out by DOE, MOIE and Other organizations for the Industrial Wastewater Management is described in Table 6.4.4.

Table 6.4.4 Next Five Years Schedule for Industrial Wastewater Management

Action Plan	Status	05	06	07	08	09
Management of Industrial Factory						
1. Centralization of Industrial Factories						
a) Promotion of Centralization	On-going					
2. Construction of Centralized Wastewater Treatment System						
a) Construction in Anzali Industrial City	On-going					
b) Expansion in Anzali Industrial City	No Plan					
b) Planning and Financial Arrangement for Rasht Industrial City	Under Discussion					
c) Construction in Rasht Industrial City	No Financial Plan					
3. Capacity Development of DOE, Gilan						
a) Expansion of Human Environmental Department	On-going					
b) Establishment of New Laboratory						
d) Education Program for Industrial Factories						
e) Establishment of Consultant Engineering Company List f						
f) Establishment of Data Base of Industrial Factories	No Detail Plan					
g)Research on Low Phosphorous Detergent						
Management of Industrial Animal Husbandry						
1. Installation of Wastewater Treatment Facilities in Industrial Animal Husbandry sites						
a) Installation of the facilities	No Detail Plan					

Source: JICA Study Team

6.4.4 Next Five Years Plan for MOJA

(1) Tasks and Duties in 4th Development Plan

For promotion of farming with less input, tasks and duties of MOJA in 4th Development Plan are as below

- Strengthening of MOJA extension system
- Promotion of Integrated pest management
- Establishment of Farmer Field School

(2) Action Plan in Next Five Years

MOJA has contributed to wastewater management. The MOJA Extension system is expected to continue to contribute to promotion of farming with less input for pollution control in the farmland. The MOJA action plan for implementation of the proposed projects is described in Table 6.4.5.

Table 6.4.5 Next Five Years Schedule for Management of Pollution from Farmland

Action Plan	Status	05	06	07	08	09
1. Promotion of Farming with Less Input						
a)Expansion of use of compost such as livestock manure	On-going					
b) Expansion of Integrated Pest Management through Farmer Field School						
c)Promotion of Proper Farming Practice						

Source: JICA Study Team

6.5 Priority Project

6.5.1 Selection of Priority Projects

It is defined that the priority projects are parts of proposed projects in 4th Development Plan, which are proposed to be carried out urgently. As the results of consideration in section 6.2, two projects for the management of urban domestic wastewater and two projects for the management of industrial effluent are selected as the priority projects as shown below.

1) Rasht Sewerage System Development Project (Phase 1)
2) Anzali Sewerage System Development Project (Phase 1)
3) Strengthening of Monitoring Activities by DOE
4) Centralized Wastewater Treatment in Rasht Industrial Cities

6.5.2 Rasht Sewerage System Development System (Phase 1)

The sewerage system can start to operate, after completion of the "Wastewater treatment plan (WWTP)", "Sewer pipe network" and "House connection works with sewer pipe". Table 6.5.1 shows the present situation of each component of . Rasht Sewerage System Development Project (Phase 1).

Table 6.5.1 Present Situation of Rasht Sewerage System (Phase 1)

Area	Component	Present Situation
Central Area	WWTP	Capacity: 65,625 m^3/d of WWTP is under construction Advanced treatment process and expansion works are to be financed by the central government
	Sewer Network	Some parts are under construction, remaining parts are to be financed by the central government.
	House Connection	No Plan
Western & Eastern Area	Sewer Network	To be financed by WB, under negotiation
	House Connection	

As shown in Table 6.5.1, the WWTP and installation of the sewer pipe network in the central area are under construction, and the sewerage system in the west and east area are planed to be financed by WB. On the other hand, there is no plan for house connection works in the central area. The WWTP is planned to be completed in 2005. However, if the house connection works is not commenced, no wastewater will reach the WWTP.

Rasht Sewerage Project (Phase 1) will be implemented following the three steps shown below.

Step 1: Commencement of operation of the sewerage system in the central area, after completion of the sewerage system.
Step 2: Installation of an advanced wastewater treatment process and expansion of the WWTP
Step 3: Completion of the sewerage system in the western and eastern area.

Completion of house connection works takes a long time. In order to implement early operation of the WWTP, introduction of temporary combined sewer system are recommended.

6.5.3 Anzali Sewerage System Development Project (Phase 1)

(1) Commencement of Suitable Operation

Table 6.5.2 shows the present condition of each component of Anzali Sewerage System (Phase 1).

Table 6.5.2 Progress of Anzali Sewerage Project (Phase 1)

Area	Component	Present Situation
Western Area	WWTP	Capacity 20,000 m^3/d of WWTP is under construction Advanced treatment process is to be financed by the central government
	Sewer Network	Some parts are under construction, the remaining parts are to be financed by the provincial government
	House Connection	Some parts are under construction and the remaining parts have no plan.
Eastern Area	WWTP	To be financed by WB, under negotiation
	Sewer Network	
	House Connection	

As shown in Table 6.5.2, the WWTP and installation of the sewer pipe network in the west area are under construction, and the sewerage system in the east area is planed to be financed by WB. On the other hand, in Anzali there is a plan for house connection works for only a limited area in the west. The WWTP is planned to be completed by the beginning of 2005.

Anzali Sewerage Project (Phase 1) will be implemented following the three steps as shown below.

Step 1: Completion of construction works of the sewerage system in the western area and Commencement of operation of the sewerage system in the western area.

Step 2: Installation of an advanced wastewater treatment process in the WWTP

Step 3: Completion of sewer networks and house connection works in the eastern area.

Completion of house connection works takes a long time in Anzali also. In order to implement early operation of the WWTP, introduction of temporary combined sewer systems are recommended.

(2) Environmental Impact of WWTP under Construction

Reduction of phosphorous discharge amount is one of the most important part of pollution control in Anzali Wetland. After completion of the sewerage system in the western part of Anzali, the lagoon of Anzali Wetland may get larger amounts of phosphorous than under the present condition, because of the following reasons.

- At present, wastewater is discharged from many outfalls to Anzali Wetland. After completion of the WWTP, all wastewater collected by sewer pipes is to be discharged from one outlet.
- The WWPT do not have advanced treatment process to reduce phosphorous contents.

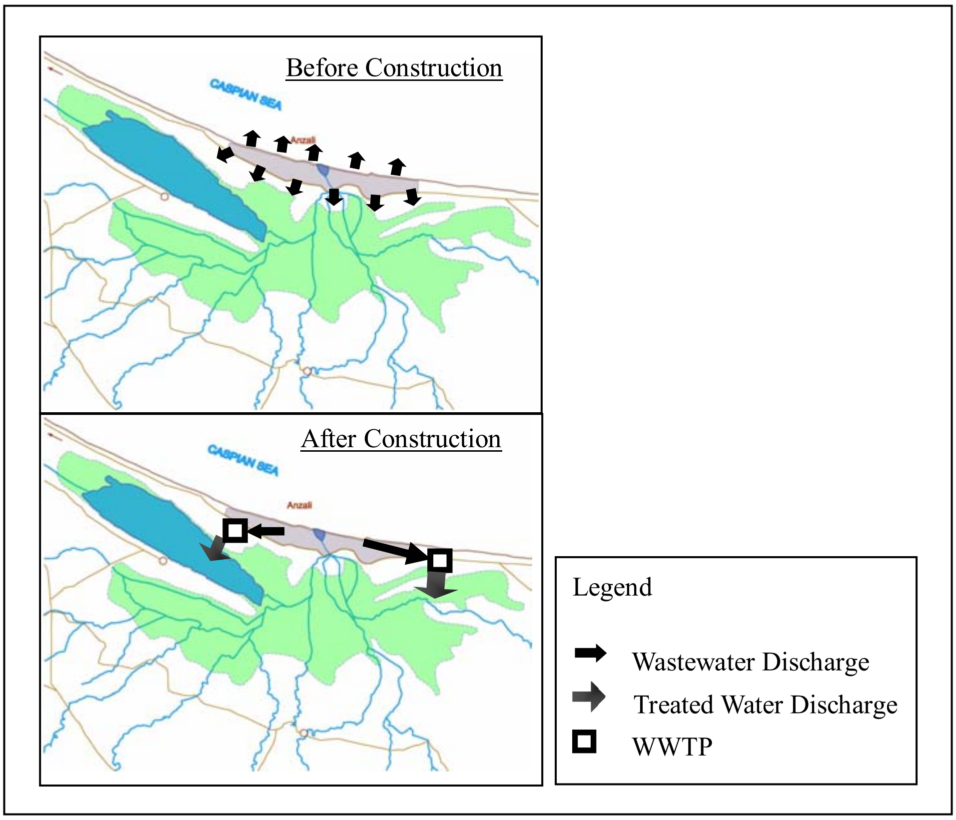


Figure 6.5.1 Condition of Wastewater Discharge in Anzali

In order to reduce the environmental impact of discharging phosphorous to the wetland, it is necessary to install an advanced wastewater treatment process in the WWTP. In addition, it is recommended that discharge point of the treated wastewater is to be considered as a measure to reduce the environmental impact.

6.5.4 Strengthening of Monitoring Activities by DOE

The following works are required for DOE, Human Environmental Department, and Strengthening of Monitoring Activities by DOE, which are Items a) and b), are proposed for the priority project.

a) Expansion of the Human Environmental Department
b) Establishment of a New Laboratory
d) Public Awareness Program and Education Program for Industrial Factories

e) Establishment of a Consultant Engineering Company List for Industrial Wastewater Management
f) Establishment of a Data Base of Industrial Factories
g) Establishment of a Phosphorous Reduction Research Group

6.5.5 Centralized Industrial Wastewater Treatment System in Rasht Industrial City

Construction of a wastewater treatment plant with treatment capacity of 14,000 m3/day is proposed for proper industrial wastewater treatment. Asewage collection system has been completed for existing industrial factories in the industrial city. Basically, Rasht Industrial City Company is required to construct it from its own funds. The financial arrangement is a critical for the implementation. It may be necessary to cooperate for the implementation with relevant organizations, such as the Provincial Government, DOE and MOIM, since it is a huge cost for one private company. The activities are .1) planning and design, 2) financial arrangement and 3) construction of the centralized wastewater treatment system. Table 6.5.3 shows water quality analysis data in two drainages from the industrial city. The figures show that the effluents are out of the standard on COD and BOD. The water flow in the two drainages is estimated to be about 2,000 m^3/day.

Table 6.5.3 Water Quality of Effluent from Rasht Industrial City

Item	COD	BOD	T-P
Drainage 1	252, 295, 212	70, 35, 38	0.03, 0.29, 0.09
Drainage 2	158, 175, 159	60, 40, 69	0.05, 0.20, 0.28
Effluent Standard	60	30	6

Source: JICA Study Team

Part 6: Solid Waste Management

THE STUDY ON INTEGRATED MANAGEMENT FOR ECOSYSTEM CONSERVATION OF THE ANZALI WETLAND

FINAL REPORT
Volume III Supporting Report

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PART 6 SOLID WASTE MANAGEMENT

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CHAPTER 1 PRESENT CONDITIONS

1.1 Outline

1.1.1 Municipal Solid Waste

Municipal solid waste should be managed by cities, as regulated by the Municipal Law.

A total of 791 tons of waste are generated daily in the study area. Of this, 670 tons are collected by municipalities 6 or 7 days in a week from every house. This is generated by 744,000 persons[1] at a rate of about 900 g/person/day. The remaining 121 tons generated in villages are not collected, but disposed of informally around the communities. The collection service coverage rates are about 65% on a population basis and about 86% on a waste amount basis. Recycling is not practiced in urban areas or villages.

Almost all waste collected from the urban areas is taken to a dumping site located in Rasht township. This has been used without any liner or leachate treatment for many years.

A composting facility was constructed in 2002 in Rasht Township with support from the central government. At present, around 200 tons of waste per day are treated in this facility.

1.1.2 Industrial and Infectious Solid Waste

Non-hazardous industrial solid wastes (ISW) are managed by the factories that transport their wastes to municipal landfill sites themselves or use private contractors.

Hazardous ISW is only generated by five factories in the Study area, according to a research questionnaire conducted by “Jahad Daneshgahi Guilan”. The total amount of hazardous ISW is estimated at only 50 ton/year, and almost all of this is sludge from plating processes containing chromium. There is no official disposal site for hazardous ISW, so factories retain the hazardous ISW inside their factories. This is clearly not a sustainable situation.

Infectious waste from hospitals, clinics, laboratories, etc, is another important hazardous waste. Some public hospitals incinerate their infectious waste in on-site incinerators or in a public incinerator.

1 MPO, 2003

1.2 Laws/Regulations and Responsibility

1.2.1 Waste Management Law

The Waste Management Law was enacted in June of 2004. This comprehensive law covers all wastes, including municipal wastes, industrial wastes, hazardous and infectious wastes. The major contents of the law are:

- The role of the Ministry of Interior to establish an ordinance to set strategies
- The role of Department of the Environment (DOE) to establish regulations to put the law into practice
- Solid Waste Management (SWM) fee to cover the total cost as much as possible
- A strict penalty system

1.2.2 Municipal Solid Waste

(1) Structure of Local Government

As illustrated in Figure 1.2.1, a township ("Shaharestan") is composed of some counties ("Bakhsh"). A county is composed of municipality ("Shahr") and villages ("Dehestan").*) See Main Report, Section 2.1 for the list of Shahrestans, Bakhshes and Shahrs in the study area.

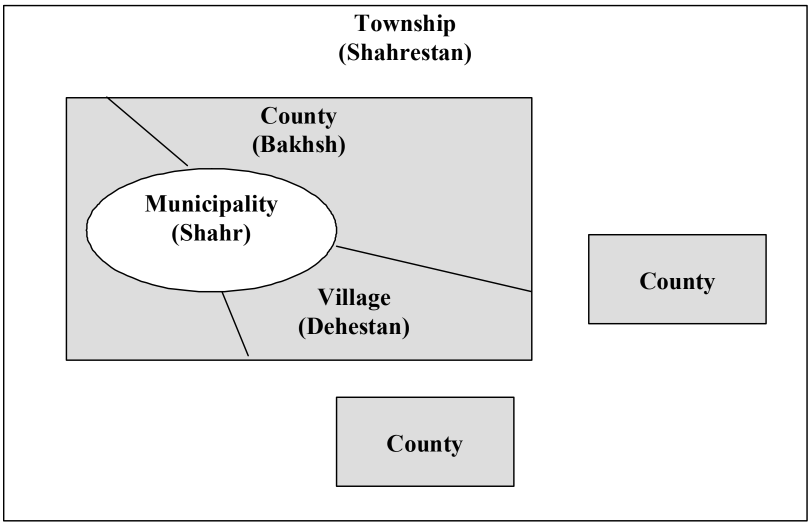

Figure 1.2.1 Structure of Local Governments

*) In this report, "Shahr" and "Dehestan" will be called as "Municipality" and "Village" respectively.

(2) Laws/Regulations

The SWM law provides that the responsible organizations in municipalities (Shahrs) and villages (Dehestans) are the Governor of the Baksh (county). Especially, the responsibility of the Governor is newly provided and very important because for a long time, there was no legal responsibility for solid waste management in villages.

(3) Related Organizations

The following ten municipalities take responsibility in the study area. The locations are shown in Figure 1.2.2.

1. Rasht
2. Anzali
3. Fuman
4. Somehsara
5. Tolam
6. Khomam
7. Shaft
8. Sangar
9. Masal
10. Masuleh

In the municipalities, there is no hierarchical department or division for SWM, though a person to be in charge of public services is appointed by the Mayor. This person acts as the department director responsible for public services including, SWM and road sweeping services.

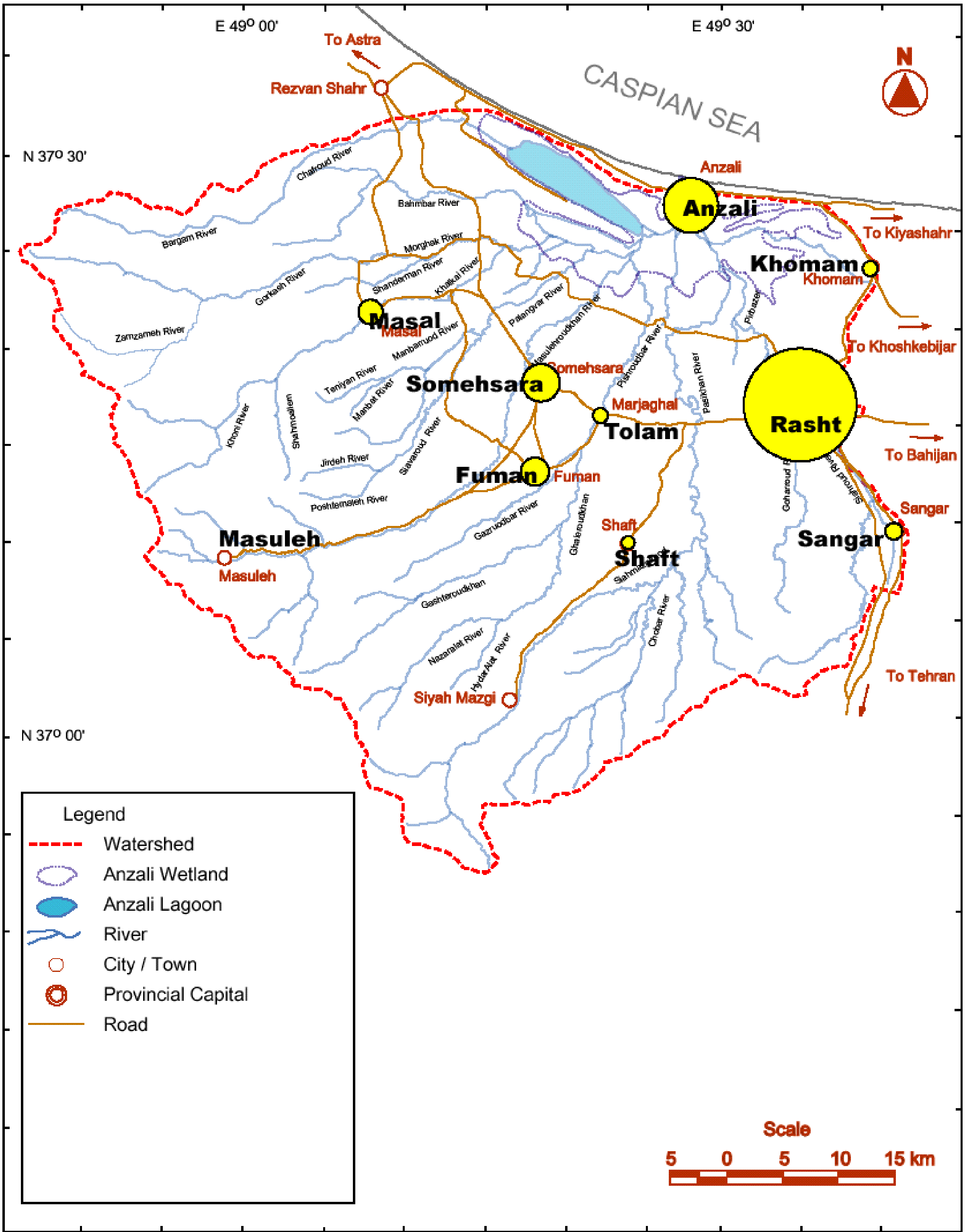

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Figure 1.2.2 Location of Municipalities in the Study Area

Note: The size of each circle shows the amount of waste in each municipality.

1.2.3 Industrial and Infectious Solid Waste

(1) Laws/Regulations

DOE has jurisdiction and power to recommend standards and criteria to any companies/institutions under the "Environmental Protection and Enhancement Act" (1974). In 2001, DOE defined pollution in the Executive Bylaw for Paragraph (C) of Article 104 of the Law of the Third Plan of Economic, Social and Cultural Development. This bylaw also provided the classification of waste material based on the contents of toxic substances in the waste and the method to estimate environmental fines for the improper disposal of solid waste. However, judging from the meager analytical capability of the DOE laboratory in Rasht, it will be difficult to enforce such regulations.

In addition, the new SWM law was enacted, as already mentioned. The law requires the dischargers to reduce and recycle their wastes so as to satisfy the regulations to be established the near future.

(2) Responsibility

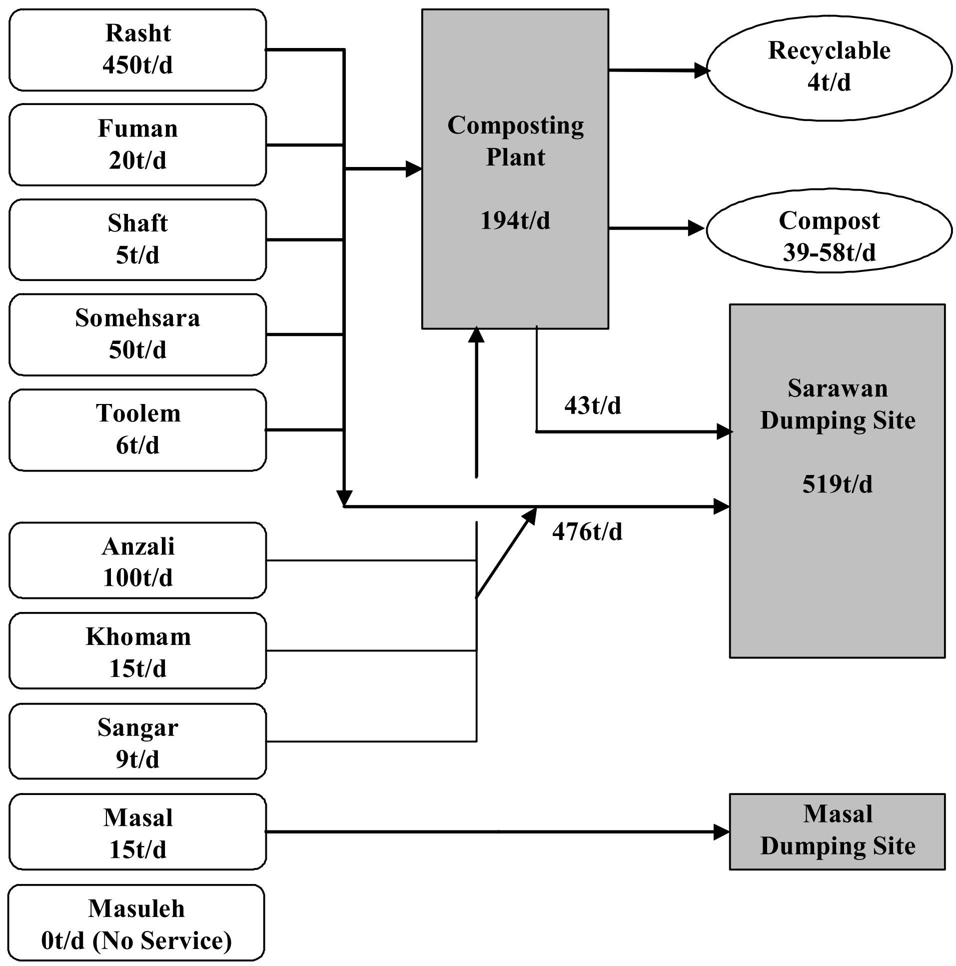
Discharging factories are responsible for their own industrial wastes, including hazardous wastes, under control of DOE.

1.3 Municipal Waste Management in the Study Area

1.3.1 Waste Flow

Figure 1.3.1 shows the flow of municipal waste in the study area. The salient features are as follows.

- The collected waste is transported and eventually open dumped at one of the solid waste dumping sites, where environmental management measures are minimal.
- Some municipal waste is brought to a pilot compost plant, and separated for recyclables, organic waste for compost and remaining waste. However, high operation cost is preventing efficient use of the plant.
- All municipalities appear to be suffering from budget constraints and some municipalities charge residents for solid waste collection services.



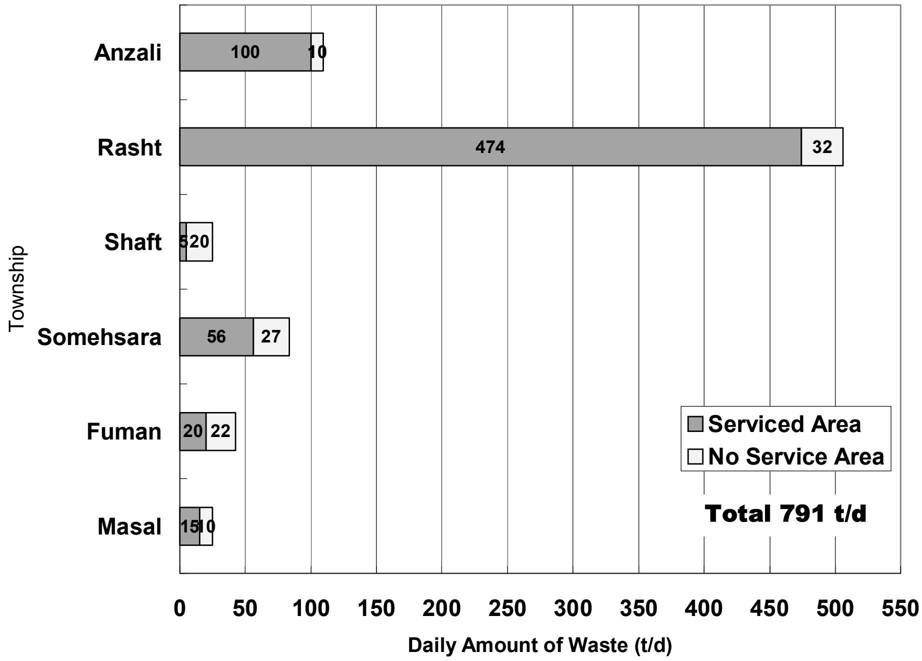
Note: No waste collection service is done in Masuleh.

Figure 1.3.1 Waste Flow in the Study Area

1.3.2 Waste Generation

(1) Amount of Waste

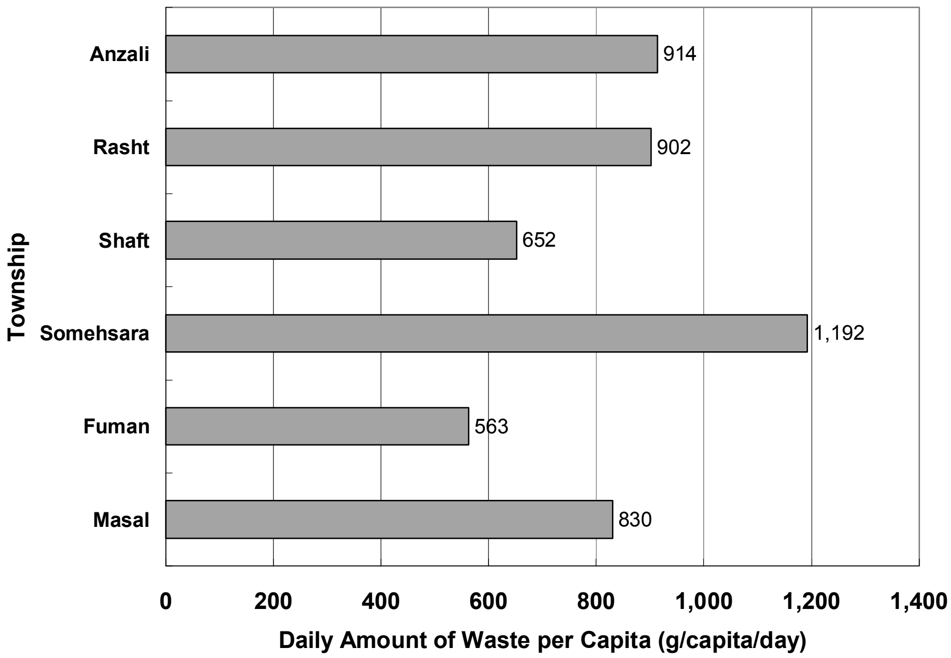
Figure 1.3.2 shows the amount of wastes discharged from each Township in the study area. The daily amount of waste generated is 791 ton per day. Out of this, 670 tons per day of waste are collected. The amount of waste from Rasht Township accounts for 64 % of the total. The amount of waste from Anzali Township corresponds to 14 % of the total waste. Up to 78% of waste is produced by these two townships.



Source: Department of Environment, 2002
Note: No waste collection service is in Masuleh.

Figure 1.3.2 Daily Amount Waste Discharged from Each Township in the Study Area

The daily amount of wastes collected per capita varies from 563 to 1,192 g/day/capita.

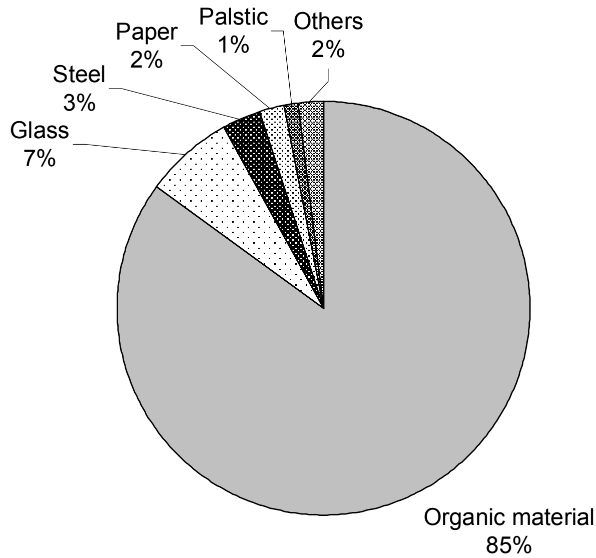


Source: Department of Environment, 2002

Figure 1.3.3 Daily Amount per Capita of Waste Collected in Each Township in the Study Area

(2) Waste Composition

According to a composition analysis conducted by Rasht Municipality, the component rate of organic matter is as high as 85%, as shown in Figure 1.3.4.



Source: Rasht Municipality

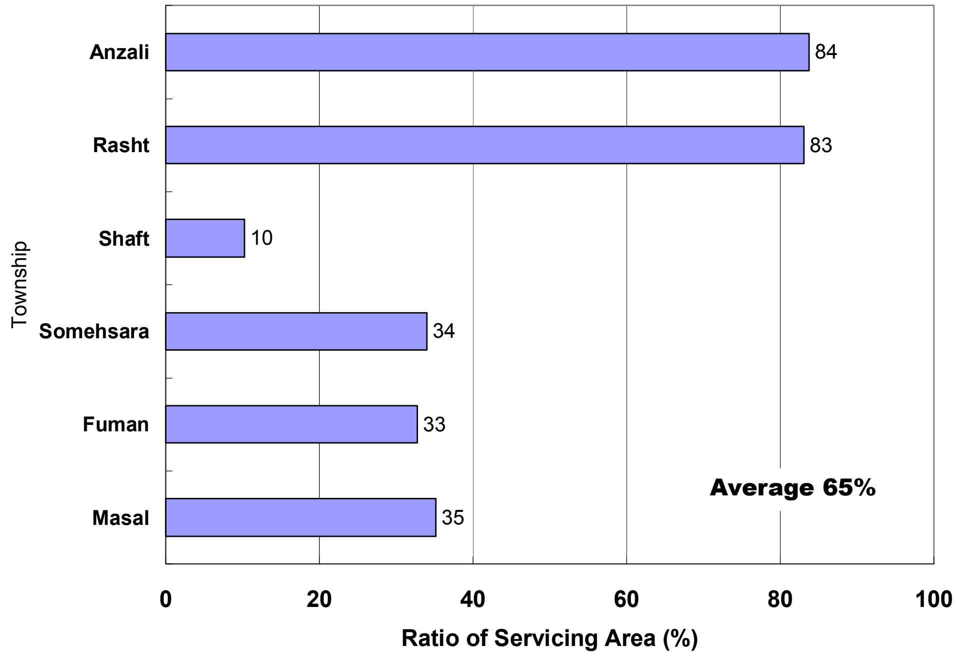
Figure 1.3.4 Average Waste Composition

1.3.3 Waste Collection

In the study area, SWM services are provided only to 65% of the total population. Even in Rasht or Anzali Township, solid waste collection services are not provided to around 15% of the population. In other Townships, the waste collection coverage is only around 30%, and in Shaft Township, it is only 10%.

In service areas, wastes are collected 6 or 7 days a week by municipalities. Residents place their wastes in front of their houses. The time of collection varies. Rasht municipality collects their wastes at night.

Rasht has 65 vehicles and Anzali has 21 vehicles to collect wastes. Other municipalities have only a few vehicles.



Source: Department of Environment, 2002

Figure 1.3.5 Ratio of Collection Service Area of Each Township in the Study Area

Figure 1.3.6 Photograph of Waste Discharged in Rasht Municipality

Table 1.3.1 Factors of Collection Systems in Municipalities

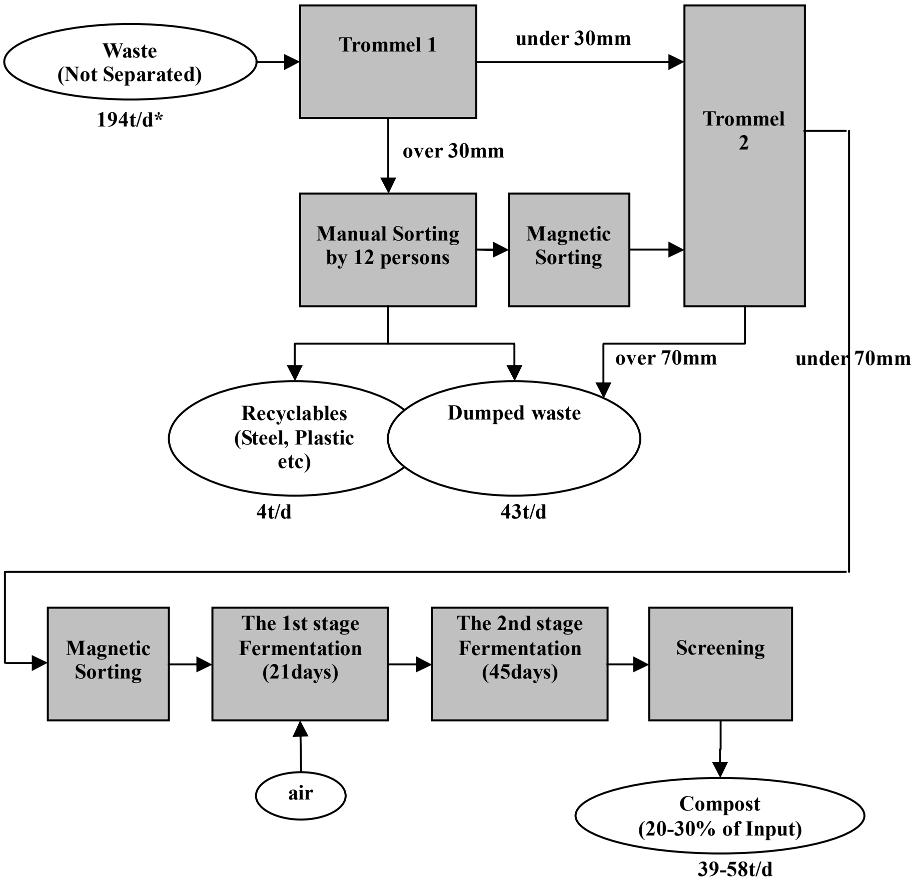
City	Collection			Transportation		Composting
	Number of collecting days per week (days/week)	Number using collection trucks	Typical volume of a collection truck (m^3)	Distance to landfill site (or composting plant) (km)	Number of average daily trips (times/day)	Use of composting plant in Rasht
Rasht	7	65	2	35	4	✓
Anzali	7	21	3-10	Anzali10km Rasht55km	Anzali4 Rasht1	✓
Fuman	7	3	4	42	2	✓
Somehsara	7	4	3	45	3	✓
Tolam	-	-	-	-	-	✓
Khomam	4	4	3	25	2	✓
Shaft	5	2	4	35	1	✓
Sangar	7	2	2	10-12	2	✓
Masal	6	4	2	2	3	
Masuleh	No Service					

Source: Questionnaire Survey to Municipalities by JICA Study Team

1.3.4 Compositing Plant

(1) Material Balance

A composting plant was constructed and opened in 2002 in Rasht as a pilot plant. Figure 1.3.7 and 1.3.8 show the processes of the compost plant. At this time, 194 tons of wastes are carried each day for 6 days a week from the following 11 municipalities and 40-60 tons of compost are produced daily.



Note: *) Wastes from Lashteneshaa, Kochesfehan and Khooshkoejar are not included.

Figure 1.3.7 Process Flow of Composting Plant in Rasht

Note: Manual Sorting Stage (upper left); 1st Fermentation Stage (upper right)
2nd Fermentation Stage (lower left); and Produced Compost (lower right)

Figure 1.3.8 Photographs of Composting Plant in Rasht

(2) Cost

The construction cost of the plant was 12 billion Rial. Approximately 75% of the construction cost, 9 billion Rial was provided by the Ministry of Interior through the provincial government, and the remaining 25% was borrowed from a bank in Iran. The annual operation cost is about 2,400 million. Rial, which corresponds to 38,000 Rial/ton of waste.

Table 1.3.2 Construction Cost of Centralized Composting Plant

(Unit: Mil Rial)

Item	Amount
Office	70
Warehouse	330
Machinery	11,010
Green Space	200
Others	113
Total	11,723

Table 1.3.3 Operation Cost of Centralized Composting Plant

Item		Quantity			Unit Price		Amount (million Rial/year)
Wage	Manager & Engineer	10	Persons		3,500,000	Rial/month	420
	Worker	38	Persons		2,000,000	Rial.month	912
Electricity		4,006,400	kWh/year		120	Rial/kWh	481
Water		2,500	M3/year	(1,600 kW*8hr* 313 day)	300	Rial/m3	1
Fuel (diesel)		400,000	Liter/year		170	Rial/liter	68
Indirect Cost						25%	470
Total							2,352

Note: Estimation from the number of persons and amount of utilities

(3) Income

The price of composts is 150-200 Rial/kg, however there are few users. So the municipalities pay the whole cost according to the amount of wastes they carried.

(4) Future Plan to Construct Composting Plant

Bandar Anzali municipality has a plan to construct a composting plant in Ab Kenar. The capacity is 300 ton per day and the municipality has already bought the site located in the Buffer zone of the Wetland with the agreement of DOE. This will be opened in 2006 and Somehsara and Fuman municipality are scheduled to use this plant.

1.3.5 Final Disposal Sites

(1) Final Disposal Sites in the Study area

Figure 1.3.9 shows the locations of the final disposal sites in the study area. There are relatively large dumping sites in Sarawan and Anzali. In addition, there are smaller sites in Masal.

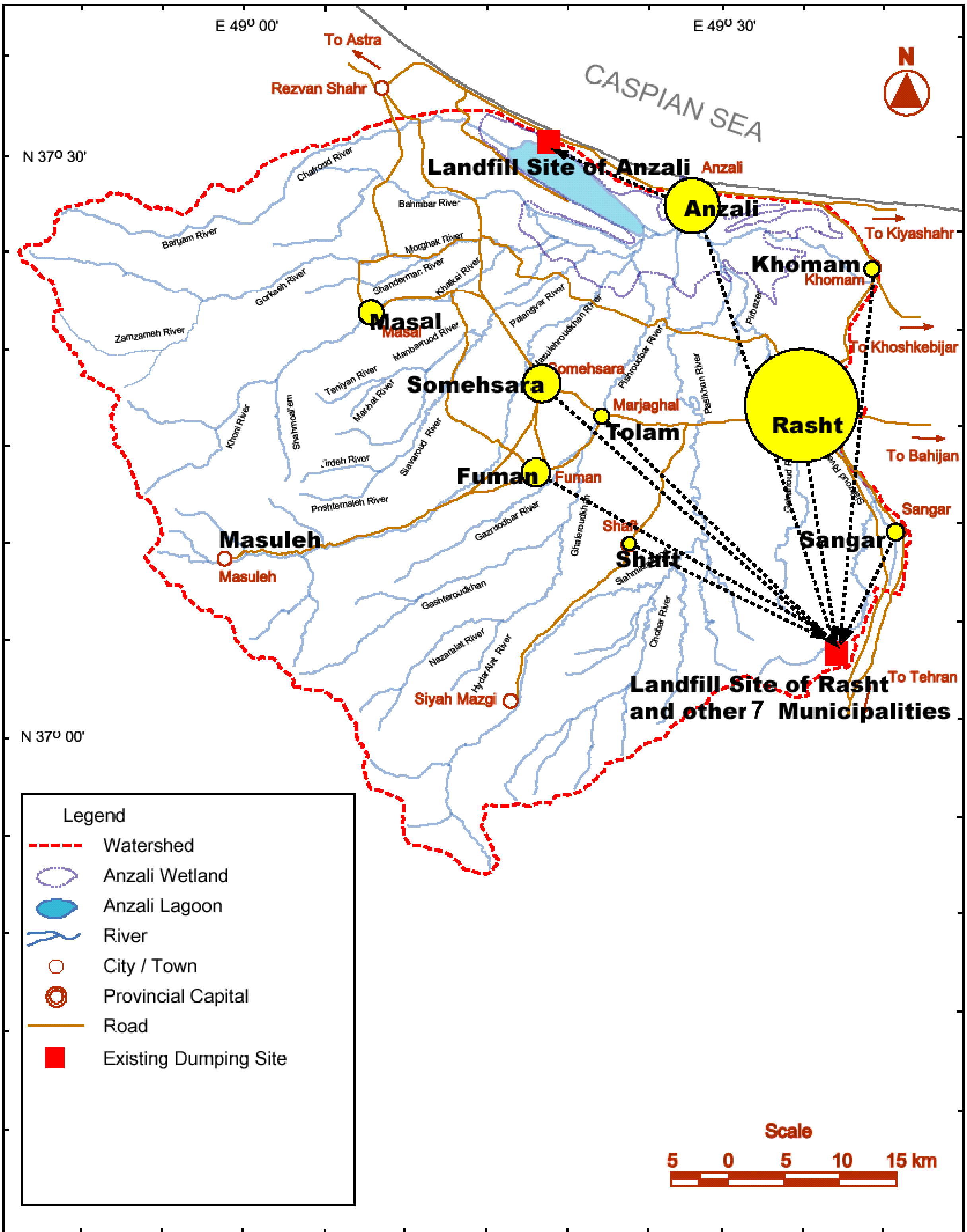


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Figure 1.3.9 Locations of Open Dumping Sites

Note1: A part of wastes dumped in the Rasht dumping site is composted.
Note2: The area of circles shows the amount of waste discharged.
Note3: Masal has its own dumping site. Masuleh does not provide any waste management service in its area.

(2) Sarawan Open Dumping Site

This is a large dumping site located 30 km from the center of Rasht, which opened 20 years ago. The following seven municipalities use this dumping site: Rasht, Fuman, Shaft, and Somehsara. The capacity is huge, but the exact capacity is not known even by Rasht municipality. This site is quite rudimentary, not equipped with liners and a leachate treatment system. There is an urgent need for improvement of this situation.

Figure 1.3.10 Panoramic View of Dumping Site at Sarawan

Figure 1.3.11 Compaction (left) and View from the Bottom (right)

(3) Anzali Open Dumping Site

Anzali municipality has an open dumping site inside the wetland. It is located between the Anzali wetland and the Caspian Sea. Leachate from this dumping site must pollute the wetland. The capacity is large but uncertain even for Anzali municipality.

Figure 1.3.12 Open Dumping Site in Anzali Municipality

(4) Other Dumping Site

In Masal, there is no controlled dumping site. Wastes in Masal are dumped in the site beside a river. No compaction is done.

1.3.6 Solid Waste Management Cost

(1) Cost for Solid Waste Management

In the study area, over 45 billion Rial are used for SWM every year according to a questionnaire survey to municipalities. The annual costs in Rasht municipality and Anzali municipality are 30 and 14 billion Rial respectively, which cover almost all of costs used in the study area.

In Rasht municipality, the cost structure is known. The total annual cost for SWM of 30 billion Rial includes the road sweeping service. 90% of the total cost is for the collection. The component ratio of this cost is unsure. However, the simulation model mentioned in Chapter 2 revealed that the cost for waste collection is half of the total cost of road sweeping and waste collection. It amounts to 14 billion Rial per year. Thus, the cost for only solid waste management will be 17 billion Rial per year. The cost per ton is 98,000 Rial in Rasht.

(2) Budget Source

There is no direct charging systems for municipal solid waste (MSW) management. The budget for MSW management is allocated from the annual budget of each municipality.

Table 1.3.4 Present Cost of Solid Waste Management in Rasht Municipality

Stage	Amount (billion Rial/year)	Component Rate (%)
1) Collection	27	90
Road Sweeping	(13)	(43)
Waste Collection & Transportation	(14)	(47)
2) Disposal (Landfill)	3	10
Total	30	100

Note: The amounts of the breakdown of the collection cost are estimated by assuming that the road sweeping cost is around half of the total collection cost.
Source: Rasht Municipality (Values with parenthesis are assumed by the Study Team through interview with Rasht municipality.)

Figure 1.3.13 Photograph of a Sweeper

1.4 Industrial and Medical Solid Waste Management in the Study Area

1.4.1 Industrial Solid Waste

The amount of industrial wastes is not monitored by DOE. They are transported to the municipal dumping site by the industries themselves or SWM companies. Only hazardous wastes are monitored by DOE. However, the amount is not known.

The Jahad Daneshgahi Guilan in Guilan University once studied hazardous industrial wastes in 2002. According to the report, there are five factories generating wastes containing heavy metals such as Chromium and the total amount is 37 tons per year, as shown in Table 1.4.1. The major source of hazardous waste at present is plating factories.

However, there is no landfill site in the study area designed for hazardous wastes. So DOE recommends storage of the hazardous wastes for now, and at least some of the hazardous wastes are stored inside factories, as shown in Figure 1.4.1.

Table 1.4.1 Hazardous Industrial Waste in the Study Area

Factory	Process	Discharged Hazardous Waste	Amount of Hazardous Waste (kg/year)
1	Metal Plating	Chromium, Copper	12,000
2	Fluorescent Lamp Manufacture	Mercury, Molybdenum	1,500
3	Natural Gas Power Plant	Chromium	7,000
4	Metal Plating	Chromium	1,500
5	Metal Plating	Chromium	15,000
		Total	37,000

Source: Ghavidel, A. et al: "Evaluation of Industrial Hazardous Waste in Guilan Province in 2002"

Note: Plating Residues in Vehicle Parts Factory (Plating (Left); Treatment Equipment for Wastewater from Plating Process (Center); Sludge including Chrome (Right))

Figure 1.4.1 Photographs of Industrial Wastes in a Car Parts Factory

1.4.2 Infectious Solid Waste

(1) Overview

There are 16 hospitals in the study area. Out of 16, 12 hospitals incinerate their infectious wastes. The total amount of infectious waste is 4 ton per day, according to the Guilan Physician and Science University.

Table 1.4.2 Number of Hospitals in the Study Area and Their Disposal Methods

Item	Rasht	Anzali	Somehsara	Fuman	Total
Incineration outside of the Hospital	7			1	8
Onsite Incineration	3	1			4
Dumping	3		1		4
Total Number of Hospitals	13	1	1	1	16

Source: DOE

(2) Hospital Waste Incinerator near Sarawan Dumping Site

There is an incinerator near Sarawan dumping site. Infectious wastes from 8 hospitals in Rasht are incinerated. However, the capacity is not adequate and it is very old. It is not equipped with a sufficient gas treatment system. Therefore, a new incinerator is needed.

Rasht municipality is now constructing a new incinerator inside the site of the composting plant in the Rasht composting plant with a capacity of 400kg per day (200kg x 2 units).

Figure 1.4.2 Hospital Waste in Yellow Bags (left) and Incinerator (right)

(3) Incinerator inside Hospitals

Figure 1.4.3 shows one of the incinerators inside hospitals. This hospital, with 200 beds, was established in June 2000. In this hospital, separation at the source is practiced. Wastes are divided into infectious and non-infectious. Infectious wastes are discharged into yellow bags. The amount of infectious wastes is 250 kg/day. The incinerator is operated three days a week.

Figure 1.4.3 Separation (upper left), and Incineration Plant (upper right and lower)

(4) New Incinerator Construction

Rasht municipality is now constructing two new incinerators for infectious waste inside the composting plant, as shown in Figure 1.4.4. The capacity is 200kg per hour each. These incinerators will incinerate infectious wastes from hospitals and private clinics.

They will be opened soon (As of September 2004).

Figure 1.4.4 New Incinerator for Infectious Waste in Rasht