No.

MINISTRY OF HOUSING
AND CONSTRUCTION
THE SYRIAN ARAB REPUBLIC

THE STUDY ON SEWERAGE SYSTEM DEVELOPMENT IN THE SYRIAN ARAB REPUBLIC

FINAL REPORT

[Volume II : Main Report]

MARCH 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

NJS CONSULTANTS CO.,LTD.
and
TOKYO ENGINEERING CONSULTANTS CO.,LTD.

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< Structure of Report >

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(Master Plan and Feasibility Study)

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PREFACE

In response to a request from the Government of Syrian Arab Republic, the Government of Japan decided to conduct a study on “The Study on Sewerage System Development in Syrian Arab Republic” and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Hirofumi Sano of NJS CONSULTANTS Co., LTD. and consisted of experts from NJS CONSULTANTS CO., LTD. and TOKYO ENGINEERING CONSULTANTS CO., LTD. between November 2006 and December 2007. In addition, JICA set up an advisory committee supported by Mr. Atsuo Furuyama, Chief Engineer, Agriculture and Forestry Division, Ninohe City Government (former JICA expert regarding Syrian Arab Republic) and Ms. Hiroko Kamata, Senior Advisor, Institute for International Cooperation, JICA, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Syrian Arab Republic and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this study and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Syrian Arab Republic for their close cooperation extended to the study.

March 2008

Ariyuki Matsumoto
Vice President
Japan International Cooperation Agency

March 2008

Mr. Ariyuki Matsumoto
Vice-President
Japan International Cooperation Agency

Letter of Transmittal

Dear Sir,

We are pleased to submit to you this Final Report on the Study on Sewerage System Development in the Syrian Arab Republic. This report incorporates the views and suggestions of the authorities concerned of the Government of Japan, including your Agency. It also includes the comments made on the Draft Final Report by the Ministry of Housing and Construction of the Syrian Arab Republic and other government agencies concerned of the Syrian Arab Republic.

The Final Report comprises a total of three volumes as listed below.

Volume I	: Executive Summary (English, Arabic and Japanese)
Volume II	: Main Report (English, Arabic and Japanese)
Volume III	: Supporting Report (English and Arabic)

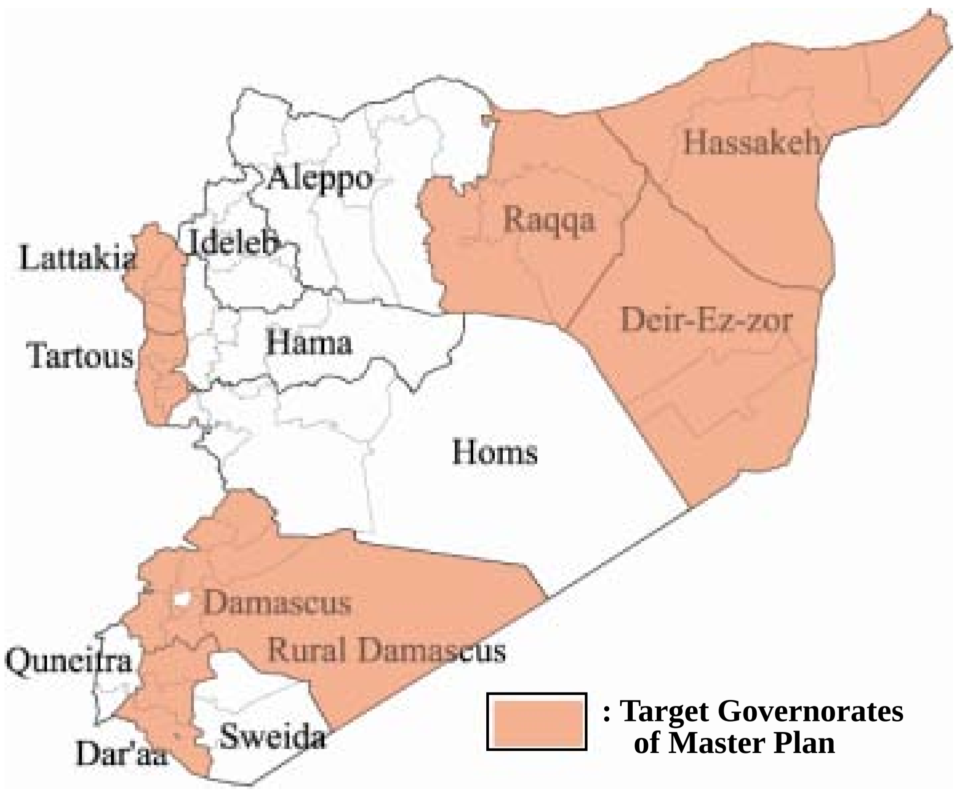
This report contains the Study Team's findings, conclusions and recommendations derived from the three phases of the Study. The main objective of the Phase I was to review of existing development plans in national sewerage sectors. That of Phase II was to formulate the Governorate Master Plan for seven Governorates, and that of the Phase III was to undertake the Feasibility Study of the priority project which had previously been identified in the Master Plan during the course of the Phase II.

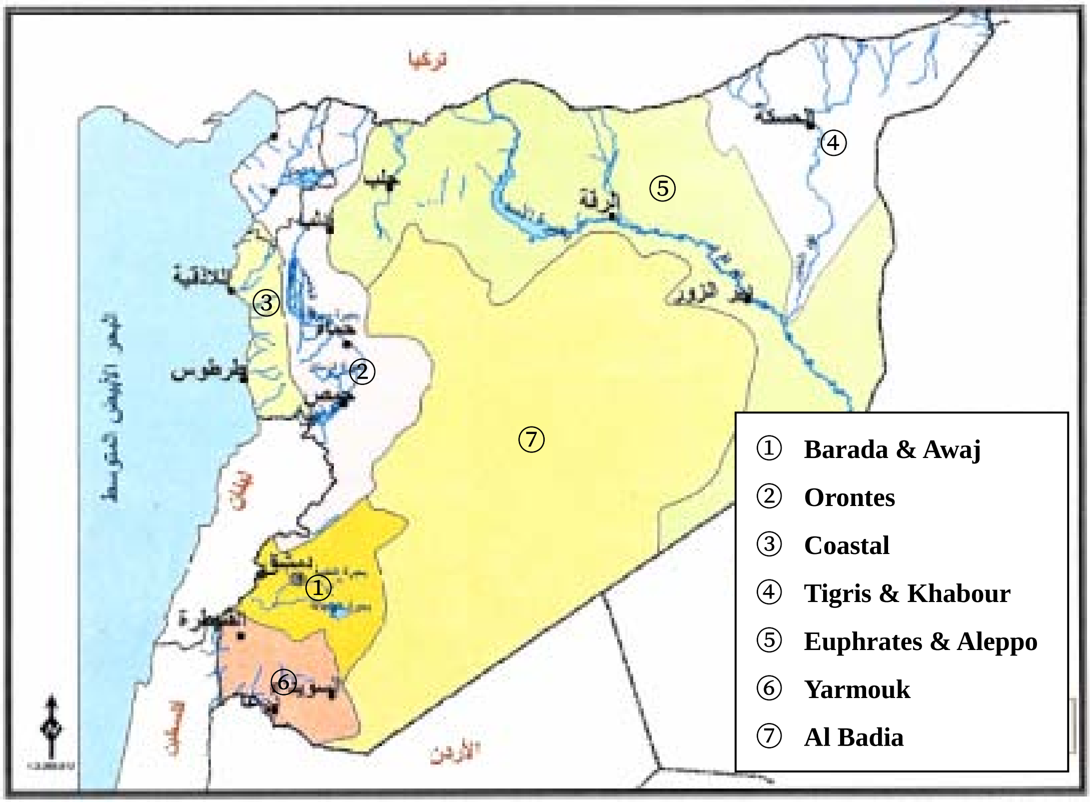
We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Land, Infrastructure, Transport and Tourism of the Government of Japan for their valuable advice and suggestions. We would also like to express our deep appreciation to the relevant officers of the Ministry of Housing and Construction of the Government of the Syrian Arab Republic for their close cooperation and assistance extended to us throughout our Study.

Very truly yours,

Hirofumi Sano
Team Leader
Study on Sewerage System Development
in the Syrian Arab Republic

Location Map of Study Area





Hydrological Basins in Syria

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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Volume II: Main Report

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List of Abbreviation

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
Company	Sewerage Company
Council	Council for the Protection of the Environment
DAWSSA	Damasucus Water Supply & Sewerage Authority
DFEA	Directorate for Environmental Affairs
DS	Dry Solid
DSDC	Damasucus Sanitary Drainage Company
EC	European Community
EIA	Environment Impact Assessment
EIB	European Investment Bank
EIRR	Economic Internal Rate of Return
Establishment	General Establishment of Potable Water and Sewerage (GEPWS)
EU	European Union
FAO	Food and Agriculture Organization
FIRR	Finacial Internal Rate of Return
F/S	Feasibility Study
GCEA	General Commission for Environmental Affairs
GCEC	General Company for Engineering Studies and Consulting
GDF	Government Debt Fund
GES	General Establishment System
GIS	Geographic Information System
GORS	General Organization of Remote Sensing
GOS	The government of Syrian Arab Republic
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IEE	Initial Environment Examination
IMF	Internatinal Monetary Fund
JD	Jordan Dinar
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau
L/A	Loan agreement
LBS	Land-Based Sources
LCD	Liter per capita per day
ℓ/s	Liter per second

MAP	Mediterranean Action Plan
MED POL	Program for the Assessment and Control of Phase Ⅲ Pollution in the Mediterranean Region
MHC	Ministry of Housing and Construction
MLAE	Ministry of Local Administration and Environment
MLSS	Mixed Liquor Suspended Solids
M/M	Minutes of Meetings
MOF	Ministry of Finance
MOI	Ministry of Irrigation
M/P	Master Plan
MPN	Most Probable Number
m^3/d	Cubic meter per day
NEAP	National Environmental Action Plan
O&M	Operation and Maintenance
PS	Pumping Station
PVC	Polyvinyl Chloride Pipe
RDAWSSA	Rural Damasucus Water Supply & Sewerage Authority
SAP	Strategic Action Program
SASMO	Syrian Arab Standards Measurement Organization
SPC	State Planning Commission
SS	Suspended Solids
STP	Sewage Treatment Plant
S/W	Scope of Work
SP	Syrian pounds
SV	Sludge Volume
TD	Tunisian Dinar
TDS	Total Dissolved Solids
10^{th} FYP	10^{th} Five-Year Plan
T-N	Total Nitrogen
T-P	Total Phosphorus
TS	Total Solids
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East
WB	World Bank

WHO	World Health Organization
WRIC	Water Resource Information Center

PART I : MASTER PLAN

CHAPTER 1 BACKGROUND OF THE STUDY

A large percentage of the land of Syrian Arab Republic is comprised of desert plateaus with elevations ranging from 200 m to 1,000 m. Owing mainly to the small precipitation, water resources in the country are scarce. The situation is aggravated by industrialization and the rapid population inflow from rural areas resulting in water shortages in the urban areas.

The development of a sewerage system has just been launched in the Syrian Republic. Presently, only the four major cities with large populations such as Damascus, Aleppo, Homs and Hama, have sewage treatment facilities. Many other cities are not equipped with basic sewage treatment facilities, thereby causing aggravation in the daily living conditions of the populace, including the worsening state of sanitation and of the environment in the area. In addition, there is a marked deterioration of groundwater and dam water for water supply, which resulted in the closing of wells and the suspension of intake from the dam water. The problem in groundwater quality is coupled with the decrease in groundwater storage volume as stated in **Figure 3.4.4** in the Main Report. This is caused by inefficient water usage, leakage from water supply pipes, illegal well construction and illegal water pipe connections. This situation demands that systematic pipe replacement planning and legal enforcement to illegal users be done immediately.

Raw industrial wastewater generated in establishments such as the olive oil factories is discharged into the rivers nearby, contributing to the overall water quality deterioration. The absence, therefore, of sewerage systems and sewage treatment facilities has a direct link in accelerating even the water source shortage.

The Syrian Government is tackling water environmental problems. Actions are mainly led by the Ministry of Housing and Construction (MHC) and the Ministry of Local Administration and Environment (MLAE). With achievement of nearly 100% of water supply service ratio, the Government is planning to develop sewerage systems and sewage treatment facilities aimed at water pollution control, effective utilization of water sources and cost recovery in sewerage works. Although the MHC requires review and renewal of the existing Governorate Master Plan, owing to the capacity shortage of Governorate offices and the headquarter of MHC, these planning works are quite difficult to do. Considering these circumstances, the Syrian Government requested the technical support from the Japanese Government. In response to this request, JICA dispatched the Preliminary Study Team in October 2005. The M/M was signed on 19 October 2005 and the S/W was also signed on 15 March 2006 for the implementation of this study.

CHAPTER 2 OBJECTIVES OF THE STUDY AND DESCRIPTION OF THE STUDY AREA

2.1 Objectives of the Study

The main objectives are as follows:

1) Review of existing development plans in national sewerage sectors
2) Formulate Governorate Master Plan for prioritized area aimed at water pollution control and public hygiene improvement
3) Conduct the Feasibility Study in Rural Damascus Governorate in cooperation with Syrian counterpart officers
4) Execute the Technical Transfer to Syrian counterpart officers in course of the study

2.2 Study Area

The study is being executed based on the S/W signed last 15 March 2006 between the Syrian Government and JICA, and is also based on the M/M. The study is divided into three phases, which correspond to a particular target study area as described below:

Table 2.2.1 Study Contents and Study Areas

Phase	Study Contents and Study Area
Phase-1	Examination on the current status of sewerage sector and preparation of improvement plan for the entire area of Syria
Phase-II	Establishment of a Master Plan for prioritized areas (four Areas in seven Governorates – Rural Damascus, Dar'aa, Tartous, Lattakia, Raqqa, Deir-Ez-zor, Hassakeh) Refer to the following Location Map.
Phase-III	Undertake the Feasibility Study as a pilot project for the selected site in Rural Damascus Governorate

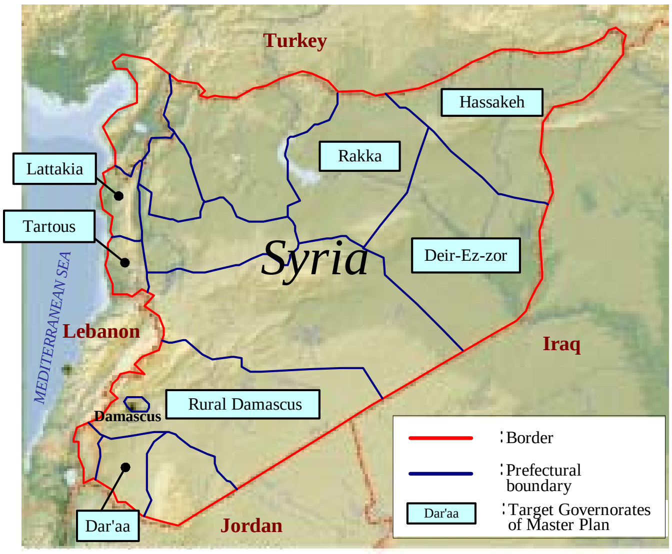


Figure 2.2.1 Location Map of the Study Area

2.3 Description of the Study Area

2.3.1 Natural Conditions

(1) Temperature

The daily differences between the maximum and minimum temperature are generally quite high throughout the land. The difference sometime reaches approximately 20℃ as shown **Table 2.3.1**. December, January and February are the coldest months of the year, while June to September is the hottest season. In winter, the temperature frequently falls under 0℃ at mountain area, while in summer it may rise frequently up to 48℃.

The daily fluctuations in temperature are greater in the desert and interior areas as compared with the more moderate areas on the coastal or in the mountain areas of high altitudes.

Table 2.3.1 Average Temperature in Syria (1996 – 2005)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum Average	13.2	15.1	19.6	24.9	31.2	35.1	38.4	37.5	34.0	28.6	21.0	15.1
Minimum Average	0.9	1.6	4.2	7.6	11.8	15.4	18.6	17.9	14.4	10.2	4.6	2.3

Source) Meteorological Office in Damascus

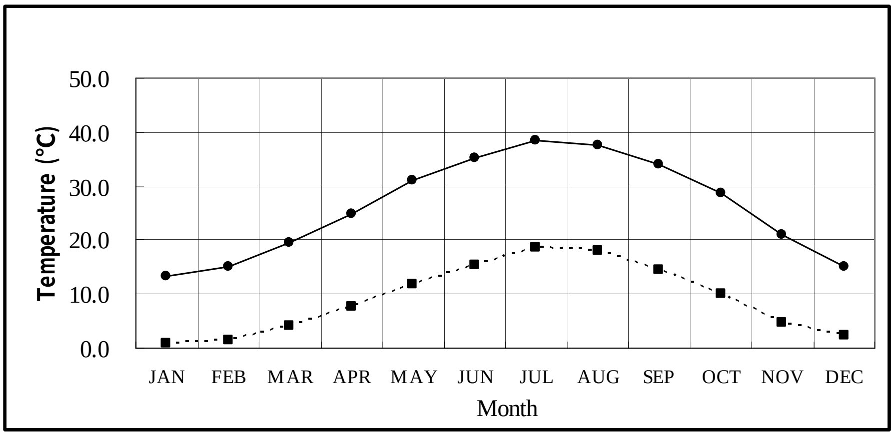


Figure 2.3.1 Average Temperatures in Damascus (1996 – 2005)

(2) Precipitation

In some places in Syria, thunderstorms and heavy rains happen in winter and may reach to 75mm in 24hours. The coastal and mountain areas have the most rains, followed by the north areas (Aleppo, Kamishly and Malkia in Hassakeh) where atmospheric depressions coming from Mediterranean Sea meet the mountains. On the other hand, in the eastern, southern and desert places, precipitation is low. The country is sometimes exposed to dry years which affect the agricultural production.

The western area reported the highest yearly and monthly total precipitation, which amounted 2,357mm and 775mm at Shatha, and the same station reported the highest daily total volume in November at 239mm.

Table 2.3.2 present the average rainfall data from 1996 to 2005 and **Figure 2.3.2** and **2.3.3** show the general phenomenon in Syria and rainfall fluctuation curve, respectively.

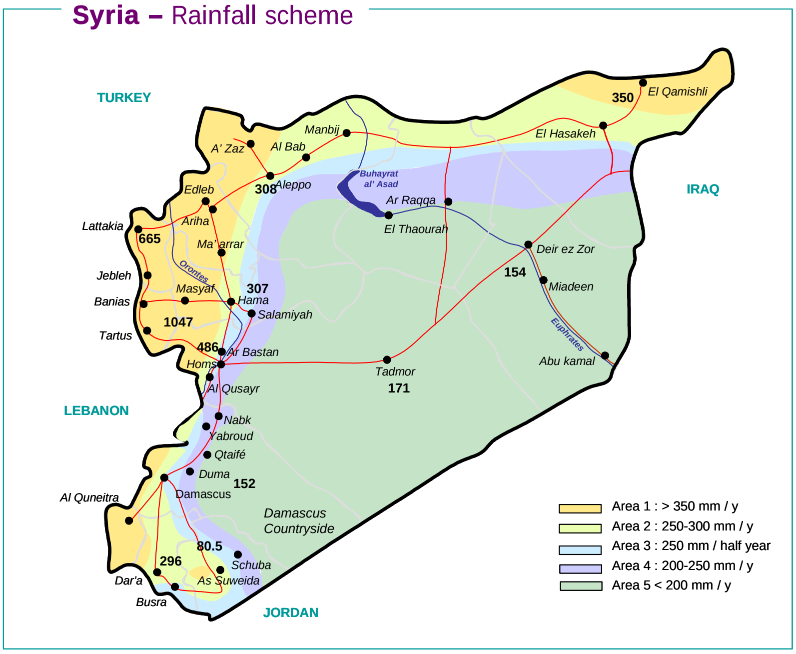


Figure 2.3.2 General Rainfall Conditions in Syria

Table 2.3.2 Average Rainfall Data by Governorate and Month (1996 – 2005)

(Unit: mm)

Governorate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Lattakia	141.4	85.2	76.6	48.7	8.3	7.9	0.4	3.5	18.9	68.7	79.2	171.1	709.9
Tartous	180.0	124.2	95.2	39.7	8.1	0.4	0.0	0.1	13.5	67.0	91.6	181.9	801.6
Deir-Ez-zor	30.0	24.8	20.0	13.3	7.3	0.1	2.3	0.0	0.2	4.0	21.4	25.4	148.8
Hassakeh	43.8	38.6	32.0	24.9	10.5	0.3	0.0	0.0	1.6	11.1	24.4	39.8	226.8
Raqqqa	38.1	26.3	30.5	17.5	9.8	0.0	0.1	0.0	0.2	5.9	16.4	24.7	169.4
Dar'aa	52.9	46.5	37.6	9.7	3.0	1.6	0.0	0.0	0.4	7.6	16.5	38.6	214.5
Rural Damascus	31.8	20.4	11.4	2.6	3.7	0.0	0.0	0.0	0.0	3.5	15.3	22.5	111.1
Damascus	47.6	37.6	18.6	4.9	2.4	0.0	0.0	0.3	0.0	6.0	25.8	41.2	184.4

Source) Meteorological Office in Damascus

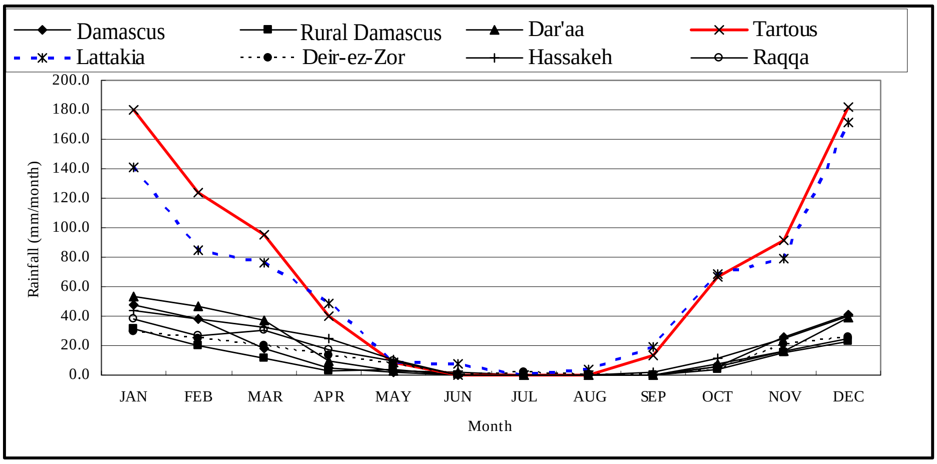


Figure 2.3.3 Rainfall Fluctuation Curve

(3) Geology

The Syrian Arab Republic lies on the eastern coast of the Mediterranean Sea bounded by Turkey to the north, Iraq to the east, Jordan from the south and Lebanon and the Mediterranean Sea to the west. The total area is about 185,000 square kilometers, the available lands form 32%, while steppes and pastures about 45%, non-liable land to agriculture about 20%, forests about 3%.

The outline of the geological condition in Syria is classified as follows and presented in **Figure 2.3.4**.

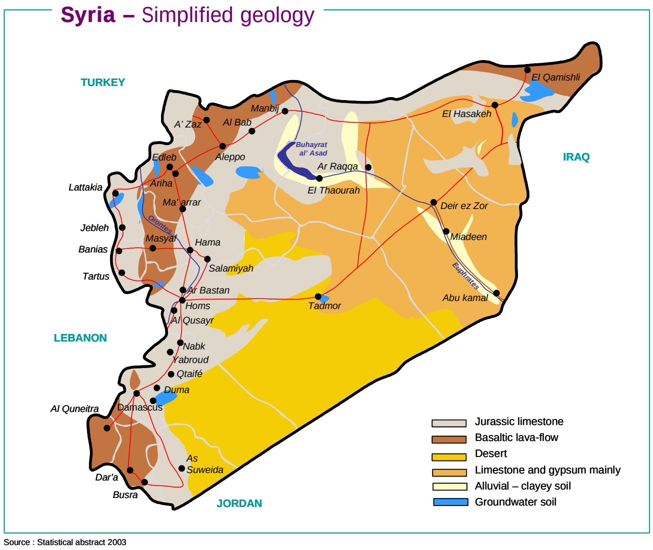


Figure 2.3.4 Geological Conditions in Syria

1) Coastal Zone

The coastal zone basically originates from the western ridge of the rift system coming from the south. It is 173km long, and is comprised of a narrow coastal plain, and the coastal range rising to 1,755m at Mount Al Akraa.

2) Anti-Lebanon Chain

Consisting in Jurassic and Cretaceous deposits, the massive range is faulted, partly clayey in the deepest basins and source iron deposits. The limestone is often Karstic and covered by sandy loams and pebbles.

Karstic limestone formations cover much of Syria, especially along the coast, in northern Syria, around Damascus and in the steppe. They have frequently suffered from severe weathering by solution owing to rainfall. The Karsts problem is arduous and costly but it must be taken into consideration in the fields investigations since it is worst precisely in the coastal area where there is an abundance of water and thus a high risk of pollution by leachate.

3) Damascus Region

The Damascus region consists in a large reception plain of some streams coming down from the Anti-Lebanon ranges, especially the perennial river, named the Barada. It is perennial due to the Harramoon limestone mountains.

The plain consists mainly in a sedimentary deposit basin mixed with sandstone and conglomerates of the upper quaternary (groundwater level is estimated to 70m). The Damascus oasis is covered with orchards and windbreaks of pines and poplars.

4) South East

The South East region is characterized by large volcanic flows of basalt with its scattered cones. At some points in the vast Hauran plain, the lava flow is very deep in thickness. The basalt formations cover nearly a quarter of Syria.

5) Syrian Plateau

The great Syrian plateau, an extension of the Arabia platform covers nearly half of the country. It crystalline basement is overlain in the west (around Homs, Hama and Aleppo) by cretaceous limestone while in the Euphrates valley late tertiary limestone lie at the surface. Gypsum is also found in the valley and raises serious problems (in Deir-Ez-zor, gypsum has been found on the new controlled landfill).

The limestone is largely overlain by vast basalt lava flows around Hassakeh. Northeast of the Plateau contains the oldest hydrocarbon fields in the country.

(4) Land Use

The total land area of Syria is 18,518 thousand hectares, 5,934 thousand hectares is arable lands and the rest is non-arable lands and others. The steppes and deserts area are about 8,300 thousand hectares and may be used for grazing when there is enough rainfall and good management. **Table 2.3.3** shows the present land use conditions from 2003 to 2005.

Table 2.3.3 Land Use (2003-2005)

(unit: thousand hector)

Year	Cultivable Lands				Uncultivable Lands				Steppes & deserts	Forests	Total lands area
	Irrigated	Non-irrigated	Fallow	Total	Buildings & roads	Water surface	Rock & sandy	Total			
2003	1,361	3,300	1,202	5,863	636	159	2,935	3,730	8,335	590	18,518
2004	1,439	3,290	1,181	5,910	651	161	2,924	3,736	8,279	593	18,518
2005	1,426	3,447	1,061	5,934	652	161	2,907	3,720	8,266	598	18,518

Source) Statistical Abstract 2006

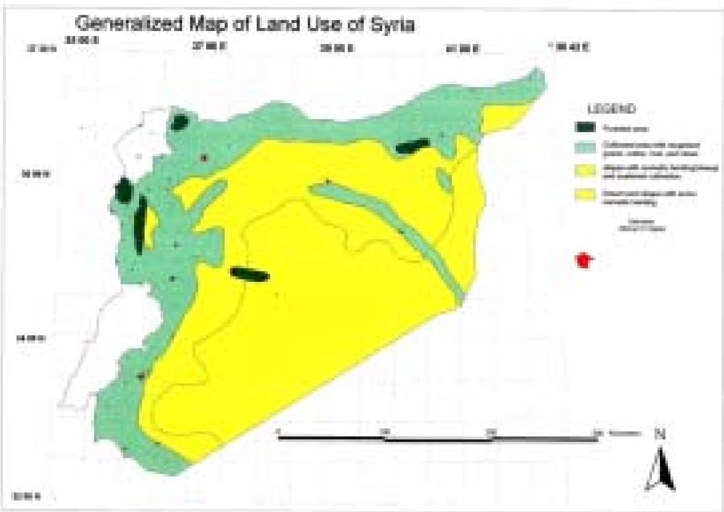


Figure 2.3.5 Land Use Map in Syria

2.3.2 Socio-Economic Conditions

Syrian society is characterized by being young. According to the 2006 Statistical Abstract, 39.5% of the population is below 15 years old, 57.2% is between 15-64 years old and 3.3% is over 65 years old. The percentage of males to females is 50.2% to 49.8%. This percentage is reflected on the economic factor. According to the 2006 Statistical Abstract, 39.2% of the total population of Syria lives in the city of Damascus, Rural Damascus and Aleppo governorates. **Table 2.3.4** shows the distribution of population in the Syrian Governorates.

Table 2.3.4 Distribution of Population

(unit: thousand person)

Governorate	Total Population	Females	Males	Percentage (%)
Lattakia	1,121	560	561	5.3
Tartous	874	433	441	4.2
Deir-Ez-zor	1,387	701	686	6.5
Hassakeh	1,349	679	670	6.3
Raqqa	839	427	412	3.9
Dar'aa	944	466	478	4.5
Rural Damascus	1,619	797	822	7.8
Aleppo	4,974	2,474	2,500	23.6
Hama	1,837	907	930	8.8
Homs	1,881	931	950	9.0
Idleb	1,744	861	883	8.3
Sweida	443	222	221	2.1
Quneitra	422	209	213	2.0
Damascus	1,627	812	815	7.7
Total	21,061	10,479	10,582	100.0

Source) Statistical Abstract 2006

The Syrian government has concentrated on the development of education in all stages. The number of students at basic education (1-9 classes) is 4.2 million in 2005. The number of students at secondary schools (1-3 classes) is 312,000 in 2005. The number of university students, students of higher studies and preparatory institutes reached 234,000 in 2005.

Around 24.3% of the total population are involved in economic activities. The distribution of this percentage is 40.8% for males and 7.5% for females. The economic activation of the population is distributed mainly in the service sector (44.4%), agriculture (6.9%), industry (16.2%), commerce (16.8%) and construction (15.7%), respectively. These figures are quoted from the Statistical Abstract 2006.

Table 2.3.5 shows the most important economic indicators in Syria, mainly the total local output, the agricultural and industrial output.

Table 2.3.5 Economic Indicators in Syria between 1990 and 2006

Economic Indicators	1990	2006
Total local output (million Syrian Pounds)	925,377	1,947,029
Agricultural output (million Syrian Pounds)	207,034	391,532
Industrial output (million Syrian Pounds)	360,233	696,029

Source) Statistical Abstract 2006

Agricultural production is the most important industry in Syria. In agricultural activities, cotton and sugar beets are the major industrial crops, which are produced under different irrigation systems especially in the Euphrates river basin. High value crops as tobacco, fruit, olives, and vegetables are grown in western areas. Large areas receive supplementary irrigation in late spring system and summer based on sub-surface water resources, which severe depletion.

The Government of Syria has prepared the 10^{th} Five-Year Plan (10^{th} FYP) for Economic and Social Development (2006-2010) in January 2006. This plan represents the supreme development plan at the national level in Syria. The 10^{th} FYP envisions a transition to the "Social Market Economy" society, and it stresses the need for enhancement of the society's awareness supported by rights of individuals and groups. The responsibilities are toward the participation in public affairs and the conviction to achieve a high productivity society, giving numerical targets for the main macroeconomic, social and infrastructural indicators towards 2010 such as the economic growth rate, infant mortality rate, illiteracy rate, drinkable water availability rate, and so on. It also gives eight strategic pillars to achieve these targets, and "Good governance of the environment and the conservation of the natural resources" is one of these pillars.

CHAPTER 3 PRESENT CONDITION OF WATER POLLUTION CONTROL IN SYRIA

3.1 National Policy for Water Resources Preservation and Water Pollution Control

3.1.1 Tenth Five-Year Plan for Economic and Social Development

The Government of Syria has prepared the 10th Five-Year Plan (10th FYP) for Economic and Social Development (2006-2010) in January 2006. This plan represents the supreme development plan at the national level in Syria.

The 10th FYP envisions transition to the "Social Market Economy"[1] society, and it stresses the need for enhancing society's awareness while supporting the rights of individuals and groups, their responsibilities for participating in the public affairs with the conviction to achieve a highly productive society. It provides numerical targets for the main macroeconomic, social and infrastructure indicators towards 2010 such as the economic growth rate, infant mortality rate, illiteracy rate, drinkable water availability rate, and so on. It also gives eight strategic pillars to achieve these targets including "Good governance of the environment and the conservation of the natural resources". Chapter 18 of the FYP provides the goals and strategies in the environment and disaster management sector.

The future visions of the environmental sector in the FYP are summarized below:

- Uplifting life quality and environmental performance in Syria and changing environmentally unfriendly production and consumption styles.
- Protecting natural resources, adapting the principle of sustainability in exploiting these resources through joint responsibility between all public, private and domestic sectors to preserve the available resources and develop the best environmentally friendly practices that can guarantee the next generation rights.

3.1.2 National Environmental Action Plan (NEAP) of Syria

The National Environmental Action Plan (NEAP) was the main outcome of the project entitled " National Capacity Building for the Environment in Syria" supported by the World Bank and the UNDP. The NEAP was adopted in April 2003 after revisions and modifications to the draft paper. It outlined the overall framework for sustainable development balancing the requirements of economic and social development on one hand, and the concern for environmental protection on the other. It also developed a list of environmental priorities and

[1] The shift towards the social market economy means using market tools and re-defining the government intervention as the regulator of the market performance and as the provider of public services.

set up a general framework for environmental planning until 2010. The environmental sector, the Ministry of Local Administration and Environment (MLAE), is currently developing the relevant programs to realize these strategic objectives in cooperation with all the concerned ministries and bodies.

The NEAP identifies the following priority environmental problems ranked in the order of importance:

1. Depletion and contamination of surface and groundwater resources
2. Land degradation
3. Air pollution
4. Inappropriate practices in solid waste disposal
5. Growth in illegal areas

As indicated above, the NEAP gives the top priority to water related problems in terms of quantity and quality. It also identifies major effects and direct causes of both water depletion and contamination problems as shown in **Table 3.1.1**.

Table 3.1.1 Water Depletion and Contamination Problems, their Causes and Effects

Problems	Major Effects	Direct Causes
Depletion of water resources	Decrease in agricultural productivity	Use of flood irrigation techniques
	Difficulty in meeting portable water requirements	Over-pumping of groundwater in response to population growth and economic development
	Drying-out of major spring sources	
Contamination of water resources	Increase in the number of water-borne diseases	Lack of sewerage networks for the discharge of domestic wastewater in population centers
	Increase in the costs of water piping networks	Lack of wastewater treatment plants or safe discharge practices of domestic wastewater
	Risk of infection in non-communicable diseases (poisoning, cancers)	Illegal discharge of industrial wastewater, and inappropriate use of fertilizers and pesticides

Further, it lists the source of problem and its locations specifying the sites which require urgent remedial measures to be incorporated in the formation of action plans, as shown in **Table 3.1.2**.

Table 3.1.2 Environmental Priority Problems Requiring Urgent Remedial Measures

Problem	Source of Problem	Location
Depletion of water resources	• Increased demand for water • Drinking water network losses of 27% • Depletion of the Barada Spring	Barada & Awaj Basin
Contamination of water resources	• Domestic wastewater discharge • Fertilizer plant • Wastes from food industries • Small business	Orontes Basin, Qatina Lake
	• Textile dyeing	Barada & Awaj Basin
	• Domestic wastewater discharge • Excessive use of nitrate-type fertilizers	Damascus Ghouta
	• Tanneries and small industries	Tanneries area, Damascus
	• Domestic wastewater discharge • Sugar manufacturing • Tanneries	Kuail Basin, Sajour River
	• Waste discharged from olive oil presses	Coastal Basin (Tartous), Daraa and Idleb

Finally, the NEAP presents a list of actions and measures against each environmental problem that may be adopted in order to address the strategic priorities mentioned earlier. With regard to "Sustainable Use of Water Resources", the following four major actions are proposed:

1. Match development planning to availability of water resources
2. Stop the over-exploitation of water resources; maintaining sustainable use levels; and stop the intrusion of saline water into coastal aquifers
3. Provide rural areas with potable water
4. Reduce the contamination of water resources from domestic and industrial wastewater discharge

Out of the four actions above, the details are proposed as follows:

Policy Development

- Complete the legislation dealing with limits for discharge of wastewater to water bodies
- Adopt the polluter pays principle, and environmental impact assessment
- Implement the Syrian government's plan for wastewater treatment
- Adopt clean and environmentally friendly technologies
- Adopt the environmental management principles to eliminate, and prevent waste generation at source, and for the reuse and recycling of wastes in industries
- Promote the use of closed loop water circuits in industrial establishments

Institutional Development

- Strengthen the coordination between ministries concerned with the management and utilization of water resources
- Ensure the systematic monitoring of water sources

- Develop the environmental inspection process for industrial establishments and enforce national legislation
- Provide import incentives for pollution control equipment and for environmentally friendly technologies

Investment Programs

- Construct pilot wastewater treatment plants in rural areas
- Construct pilot wastewater treatment plants for industrial discharges
- Establish industrial zones that satisfy the required environmental conditions, served by combined wastewater treatment plants, and provide incentives for industries to move into these zones (under implementation)
- Establish a fund financed by loans and grants, which provides low interest loans to small industries in order to implement environmental control projects (industrial wastewater treatment plants)
- Establish an integrated plan for the management of industrial wastewater in accordance with the requirements of environmental legislation

Training and Information

- Training in the management and operation of domestic and industrial wastewater treatment plants
- Training in environmental impact assessments
- Training in the monitoring and analysis of solid, liquid and gaseous wastes

As of August 2007, some of these action plans have either been completed or are still ongoing. In the areas of legislation and institution, water quality regulations for discharge of wastewater are already being enforced, while the Decree for implementing the EIA has recently been approved by the Environmental Protection Council last February 2007, and is presently awaiting the Ministry's approval. The environmental monitoring and inspection processes have been developed through JICA technical cooperation. The issuance of a Decree on providing import incentives for environmentally friendly technologies is still under consideration. In terms of the environmental investment, noteworthy is the establishment of an industrial zone in each Governorate. Such zones were already established in Damascus, Aleppo and Homs, and hundreds of factories have located there and are in operation, while the construction of a communal industrial wastewater treatment plant has been planned for these zones. Thus, it appears that the NEAP has been implemented step by step.

3.1.3 Protection of Marine Environment

As can be seen in the previous section, the NEAP gives the highest priority to the preservation of water resources such as springs, groundwater and surface water, and focuses on the measures to preserve such water resources.

Apart from the water resources preservation, Syria is tackling pollution control of the marine waters. Syria is one of the contracting parties to the Barcelona Convention for Protection of the Marine Environment and the Coastal Region of the Mediterranean-with the six Protocol, which it ratified in 1995. Twenty contracting countries contracting in the Barcelona Convention and Europe Union (EU) make up the Mediterranean Action Plan (MAP). The MAP coordinator (Greece) works under the auspices of the United Nations Environment Program (UNEP). The MAP comprises the Mediterranean Marine Pollution Monitoring and Research Program (MED POL), which assists member countries in the formulation and implementation of a pollution monitoring program, including pollution control measures and the drafting of action plans to reduce and, ultimately, eliminate pollution from land-based sources (LBS). The development of MED POL eventually led to the adoption of the Strategic Action Program (SAP) in 1997, a timetable with a schedule of activities for the implementation of the LBS Protocol with a 25-year horizon. SAP also targets the region's identified pollution hot spots and sensitive areas. For Syria, Banias and Jableh areas in the Tartous Governorate have been identified as pollution hot spots.

In accordance with these steps, Syria prepared an investment portfolio for implementation in the period 2006-2010 geared toward the reduction of LBS emissions in the Mediterranean, as presented in **Table 3.1.3**.

Table 3.1.3 Investment Portfolio to be Implemented during 2006-2010

Category		Project		Status
A.	First priority projects	1.	Re-qualification of Basuta Solid Waste Dumping Project, Lattakia	
		2.	Sewerage System of Lattakia	Construction of PS on going STP construction waiting for re-contract
		3.	Sewerage System of Banias (canalization + pump stations)	Investment Study completed but review of the plan on-going by JICA Study
		4.	Sewage treatment plant of Banias (3 stages)	ditto
		5.	Industrial wastewater treatment plant (oil refinery of Banias)	Investment Study completed waiting for financing
		6.	The shift from oil to natural gas (Banias thermal station)	Study ongoing by Ministry of Electricity and SPC
		7.	Sewage treatment plant (Tartous)	Same as Lattakia
		8.	Landfill compound of Tartous (Hidde Valley)	
		9.	Air filters (Tartous cement plant)	Under construction by Ministry of Industry
B.	Second priority projects	1.	Rehabilitation of sewerage system of Jableh plus sewage treatment plant	Construction was suspended due to appearance of archeological ruins
		2.	Fawwar Spring Project	No progress

3.2 Institutional Framework

3.2.1 Outline of Administration relating to Water pollution Control

The responsibility for dealing with the main environmental issues in Syria lies within the Ministry of Local Administration and Environment (MLAE). However, in so far as water quality monitoring/control is concerned, its administration is the responsibility of several Ministries and organizations, which exert varying degrees of planning and controlling functions.

The MLAE is responsible for the protection of the environment by issuing the required standards and for monitoring the quality of water for all its uses. In addition, it is tasked to plan and implement all governmental activities at the regional level (Refer to 3.2.2).

The Ministry of Irrigation (MOI) is responsible for water resources management and for the provision of irrigation water in the entire country, including sewage effluent. The MOI is also in charge of controlling and monitoring water quality through the Water Safety Committee (Refer to 3 2 3).

The Ministry of Housing and Construction (HMC) is responsible for proposing, planning and executing the Government's programme in the field of water supply and wastewater in all the regions of Syria. However, the Public Establishments of Drinking Water and Sewerage (Establishments) under the auspices of MHC conduct drinking water quality tests in their laboratories (Refer to Chapter 4).

Thus, fragmentation and overlapping of institutional responsibilities exist in monitoring and controlling water quality. There is also a lack of coordination among these institutions, and poses a risk in establishing adequate and efficient water pollution management.

3.2.2 Ministry of Local Administration and Environment (MLAE)

The MLAE is in charge of monitoring water quality and for coordinating measures in the field of water resources protection in cooperation with the MOI, which has regulatory, coordination, and research functions. In addition, it is responsible for the execution of all projects in the fields of urban planning, local roads, solid waste management and wastewater networks. The MLAE has the mandate to enforce the laws on water quality and on the protection of water resources. These instructions have to be approved by the Council for the Protection of the Environment (Council), headed by the Prime Minister.

Law No. 50 describes the responsibilities of the General Commission for Environmental Affairs (GCEA). It is an important unit within the MLAE and carries out policy formulation, inter-sector coordination, regulatory and research functions. The commission has the following tasks: (1) identifying the existing environmental problems and performing necessary studies and research in order to identify suitable solutions and abate any future environmental risks; (2) preparing the needed plans, legislation and programmes for conserving and developing the environment within the general policy of the country; (3) raising environmental public awareness through different types of media; (4) adjusting the risks resulting from the usage of different materials that affect human health, environmental safety and natural resources; (5) performing general environmental monitoring on all activities on Syrian land sea and air and (6) enforcing these laws and imposing fines for improper discharge of solid or liquid wastes.

At the local level, the environmental directorates have been established to implement and enforce the adopted environmental policies on the local level. Furthermore, each governorate has an environmental committee, which delegates the following main responsibilities: (a) following up the implementation of the decisions of the Council; (b) following up the implementation of the environmental specifications and pollution standards adopted by the Council; (c) following up the conformance of industrial establishments, and others with negative impacts on the environment, to the licensing requirements for permission of their operation. The Governor has thus the authority to close a factory for a limited period of time for violations of Environmental Law.

3.2.3 Ministry of Irrigation (MOI)

The MOI is the key actor of water resources management in Syria. It is responsible for developing, maintaining and controlling the country's water resources: and in planning, constructing, operating and maintaining of irrigation and drainage systems. If a Water Establishment wants to expand water supply in new settlements, the MHC sends a request for the increased allocation of water to the MOI. If water availability is limited, the problem id solved by the MOI in coordination with the MHC and the MLAE.

To carry out its mandate, the MOI is responsible for the hydrological and hydro-geological monitoring of river flow, dam storage volume, ground water level and water abstraction. It is the only institution that can authorize the abstraction of water from the river basins, the utilization of ground water including licensing groundwater wells, through providing separate permits for drilling and operation and the re-use of wastewater for irrigation purposes. The MOI is responsible for water sources assessment and allocation and, at the same time, represents the interests of the biggest consumer of water, which can present a potential conflict of interests.

It is important to note that the MOI through its Pollution Control Directorate is responsible for the monitoring and assessment of water quality, industrial effluents, and domestic wastewater discharges, which should be the function of MLAE. The results of the monitoring activities are disseminated to relevant ministries and authorities, such as the MLAE and the concerned governorates.

The MOI calculates the cost of water supply for irrigated agriculture and is responsible for establishing charges. There is a uniform irrigation service charge throughout Syria for surface irrigation supplies (only for irrigation perimeters where the GOS has financed the main infrastructure) of SP 3,500/ha, which is supposed to cover O&M costs. This charge is not related to the opportunity cost of water or to the quality of its use. Water from other sources including groundwater is free of charge for the farmers. The MOI is further responsible for carrying out the necessary maintenance operations for the existing irrigation and drainage systems, for lining the irrigation cannels and the main river course.

3.3 Legislative Framework

3.3.1 Environmental Law No.50 2002

In 2002, the Syrian Government issued Law No. 50, the country's environmental law. This law specified the objectives, tasks and organizational structure of the General Commission for Environmental Affairs (GCEA), the Environmental Protection Council, the Environmental Protection and Support Fund, and Responsibility and Compensation.

Noteworthy among the articles stipulated in the law is the responsibility and compensation, which includes signifying responsibilities for damages and compensation in cooperation with the Ministry of Justice and other relevant agencies, as follows:

- The Commission, in agreement with the Justice Minister, shall set a list of experts specializing in environment affairs who may be sought to give advise in the entry of sites with the support of the police that will testify the violations related to this law. Their reports shall have the capacity of minutes organized by the justice authorities after adoption by the Minister.

- The fine of [100,000-2,000,000] SP penalty shall be imposed on the owner of the installations of industrial economic, development, tourist or service activity or on the manager if he gets rid of solid, liquid or gaseous wastes contrary to the provisions of this law.

- The installations and/or activities existing on the date of this law issue shall be given a one-year period as of the date of their notification to reconcile their situations with the provisions of this law. The Council may extend this period for a maximum of two additional years if justified.

The Environmental Protection Council replaces the Higher Council for Environment Safety and as stipulated in legislative decree No.11 for 1991, it is the supreme council for environmental administration. The council is headed by the Prime Minister and consists of 25 members from 17 ministries, with different sector responsibilities and interests. The law specifies the tasks of this council as follows:

- Approve the general policy for environmental protection, the national strategy and related plans and programs.
- Approve the standards and criteria and the regulations that must be met in the industrial institutions.
- Makes decisions on prohibiting, suspending or imposing restrictions on the operation of installations or on activities that are deemed to cause harm to the environment.
- Approve the instructions, decisions and rules necessary to implement this law.
- Approve emergency plans to overcome the environmental disasters.

In 2004, through an Executive Instruction issued by the General Commission for Environmental Affairs (GCEA), the Environmental Law was modified by Law No. 17, providing more teeth to the enforcement of the Environmental Law. The new law has seven instructions with regard to:

1) Measuring the Environmental Elements, following up the laboratories adopted by the council and identifying the methods by which said laboratories are evaluated and adoption.

2) Preparing the standards and the criteria to measure the environment elements, and applying the required basis and instructions in preparing the Environmental Impact Assessment (EIA).

3) Conducting researches and studies in support of environmental affairs: and assessing threats resulting from the use of different materials that threaten the safety of the environment.

4) Setting the necessary instructions, environmental conditions and specifications for agricultural, commercial, industrial, residential and development projects, and the relevant precautions for licensing or re-licensing.

5) Setting bases for dealing with harmful materials that threaten the environment and categorizing, storing, transferring and destroying them, and determining what is prohibited to be introduced or enter Syria.

6) Taking the necessary procedures to prevent any kind of wastes to enter Syria, or for burying wastes, and categorizing the degree of danger and the treating mechanism.

7) Preparing a list of specialized environmental inspectors, from the staff of the MLAE, the GCEA or other public agencies, in agreement with Minister of Justice.

3.3.2 Regulations/Standards for Water Pollution Control and Wastewater Management

During 2002-2003, the Syrian Government issued a series of legal regulations/standards for environmental protection, such as air pollution, solid waste, hazardous waste, global issues, wastewater management, and so on. Although an ambient standard for the air quality was already issued, that for the water quality of public water bodies has not yet been instituted. Currently, the following regulations/standards are issued in terms of water pollution control and wastewater management.

- ✧ The maximum limits of industrial polluters permitted to be discharged to the external environment
- ✧ The maximum limits of industrial polluters permitted to be discharged to the sewer networks
- ✧ Regulations for treated water reuse for irrigation; and
- ✧ Regulations on the sludge use in agriculture

Standard No. 45 for drinking water was issued in 1994: but it has not yet been approved by the Council of Environmental Protection, as it is presently being updated and amended. This standard for drinking water quality provides the maximum permissible concentrations of different parameters presented in groups to determine the physical, chemical, biological, bacteriological, viral, and radioactive quality of drinking water.

(1) Maximum Limits of Industrial Polluters Permitted to be Discharged to the External Environment

In 2002, the Council for the Protection of the Environment approved pollution standards which set the limits for its discharge to the environment as presented in **Table 3.3.1**. This standard is being enforced on every establishment or activity that discharges polluted water, including municipal wastewater treatment plants.

Table 3.3.1 The Maximum Limits of Industrial Polluters permitted to be discharged to the External Environment

Indications		Code	Unit	Type of receivers (Water environment)			
				Seas	Earth surface*	Rivers	Agriculture drain nets
1	Color	Color	Blaninin Cobalt scale	Colorless	Colorless	Colorless	Colorless
2	Hydrogen ion concentration	pH		6-9	6-9	6-9	6-9
3	Temperature	Percentage Degree	10 degrees more than the used media	5 degree more than receiving media			
4	Biochemical oxygen demand	BOD_5 at 20^oC	mg/l	60	20	40	60
5	Chemical oxygen demand	COD	mg/l	200	30	150	100

Table 3.3.1 The Maximum Limits of Industrial Polluters permitted to be discharged to the External Environment

Indications		Code	Unit	Type of receivers (Water environment)			
				Seas	Earth surface*	Rivers	Agriculture drain nets
	(Dichromate)						
6	Oil and & grease	Oil & grease	mg/l	15	10	10	10
7	Total suspended solid	TSS	mg/l	60	30	30	60
8	Total dissolved solids	TDS	mg/l	-	800	1200	1000
9	Settleable soils	Settleable soils	mg/l	-	-	-	-
10	Phosphate	PO_4	mg/l	10	1	15	10
11	Ammonia (Nitrogen)	NH_3-N	mg/l	10	5	5	0.5
12	Nitrate (Nitrogen)	NO_3-N	mg/l	50	30	50	40
13	Phenol	Total recoverable Phenol	mg/l	0.5	0.01	0.02	0.5
14	Flourides	F	mg/l	1	1	1	1
15	Sulfide	S	mg/l	1	1	1	1
16	Residual chlorine	Residual Cl	mg/l	-	1	1	-
17	Surfactants	Surfactants	mg/l	3	0.05	0.05	0.5
18	Dissolved oxygen	DO	mg/l	4	4	4	4
19	Hydrocarbons	Hydrocarbons	mg/l	15	5	5	5
20	Floating matter	Floating matter	mg/l	No floating matter			
21	Aluminum	Al	mg/l	3	1	1	1
22	Arsenic	As	mg/l	0.1	0.1	0.1	0.1
23	Barium	Ba	mg/l	2	-	1	-
24	Beryllium	Be	mg/l	0.05	0.05	0.05	0.05
25	Cadmium	Cd	mg/l	0.05	0.05	0.05	0.05
26	Cyanides	CN	mg/l	0.15	0.1	0.1	0.05
27	Chromium	Cr	mg/l	0.5	0.5	0.5	0.5
28	Chromium	Cr^{6+}	mg/l	0.5	0.5	0.5	0.5
29	Nickel	Ni	mg/l	0.5	0.3	0.3	0.5
30	Mercury	Hg	mg/l	0.005	0.005	0.005	0.005
31	Iron	Fe	mg/l	2	1	2	2
32	Antimony	Sb	mg/l	1	0.3	0.3	0.3
33	Copper	Cu	mg/l	1.5	1	1	1
34	Manganese	Mn	mg/l	1	0.5	0.5	0.5
35	Zinc	Zn	mg/l	2	1	2	2
36	Lead	Pb	mg/l	0.5	0.2	0.2	0.5
37	Silver	Ag	mg/l	0.1	0.05	0.05	-
38	Total value of the heavy metals**	Total value of the heavy metals**	mg/l	2	1	1	1
39	Total count of coliform bacteria	Total count of coliform group	MPN/100ml	5000	2500	100	5000

* Areas in which leakage to underground water could be expected.

** Heavy metals, includes: Mercury-Lead-Cadmium-Beryllium- Nickel-Zinc-Copper

Note) Issued by the High Council of Environment Safety on 13. 05. 2002 and published by decision No. 67 dated 5.7.2003

(2) Maximum Limits of Industrial Polluters Permitted to be Discharged to the Sewer Networks

The Syrian Arab Standards Measurement Organization (SASMO) published the maximum limits of industrial polluters permitted to be discharged to the sewer networks in 2002 (SASMO 2580/2002). This standard determines the conditions and specifications in the liquid wastes from economic activities discharged into the sewage network, to ensure the optimal operation of wastewater treatment plants and to get environmentally safe wastes.

This standard is enforceable for the following activities:

- Chemical industries
- Medical and food industries
- Textile industries
- Hygienic services
- Any establishment or activity discharges polluted water

Table 3.3.2 The Maximum Limits of Industrial Polluters Permitted to be Discharged to the Sewer Networks

Element Name	Code	Maximum Limit Allowed	Unit	Notes
1- temperature	T	35	^{0}C	
2- pH	pH	6.5 – 9.5	/	
3- percipitable solid materials	S.S	10	mg/l	After 30 min.
4- total of suspended particles	T.S.S	500	mg/l	
5- sulfide	S	2	mg/l	
6- sulfate	SO_4	1000	mg/l	
7- ammonia / ammonium	NH_4-N NH_3-N	100	mg/l	
8- phosphate	PO_4	20	mg/l	
9- saponifiable oils and grease and resinous materials.	-	100	mg/l	
10- metallic oil and grease	-	10	mg/l	
11- Barium	Ba	3.0	mg/l	
12- Boron	B	1.0	mg/l	
13-Cadmium	Cd	0.1	mg/l	
14- Cr^{6+}	Cr	0.1	mg/l	
15- calcic chromium	Cr	2.0	mg/l	
16- copper	Cu	0.1	mg/l	
17- lead	Pb	0.1	mg/l	
18- mercury	Hg	0.01	mg/l	
19- nickel	Ni	2.0	mg/l	
20- Selenium	Se	1.0	mg/l	
21- silver	Ag	1.0	mg/l	
22- zinc	Zn	4.0	mg/l	
23- cyanide	CN	0.5	mg/l	
24- arsenic	As	0.1	mg/l	
25- phenol compounds	-	2.0	mg/l	
26- BOD	BOD	800	mg/l	
27- COD	COD	1600	mg/l	

Table 3.3.2 The Maximum Limits of Industrial Polluters Permitted to be Discharged to the Sewer Networks

Element Name	Code	Maximum Limit Allowed	Unit	Notes
28- T.D.S	T.D.S	2000	mg/l	
29- Chloride	Cl	600	mg/l	
30- fluoride	F	8.0	mg/l	
31- pesticides	-	0.005	mg/l	
32- detergents	ABS	5	mg/l	
33- Algonac organic compounds	AOX	0.1	mg/l	

Note) Issued by the High Council of Environment Safety on 13. 05. 2002 and published by decision No. 67 dated 5.7.2003

(3) Regulations for Treated Water Reuse for Irrigation

The SASMO published effluent reuse standards generated from sewage treatment plants in 2002. The Syrian standards for effluent reuse (SASMO 2752/2002) provides for three classes of effluent quality according to irrigation use as follows:

- Class A for irrigation of cooked vegetable crops and public areas
- Class B for processed food crops, fruit trees and other urban areas
- Class C for industrial crops and forestry

The standards require the determination of 38 parameters, some of which are technically difficult and require expensive analytical instruments and experienced laboratories, particularly for heavy metals (See **Table 3.3.3**). The 38 parameters regulated in the standards can be divided into the three types:

✧ Type 1: Those that can have a negative effect on health and which can be modified by wastewater treatment method (Fecal coli, Helminth eggs)

✧ Type 2: Those that represent environmental negative effect on health (BOD, COD, SS) for regulation of treated wastewater.

✧ Type 3: Those that are intended to assist in the interpretation of the potential restrictions on crops to be grown and soil conditions (TDS, SAR, Nitrogen, Chloride, Sodium).

Heavy metal and nitrogen, as they can have a negative effect on health and environment as well as crops, can be included in the types common to all.

The standards prohibit the use of the treated water for the irrigation of vegetable consumed uncooked, such as tomato, cucumber, carrot, lettuce, radish, mint, pepper, parsley, flower, and cabbage...etc. Also, the groundwater recharge using treated water is prohibited in aquifers used as drinking water.

Table 3.3.3 The Maximum Allowed Limits of the Measurement Criteria Related to the Treated Water for Irrigation Purposes

Indicators	Cooked vegetable	Parks, playgrounds, and roads within cities	Sporting playgrounds	Fruit trees	Highway sides	Green spaces	Grain and fodder crops	Industrial crops	Forest trees
Categories	A			B				C	
BOD_5 (mg/l)	30			100				150	
COD (mg/l)	75			200				300	
DO (mg/l)	more than 4			-				-	
TDS (mg/l)	1500			1500				-	
SS (mg/l)	50			150				150	
SAR*	9			9				9	
pH	6-9			6-9				6-9	
Cl_2 Residual	0.5			-				-	
NO_3-N (mg/l)	20			25				25	
NH_3-N (mg/l)	3			5				-	
SO_4 (mg/l)	300			500				500	
PO_4 (mg/l)				20					
HCO_3 (mg/l)				520					
Cl (mg/l)				350					
Lubricants and fats (mg/l)				5					
MBAS (mg/l)				50					
Phenol (mg/l)				0.002					
Na (mg/l)				230					
Mg (mg/l)				60					
Ca (mg/l)				400					
Hygiene Criteria									
Fecal coliform (MPN/100ml)	<1000			<100000				<10000	
Intestinal helminthes eggs (egg/l)	one ovum at least								

Trace Elements			
Parameters	Long term use (continues)	Short term use (up to 20 years)	Remarks
Al (mg/l)	5	20	
As (mg/l)	0.1	2	
Be (mg/l)	0.1	0.5	
B (mg/l)	0.75	2	
Cd (mg/l)	0.01	0.05	
Cr (mg/l)	0.1	1	
Co (mg/l)	0.05	5	
Cu (mg/l)	0.2	5	
F (mg/l)	1	15	
Fe (mg/l)	5	20	
Pb (mg/l)	5	10	
Li (mg/l)	2.5	2.5	
Mn (mg/l)	0.2	10	
Mo (mg/l)	0.01	0.05	
Ni (mg/l)	0.2	2	
Se (mg/l)	0.02	0.02	
V (mg/l)	0.1	1	
Zn (mg/l)	2	10	

Note) * SAR means sodium adsorption ratio, and is sometimes reported by the symbol RNa. At a given SAR, infiltration rate increases as water salinity increases.

(4) Regulations on the Sludge Use in Agriculture

The SASMO published standards for the safe use of sludge produced by wastewater treatment plants in 2002 (No. 2665) along with the aforementioned standards for effluent reuse (No. 2752). The standards specify procedures for producing and distributing sludge for agricultural use, required sludge treatment methods, duties of sludge producers and distributors, and criteria on heavy metal concentrations in sludge for the safe use for agricultural purposes.

The standards give two options for the sludge treatment methods to eliminate pathogens such as fecal coliform, salmonella bacillus and ascaris ova. These options include advanced treatment and conventional treatment, and the detailed descriptions of these two options are as follows:

Advanced treatment

- Thermal drying: 80℃ and to contain less than 10% moisture
- Aerobic digestion: 55℃ for 20 hours, batch treatment
- Anaerobic digestion: 53℃ for 20 hours, batch treatment
- Thermal treatment (hydrolysis): 70℃ for 30 minutes followed by anaerobic digestion 35℃ for 12 days
- Lime treatment: pH 12 and 55℃ for 2 hours
- Lime treatment: pH 12 for 3 months

Conventional treatment

- Aerobic digestion: 55℃ for 20 days
- Anaerobic digestion: 53℃ for 20 days
- Lime treatment: pH 12 for 24 hours
- Anaerobic digestion: 35℃ for 15 days
- Aeration time for the batch treatment shall be determined based on the ambient temperature by the competent authority.

The standards prohibit the use of all sludge on all vegetable crops regardless of the level of sludge treatment. In the use for crops other than vegetable, it specifies that sludge should comply with the following microbiological quality:

- Fecal coliform <1,000MPN per gram DS
- Salmonella <3MPN per 4gram DS
- Ascaris ova <1 viable per 5gram DS

The standards further specify five levels of sludge use depending on the contamination of heavy metals as follows:

  - Level A unrestricted usage
  - Level B,C, and D restricted of usage

- Level E not valid of usage

Table 3.3.4 shows permitted concentration for each level and **Table 3.3.5** shows the possible usages of every level of sludge.

It also describes the method of determining the total quantity of sludge that may be applied to land. The calculation is based on the maximum permitted soil concentration of each heavy metal as shown in **Table 3.3.6**.

Table 3.3.4 Permitted heavy metal concentrations in sludge for sludge use level (mg/kg DS)

Element	Level				
	A	**B**	**C**	**D**	**E**
Arsenic (As)	20	20	20	30	-
Cadmium (Cd)	3	5	20	32	-
Chrome (Cr)	100	250	500	600	-
Copper (Cu)	100	375	1500	1500	-
Lead (Pb)	150	150	300	400	-
Mercury (Hg)	1	4	15	19	-
Nickel (Ni)	60	125	270	300	-
Selenium (Se)	5	8	50	90	-
Zinc (Zn)	200	700	500	2800	-

Table 3.3.5 Sludge usages field according to the level of classification

Level of classification	Usage field	Usage expiration
A	1) Domestic grassland and parks 2) Spaces of domestic public activities 3) Green-space areas (gardens and green areas) 4) Agriculture 5) Forests 6) The soil of the reclaimed sites 7) Sanitary landfill sites 8) Wastes disposal in piles on the ground surface within the boundaries of the treatment stations	**Unrestricted use**
B	From subject 2 to subject 8	**Restricted use 1**
C	From subject 4 to subject 8	**Restricted use 2**
D	From subject 5 to subject 8	**Restricted use 3**
E	From subject 7 and 8	**Not suitable for use**

Table 3.3.6 Maximum soil concentrations of allowed heavy metals where sludge is added to the agricultural and green-space areas (mg/kg DS)

Element	Agricultural soil	Green-space areas soil
Arsenic (As)	20	20
Cadmium (Cd)	1	5
Chrome (Cr)	100	250
Copper (Cu)	100	375
Lead (Pb)	100	150
Mercury (Hg)	1	4
Nickel (Ni)	60	125

Table 3.3.6 Maximum soil concentrations of allowed heavy metals where sludge is added to the agricultural and green-space areas (mg/kg DS)

Element	Agricultural soil	Green-space areas soil
Selenium (Se)	5	8
Zinc (Zn)	200	700

3.3.3 Observation on Existing Legislation

The issuance of the Environmental Law demonstrates that the Syrian Government gives high priority to the protection of the environmental. However, actual enforcement is very weak because the specific instructions related to the main Law No. 50 are not adequate.
Wastewater discharged into the public sewers from most enterprises in Syria is not treated, and therefore, effluent does not meet legal regulations. While the law has a steep penalty clause against violators, it may be difficult to apply the law since most enterprises or entities violate the law.

It generally seems that the water quality criteria required in the "effluent standards discharged to the external environment" are too stringent and impractical for the present Syrian situation. (**Table 3.3.1**) It would be very difficult for all the enterprises (including small and medium scale enterprises) to comply with these standards. In Japan, for example, the criteria of the effluent standards stipulated by the central government (called the national uniform standards) are laxer than those in Syria (e.g. permitted maximum concentrations of BOD and SS are 160 mg/l, 200 mg/l respectively), and these standards are applied only to the specified factories by the law with the effluent discharge amount of more than 50 m^3 per day. Since the environmental problems tend to vary according to the locality, the law in Japan allows the prefectural government to be able to enforce the local effluent standards that are more stringent than the national standards.

To improve law enforcement for Law No. 50 in depth clauses or by laws should be issues, such as:

- detailed definition of the type and scale of industry to be regulated,
- obligation of reporting on treatment facilities and discharged wastewater quantity and quality from industrial wastewater dischargers,
- provision of temporary standards or moratorium periods for existing industries and,
- restriction on new industries' locations (limiting them to the exclusive industrial zones, for example)

would be necessary.

Syrian standards also include parameters for heavy metals, since heavy metals are toxic to the environment as well as the human health. However, analysis of these parameters is technically difficult and requires expensive analytical instruments and experienced laboratories, and is not being performed by the existing analytical staff in Syria. Under such circumstances, the capacity development of environmental monitoring is being carried out by the JICA expert team, which will include improvement in the use of analytical technique.

With regard to the regulations for treated water reuse for irrigation, the criteria include three Types of parameters as stated earlier, namely, Type 1: negative effect parameters on health, Type 2: negative effect parameters on environment and health, and Type 3: potential restriction parameters on crops growth and soil conditions. It is perceived, among others, that parameters of Type 3 is adapted from the "Guidelines for interpreting water quality for irrigation" by the Food and Agricultural Organization of the United Nations (FAO). However, the WHO guidelines require only the Type 1 parameters, based on the conclusion that the main health risks associated with reuse in developing countries are associated with helminthic diseases and that a high degree of helminth removal is necessary to use wastewater in agriculture safely. Instead, no restrictions are required in terms of the Type 3 parameters (See **Table 3.3.7**). Since these parameters represent usable water quality in agriculture, these should only be used as a technical guideline with no legal restrictions.

Moreover, the WHO guidelines allow to practice of reusing of treated wastewater in irrigating crops that are eaten uncooked if the values of the microbiological parameters meet the requirements (i.e. Fecal coliform <1000/100ml and Helminth ova <1/l), while the Syrian standards prohibit this practice. This is a negative factor on promotion of treated water reuse in irrigation purposes.

Table 3.3.7 Reference-Recommended microbiological guidelines for wastewater use in agriculture[a] (WHO, 1989)

Reuse conditions	Exposed group	Intestinal nematodes[b] (Number of eggs per liter)[c]	Fecal coliforms (Geometric mean per 100ml)[c]	Wastewater treatment required
A. Irrigation of crops likely to be eaten uncooked, sports fields, public parks	Workers, consumers, public	Equal to or less than 1	Equal to or less than 1000[d]	A series of stabilization ponds designed to achieve the microbiological quality indicated or equivalent treatment
B. Irrigation of cereal crops, industrial crops, fodder crops, pasture and trees[e]	Workers	Equal to or less than 1	No standards recommended	Retention in stabilization ponds for 8-10 days or equivalent helminth fecal coliform removal
C.Localized irrigation of crops in category B if exposure of workers and the public does not occur	None	Not applicable	Not applicable	Pretreatment as required by the irrigation technology, but not less than primary sedimentation

[a]In specific cases, local epidemiological, sociocultural, and environmental factors should be taken into account, and the guidelines modified accordingly.

[b]*Ascaris* and *Trichuris* species and hookworms.
[c]During the irrigation period.
[d]A more stringent guideline (200 fecal coliform/100ml) is appropriate for public lawns such as hotel lawns with which the public may come into direct contact.
[e]In the case of fruit trees, irrigation should cease two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation over the crowns of the trees should not be used when fruit is on the trees.

3.4 Present Condition of Water Pollution in Public Waters

3.4.1 Characteristics of Natural Condition in Hydrological Basins

The land area of Syria can be divided into seven hydrological basins as shown in **Table 3.4.1**.

Table 3.4.1 Hydrological Basins in Syria

Hydrological Basins	Area (km^2)	Annual Rainfall (mm)	Major Water Resources
1) Barada & Awaj	8,630	862	Groundwater (well and spring)
2) Orontes	21,634	403	Surface water
3) Coastal	5,049	1,294	Groundwater (well and spring)
4) Tigres & Khabour	21,129	402	Surface water
5) Euphrates & Aleppo	51,238	308	Surface water
6) Yarmouk	6,724	287	Groundwater (well and spring)
7) Al Badia	70,786	138	Groundwater (well)
Total	185,180	252	

Source) Ministry of Irrigation 2002

The characteristics of natural conditions in each basin is as follows:

1) Barada & Awaj Basin

This basin includes high surface topography in the north-west and flat terrains in the east that do not exceed 700 meters in elevation. The climate is a combination of both the Mediterranean mountainous and internal highlands climates. The basin does not possess an extensive surface water network, and water resources are very limited.

2) Orontes Basin

This basin varies in elevation between 80 and 900 meters. The climate is classified as a Mediterranean mountainous climate. The main water resource is the Orontes River. The basin has experienced significant water pollution, mainly from the oil refinery, and as a result of industrial discharge to the Orontes River and Qatina Lake.

3) Coastal Region

This region is characterized by its sandy mountainous terrains, and flat lowlands situated between the fault of Al Ghab and Al Omq basins, and the Orontes and Qarasto Rivers, from the east, and the Mediterranean coastline from the west. The region is characterized by its moderate weather conditions with low temperature variations. Rainfall is high, with precipitation varying from 800 to 1000 mm along the coastline and adjacent lowlands.

4) Tigres & Khabour Basin

The flat plateau with an average elevation of 350 meters above mean sea level extends over the area. This basin is characterized by its semi-arid Mediterranean climate, which can be classified as a desert-like Mediterranean climate. In general, the summer season is dry and hot, the winter season is rainy and cold. Although this basin is abundant in natural resources such as petroleum, the water balance is critical due to the huge consumption of irrigation water.

5) Euphrates & Aleppo Basin

The natural condition of this basin is similar to that of Tigres & Khabour in general. However, the climate of the Aleppo highlands combines both the Mediterranean mountainous, and internal highlands climates. Water resources, as a whole, are abundant.

6) Yarmouk Basin

The Golan Heights constitutes one of the passageways permitting southwestern weather fronts to penetrate the interior lands. Average rainfall precipitation varies between 200 mm in the lowlands up to 1000 mm in the Golan Heights. Most water resources originate from winter flood events.

7) Al Badia Region

This is the largest region of Syria, characterized by its dry climate, which is classified as desert-like with low rainfalls and high temperature variations. This region is distinguished by its seasonal rivers that flow in small valleys, and by its small lakes, which are formed by the accumulation of flowing water after extended periods of rainfall.

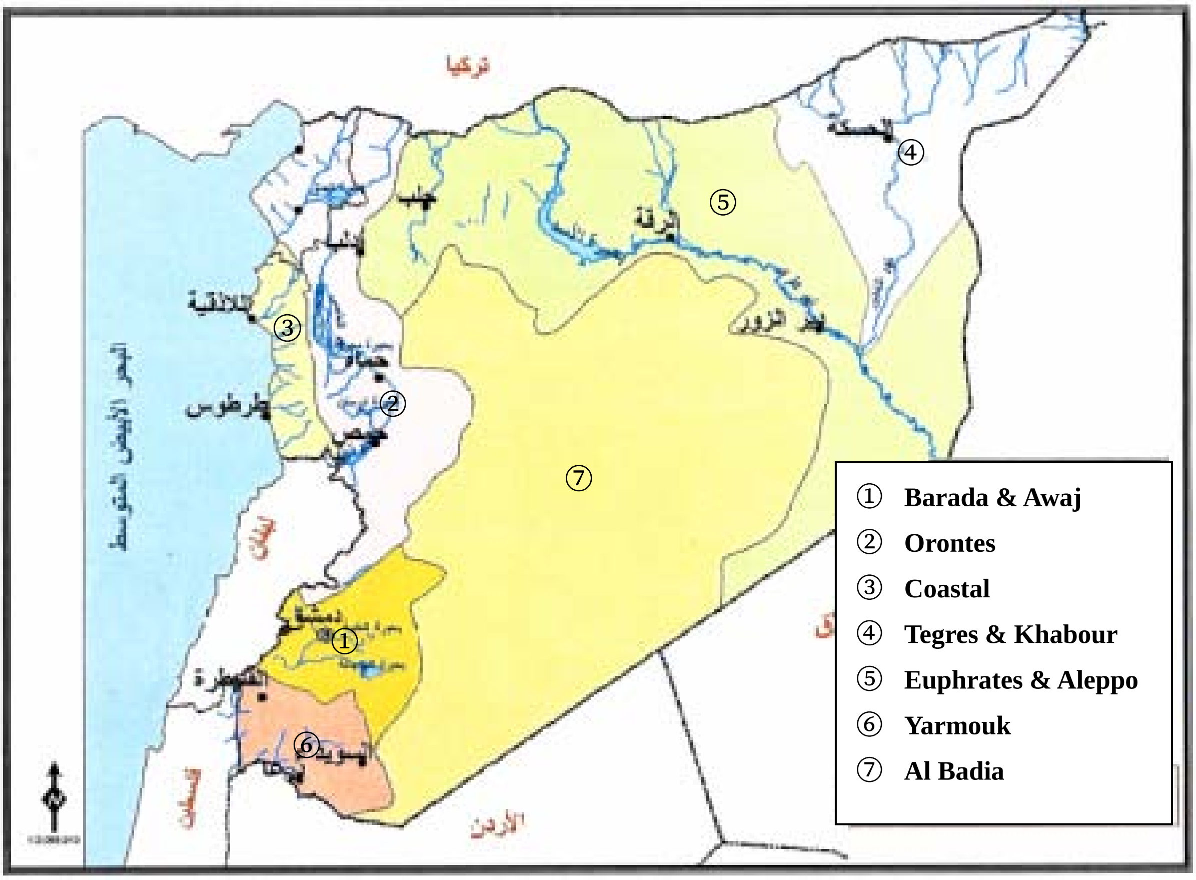


Figure 3.4.1 Hydrological Basins in Syria

3.4.2 Water Resources

As mentioned in the previous section, the distribution of water resources in Syria differs significantly by regions. For example, the Euphrates River is a very large international river with abundant water volume, while the dry zone only has several wadis which have almost no water throughout the year. The Mediterranean Coastal area has a mild climate with rich water resources. The water supply systems in Syria utilize either groundwater (including spring) or surface water as the water source depending on the water resources situation of its basin. The water supply volume by Governorates is shown in **Table 3.4.2** and **Figure 3.4.2.**

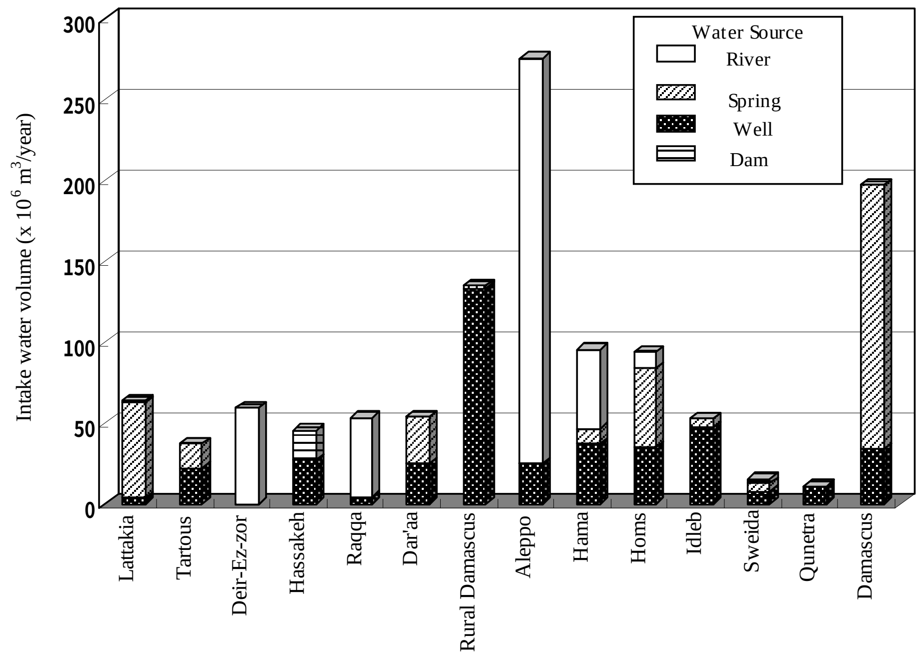
Table 3.4.2 Water Volume of Governorate for Water Supply by Water Sources (2005)

Governorate	Water Intake volume for Water Supply (×1,000 m^3/year)				
	Well	Spring	River	Dam	Total
Lattakia	3,925	58,796	-	1,199	63,920
Tartous	22,170	14,800	-	-	36,970
Deir-Ez-zor	-	-	59,000	-	59,000
Hassakeh	27,300	-	-	18,150	45,450
Raqqa	4,250	-	48,975	-	53,225
Dar'aa	24,800	29,300	-	-	54,100
Rural Damascus	133,300	1,700	-	-	135,000

Table 3.4.2 Water Volume of Governorate for Water Supply by Water Sources (2005)

Governorate	Water Intake volume for Water Supply (×1,000 m^3/year)				
	Well	Spring	River	Dam	Total
Aleppo	25,300	-	250,219	-	275,519
Hama	37,162	9,318	48,950	-	95,430
Homs	34,582	49,269	9,631	-	93,482
Idleb	47,126	5,914	-	-	53,040
Sweida	7,672	4,700	-	3,228	15,600
Quneitra	10,875	-	-	-	10,875
Damascus	33,974	163,161	-	-	197,135
Total	412,436	336,958	416,775	22,577	1,188,746

Source) Ministry of Housing and Construction



Source）Ministry of Housing and Construction

Figure 3.4.2 Water Volume for Water Supply by Governorate

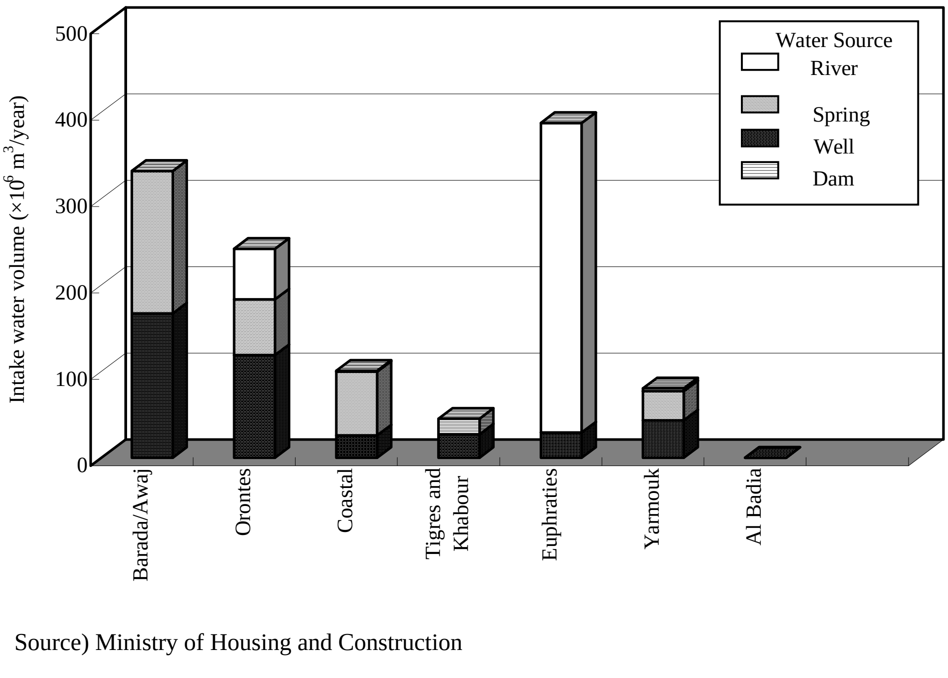
The water volume intake for water supply by Governorate (2005) shows that Aleppo uses the largest volume, its share being approximately 23% of the total amount of water supply in Syria, followed by Damascus with a share of 17% and Rural Damascus with 11%. The total water supply intake volume of these three Governorates exceeds 50% of the total volume in Syria, implying that population and industrial and commercial activities are concentrated in these Governorates.

As to the water resources type, Aleppo, Raqqa and Deir-Ez-zor heavily depend on the surface water with more than 90 % of the total volume. Damascus, Rural Damascus、Tartous, Lattakia, Idleb, Dar’aa and Qunetra, on the other hand, are highly dependent on groundwater Homs, Hama, Hassakeh and Sweida utilize both types of water resources.

The water supply volume in each hydrological basin is assumed to be the sum of all the basin in each governorate as below.

Barada/ Awaj River basin:	Damascus and Rural Damascus
Orontes (Al Assi) River basin:	Homs, Hama and Idieb
Coastal area (Mediterranean Sea basin):	Tartous and Lattakia
Tigres and Khabour River basin:	Hassakeh
Euphrates River basin:	Aleppo, Raqqa and Deir-Ez-zor
Yarmouk River basin:	Dar'aa, Sweida and Quneitra
Al Badia:	Omission

The Euphrates River basin (including Aleppo) uses the biggest volume for water supply in Syria, and its source is the Euphrates River. The Barada/Awaj River basin is next, but it is dependent on groundwater. Three-fourths of water supply sources in the coastal area depend on groundwater and one-fourth on surface water. Water sources in Khabour River basin are groundwater and dams while groundwater is the only source in the Yarmouk River basin. (See **Figure 3.4.3**)



Source) Ministry of Housing and Construction

Figure 3.4.3 Water Volumes for Water Supply by Basin (2005)

3.4.3 Water Quality in Public Waters

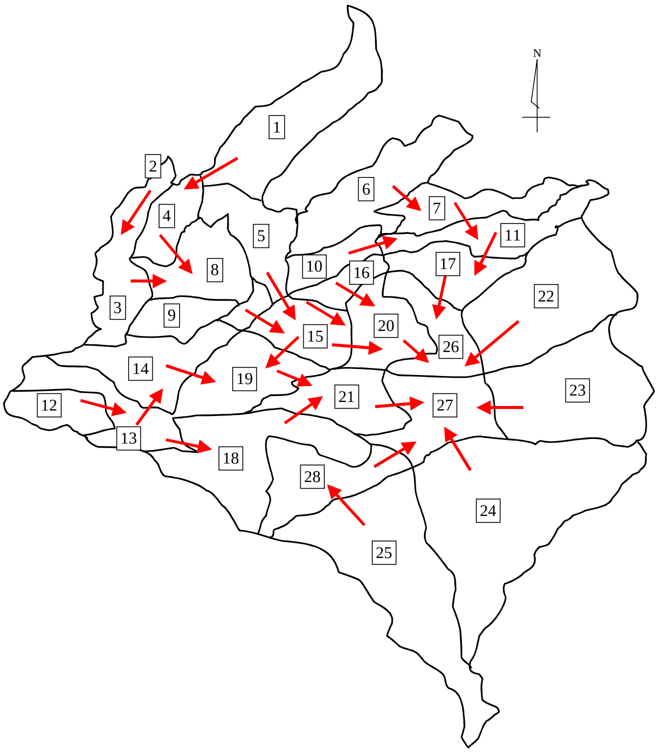
The water pollution problems in the seven hydrological basins in Syria are summarized as below.

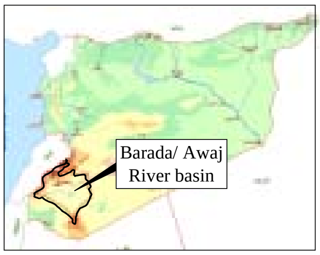
(1) Barada & Awaj Basin

The Barada/ Awaj River Basin in Damascus and Rural Damascus are characterized as follows:

- The Barada/ Awaj River Basin is one of the most densely inhabited and highly industrialized areas in Syria
- Annual precipitation in thisw area is less than 200 mm (flat lands) and 600 to 800 mm (mountainous area) in this area
- The Barada /Awaj River water is utilized for irrigation.
- River water in the downstream of Barada /Awaj River is used up by actual water use, evaporation and infiltration.
- Flow direction in this basin is mainly from Northern and Western areas to Eastern area of Elhejaneh (No. 27Sub-basin). (See **Figure 3.4.4**)
- Due to the decrease in river flow rate downstream, river water quality is easily influenced by domestic and industrial wastewater discharges.

It is considered that seriousness of the pollution of the Barada/ Awaj River is caused by these factors.





Source) Water Resources Information Center

Figure 3.4.4 Flow Direction of Surface Water in the Barada/ Awaj River Basin

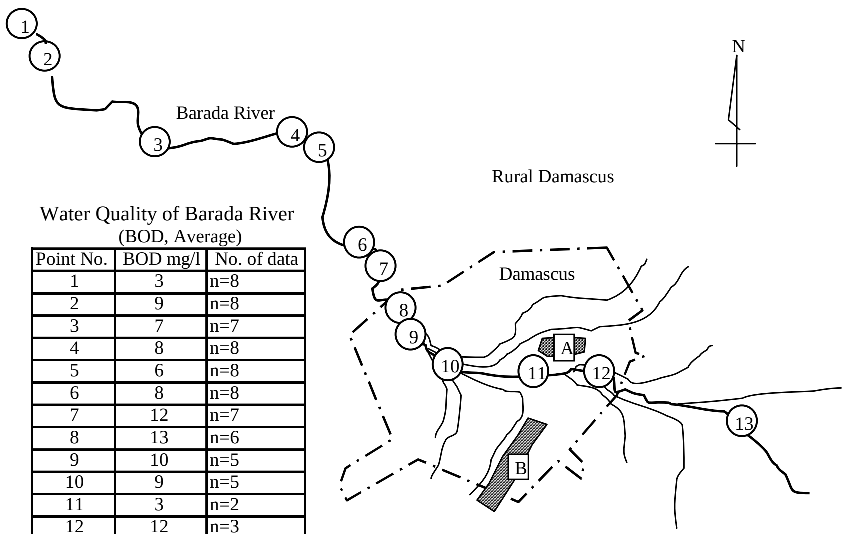
Water quality analysis results of Barada River sre shown in **Figure 3.4.5**. The table clearly shows that Barada River is not significantly polluted until it flows down to the east end of

Damascus urban area. This river water is utilized for irrigation purpose only and the maximum allowed limits of the measurement criteria related to the treated water for irrigation purposes (BOD 30 mg/l of Category A) is satisfied.

Barada River is highly polluted in the lowest reaches from the east end of urban area to the rural area, by the discharges of domestic, commercial and industrial wastewater. Its tributary is heavily polluted by two industrial areas in urban area of Damascus by the discharge of industrial wastewater from the tannery factory area (A) and the industrial area (B). There is also possible chromium contamination coming from tannery factories in area A.

Additionally, it seems that reduction of water quality (BOD) at the point No. 11 in the central urban area is considered to be the following reasons;

- The almost river flow is diverted in the upstream of point No.11.
- River water at the point No. 11 mainly consists of river-bed water and groundwater.
- There is little discharged wastewater in the central urban area by the sewerage system.



Water Quality of Barada River
(BOD, Average)

Point No.	BOD mg/l	No. of data
1	3	n=8
2	9	n=8
3	7	n=7
4	8	n=8
5	6	n=8
6	8	n=8
7	12	n=7
8	13	n=6
9	10	n=5
10	9	n=5
11	3	n=2
12	12	n=3
13	33	n=2

Sampling date is from Jan. 2005 to Oct. 2005

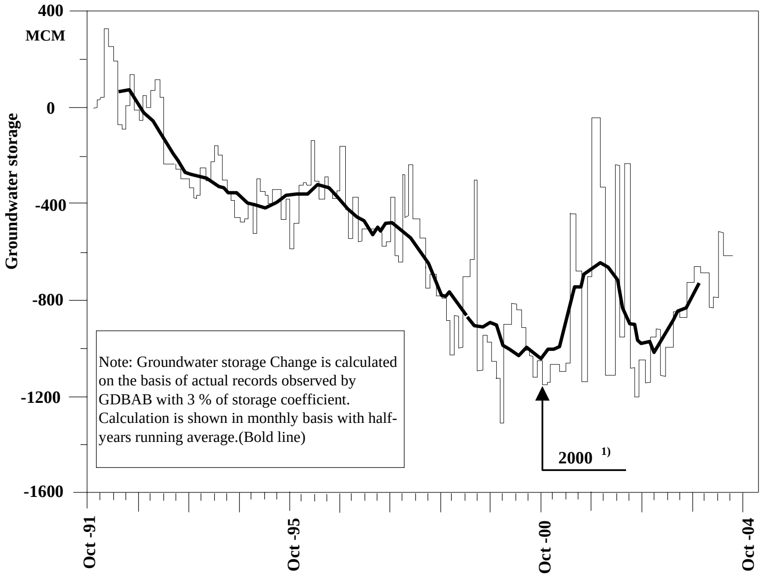
A: Industrial Area (There are Tannery Factories)
B: Industrial Area (There are many type of factories)

Source) Ministry of Irrigation

Figure 3.4.5 Water Quality Condition of Barada River (2005)

<u>Groundwater Contamination</u>

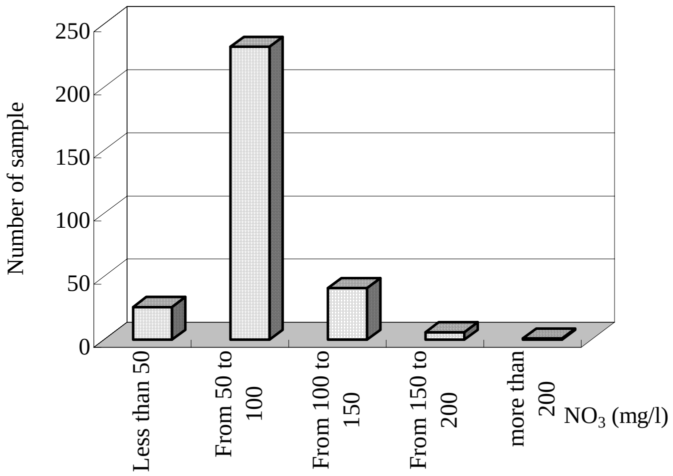
As mentioned above, a large volume of groundwater is utilized in this area, and it seems that the actual volume of groundwater usage is more than the designed volume for exploitation. Changes in groundwater storage from 1991 to 2004 are shown in **Figure 3.4.6**. From this Figure, it can be said that groundwater storage has recently decreased in this area.



1）The calculation minimum groundwater level was obtained in 2000.
Source) Water Resources Information Center (2005)

Figure 3.4.6 Groundwater Storage Change (1991-2004)

Meanwhile, it is reported that groundwater is unsuitable for drinking and irrigation in the Ghouta area and in the area around the treatment plant in Adra, Rural Damascus.
According to the water quality data of water sources (well and spring) by the Damasucus Water Supply & Sewerage Authority (DAWSAA), a high concentration of Nitrate Nitrogen was detected exceeding 50 mg/l (as NO_3) at 280 observation points out of 306 points studied. The WHO guideline value for Nitrate Nitrogen in drinking water is 50 mg/l as NO_3 (short-term exposure) to protect against methaemoglobinaemia in bottle-fed infants. (See **Figure 3.4.7**)



Source) Damasucus Water Supply & Sewerage Authority

Figure 3.4.7 Water Quality Data of Groundwater (NO_3)

(2) Orontes Basin

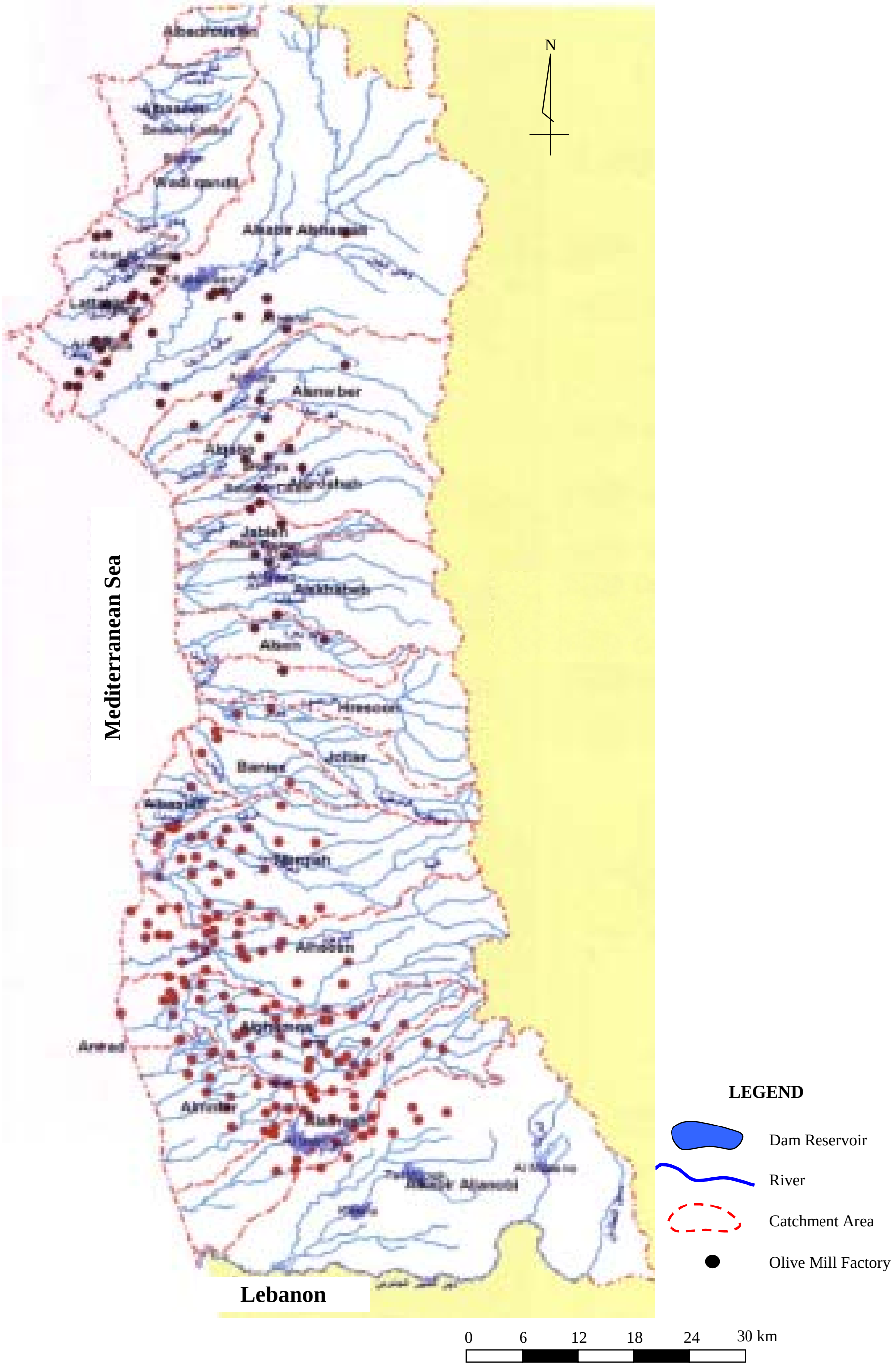
According to the field survey, it seems that Orontes River and Qatina Lake are deteriorated significantly by industrial and domestic wastewater. These river and lake water are utilized for irrigation purpose, however, the exact water quality situation is unknown because of a lack of water quality data.

(3) Coastal Region

As shown in **Figure 3.4.8**, rivers found in Tartous and Lattakia have small basin areas. Its population and public factories, and thus its pollution sources are concentrated along the coastal area. This area receives a lot of precipitation 800 mm/year in flatlands and 1,200 – 1,400 mm/year in mountainous area. Consequently, rivers in this area have no significant pollution. However, according to the Directorate for Environmental Affaires (DFEA) in Tartous and Lattakia, some rivers receive seasonal pollution by the wastewater discharge from olive pressing factories.

Groundwater Contamination

According to a public hearing by the Directorate for Environmental Affaires (DFEA) in Tartous and Lattakia, the water pollution problem tends to rise during the period when olive pressing factories are in operation and therefore, its pollution sources would be the wastewater from such factories. There are approximately 250 olive pressing factories in two Governorates. These small-scale factories are widely scattered throughout. (See **Figure 3.4.8**)

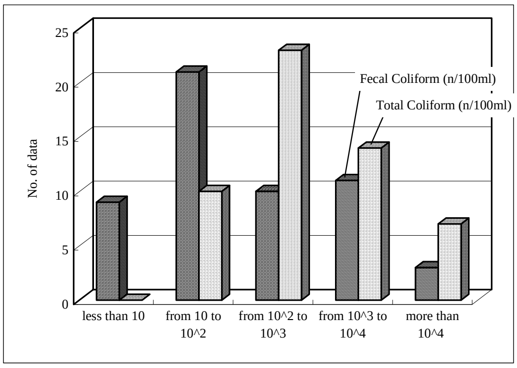


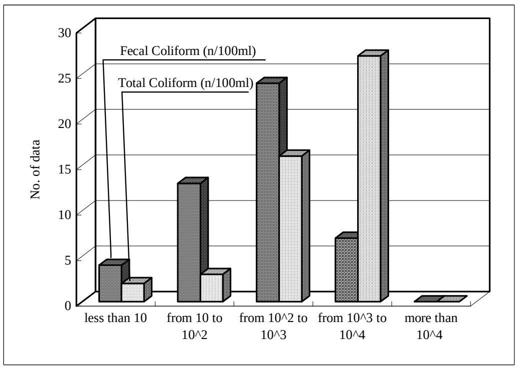
Source) Water Resources Information Center

Figure 3.4.8 Regional Distribution of Olive Oil Pressing Factory in Tartous and Lattakia

<u>Seawater Contamination</u>

The Mediterranean Sea area does not seem to be much polluted from the visual observation, except in the adjacent areas or points where sewage is discharged. However, according to the results of water quality analysis (bacteriological examination) conducted in March and August 2006, it was found that the whole costal area had bacteriological contamination showing a high concentration of Fecal Coliform in all sampling points. It can be said that these bacteriological contaminations have a serious impact on the tourism industry of Tartous and Lattakia including marine recreation such as sea bathing. (See **Figure 3.4.9 and Table 3.4.3**)





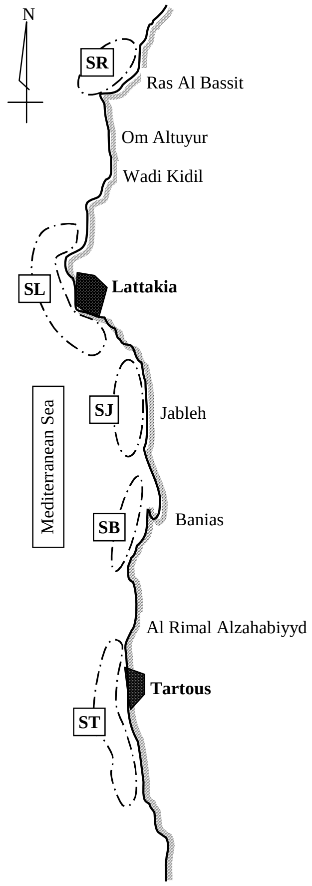
Source) Mediterranean Sea Basin Office

Figure 3.4.9 Water Quality Data of the Mediterranean Sea (Bacteriological Contamination)

Table 3.4.3 Water Quality Data of the Mediterranean Sea (Bacteriological Examination)

unit: n/100ml

Sampling date / Point No		12/3/2006 Fecal Col.	12/3/2006 Total Col.	7/8/2006 Fecal Col.	7/8/2006 Total Col.
SRCB	1	1.0E+01	1.6E+02	1.0E+03	4.0E+03
	2	6.0E+01	1.2E+02	7.5E+02	2.0E+03
	3	1.0E+03	4.0E+03	8.0E+02	2.2E+03
	4	1.5E+03	2.4E+03	5.0E+02	2.0E+03
	5	5.0E+01	6.0E+01	2.5E+03	1.9E+03
	6	3.0E+01	2.4E+02	4.5E+02	6.0E+03
	7	1.0E+01	8.0E+02	7.0E+02	8.0E+02
	8	0.0E+00	8.4E+02	6.0E+02	6.0E+02
	9	5.5E+01	1.6E+03	2.2E+02	5.0E+02
	10	4.0E+01	2.3E+03	3.5E+02	3.0E+02
	11	5.0E+01	1.8E+03	1.5E+02	4.0E+02
SLCB	1	2.4E+02	5.4E+02	8.0E+01	2.0E+03
	2	0.0E+00	2.0E+01	2.8E+02	5.0E+02
	3	2.0E+03	1.8E+04	6.0E+01	9.0E+02
	4	6.0E+01	7.2E+01	1.2E+02	6.5E+02
	5	7.2E+01	6.0E+02	3.6E+02	1.5E+03
	6	3.6E+02	6.6E+02	1.6E+02	1.3E+03
	7	4.0E+01	5.0E+01	1.7E+02	1.2E+03
	8	3.0E+01	5.0E+01	1.4E+02	1.1E+03
	9	7.0E+01	1.6E+02	1.0E+02	9.0E+02
	10	2.5E+04	3.0E+04	5.0E+03	4.2E+03
	11	1.3E+04	1.5E+04	7.0E+03	6.8E+03
	12	1.5E+04	2.5E+04	2.5E+03	2.8E+03
	13	9.5E+03	1.7E+04	1.8E+03	3.2E+03
	14	7.5E+03	1.0E+03	3.0E+02	8.0E+02
	15	9.5E+03	2.2E+04	7.6E+02	5.0E+02
SJCB	1	1.6E+03	2.4E+03	1.0E+01	6.0E+01
	2	1.5E+03	3.2E+03	2.0E+01	0.0E+00
	3	1.8E+03	5.0E+03	8.0E+03	1.9E+03
	4	1.4E+03	4.8E+03	0.0E+00	0.0E+00
	5	1.0E+02	2.0E+02	4.8E+02	1.2E+02
	6	2.2E+03	1.8E+04	1.2E+03	2.0E+03
SBCB	1	4.5E+02	1.1E+03	-	-
	2	3.0E+02	7.0E+02	-	-
	3	2.0E+01	6.0E+01	-	-
	4	1.0E+01	1.2E+02	-	-
	5	9.0E+00	2.0E+01	-	-
	6	1.1E+01	4.0E+01	-	-
STCB	1	3.0E+00	2.2E+01	8.0E+02	6.0E+01
	2	1.0E+02	2.5E+02	2.0E+01	8.0E+01
	3	3.0E+00	2.5E+01	3.0E+01	1.6E+03
	4	2.0E+01	2.3E+02	6.0E+01	2.0E+03
	5	2.0E+01	2.0E+02	4.0E+01	1.6E+03
	6	2.0E+02	1.6E+03	6.0E+01	1.8E+03
	8	1.8E+02	1.6E+03	9.5E+02	2.0E+03
	9	3.0E+02	1.1E+03	4.5E+02	1.5E+03
	10	3.0E+00	3.0E+02	3.0E+02	1.0E+03
	11	2.0E+01	1.6E+02	3.0E+02	1.1E+03
	12	4.0E+01	4.0E+02	1.0E+02	1.4E+03



Location map of sampling point

Source) Mediterranean Sea Basin Office

(4) Tigres & Khabour Basin

Results of water quality analysis of Al Basel Lake in the Khabour Rive are shown in **Table 3.4.4.** From this table, it was found out that the water quality of Al Basel Lake generally meets the water quality standards for irrigation (for fruit trees, external street sides, green area and animal feed crops) except TDS. (See **Figure 3.4.9**)

It seems, therefore, that the pollution of the Khabour Rive in Hassakeh city is caused by untreated sewage discharges.

Table 3.4.4 Water Quality Data of Al Basel Lake

unit: mg/l

Items / Date		TDS	EC (μS/cm)	COD	NH_4	NO_3
Water Quality Standards for Irrigation *	C-1**	1,500	-	75	3.87***	88.60***
	C-2**	1,500	-	200	6.45***	110.75***
	C-3**	-	-	300	-	110.75***
6 Jan. 2001		1,055	2,110	6.0	0.51	13.30
7 Mar. 2001		875	1,750	6.5	0.51	17.16
5 Apr. 2001		888	1,777	5.5	0.53	16.28
19 May. 2001		1,040	2,080	7.4	0.70	13.63
30 Jun. 2001		1,200	2,400	8.2	0.71	12.52
31 Jul. 2001		1,400	2,800	8.0	0.78	13.41
7 Aug. 2001		1,500	3,000	7.6	0.90	16.48
3 Aug. 2001		1,620	3,240	6.6	0.98	10.23
10 Sep. 2001		1,640	3,280	7.1	1.10	10.23
8 Oct. 2001		1,600	3,200	0.8	1.21	29.04
3 Nov. 2001		1,500	3,000	7.7	1.32	22.15
19 Dec. 2001		1,700	3,400	7.9	1.21	21.45
16 Feb. 2002		1,500	3,000	8.2	0.46	24.50
10 Mar. 2002		1,600	3,200	8.4	0.68	26.84
6 Apr. 2002		1,550	3,050	8.7	0.70	24.62
6 May. 2002		1,525	3,050	9.0	0.71	13.60
29 Jun. 2002		1,895	3,790	9.0	1.12	12.70
29 Jun. 2002		1,895	3,790	9.2	1.41	12.70
14 Jul. 2002		2,000	4,000	9.4	1.33	21.73
1 Sep. 2002		2,150	4,300	10.0	1.40	14.52
2 Nov. 2002		1,960	3,920	10.4	1.30	5.20
21 Jan. 2003		1,075	2,150	10.0	0.96	17.61
12 Mar. 2003		1,435	2,870	10.6	0.90	5.28
11 May. 2003		1,375	2,750	11.0	0.89	6.60
9 Jul. 2003		1,575	3,150	11.3	0.97	3.54
16 Oct. 2003		1,525	3,050	12.0	1.00	4.40
28 Dec. 2003		995	1,990	11.5	0.65	3.52
26 Feb. 2004		1,355	2,720	14.0	0.38	4.40
9 Apr. 2004		1,150	2,300	16.0	0.23	2.64
7 Jun. 2004		1,325	2,650	17.0	0.50	26.40
23 Aug. 2004		1,600	3,200	17.5	0.62	4.41
18 Oct. 2004		1,750	3,500	18.0	1.15	12.76
2 Dec. 2004		1,650	3,300	16.5	0.88	2.88
8 Jan. 2005		1,600	3,200	17.0	1.23	18.48
17 Feb. 2005		1,440	2,890	18.0	1.12	3.96
24 Mar. 2005		1,400	2,800	20.0	1.45	17.60
19 Apr. 2005		1,475	2,950	21.0	0.88	4.00
Average		1,482	2,962	10.9	0.90	13.26
Minimum		875	1,750	0.8	0.23	2.64
Maximum		2,150	4,300	21.0	1.45	29.04

Source) Hassakeh Governorate

*: The Maximum Allowed Limits of the Measurement Criteria Related to the Treated Water for Irrigation Purposes

**: C-1 (Category-1) Cooked vegetable, parks, playgrounds, and roads within cities and sporting playgrounds
C-2 (Category-2) Fruit trees, highway sides, green spaces and grain and fodder crops
C-3 (Category-3) Industrial crops and forest trees

*** : Conversion factor: NH_4=NH_4-N×1.29, NO_3=NO_3-N×4.43

(5) Euphrates & Aleppo Basin

The Euphrates River originates from Turkey and flows through northern Syria to southern Syria and then to Iraq. This river is an international river with a total length of 2,800 km (680 km in Syria). The River flow is 79 m^3/sec at minimum and 995 m^3/sec on average. (Source: Statistical Abstract 1995)

At present, water in upstream of the Euphrates River (Al Asad Dam) is not polluted, and it seems that water quality problem of the Euphrates River in Deir-Ez-zor is limited to the vicinity of the wastewater discharging points. However, the available data are not enough to understand the water quality situation in more detail, because the sampling data were obtained once or twice only and samples were taken from inadequate sampling points. (See **Table 3.4.5 and Figure 3.4.10**)

Table 3.4.5 Water Quality Data of the Euphrates River

Location of sampling point		Results of Water Quality Analysis (mg/l)					Note
		TDS	COD	BOD	NH_4-N	NO_3-N	
Al Asad Dam		202	<4	<1	<0.08	<0.8	3-Jun-06
		194	<4	<1	<0.08	<0.2	26-Jun-06
Raqqa	Nearby the city	284	<30	8	7.00	0.50	4-Aug-06
	Down stream of the slaughterhouse	284	<30	<1	6. 70	<0.8	13-May-06
	Ma'adar area	291	<30	<1	<1	<0.8	14-May-06
	Downstream of Hallab area	312	<30	4	<1	<0.8	6-May-06
		258	<10	3	<1	<0.8	7-May-06
Deir-Ez-zor	Upstream of urban area	343	7.1	20	0.04	0.73	17-Jul-06
		281	5.0	4	0.09	<0.2	13-Nov-06
	City center	343	12	19	0.02	0.80	17-Jul-06
		280	<4	4	0.10	<0.2	13-Nov-06
	Downstream of urban area	454	9.0	23	0.44	1.10	17-Jul-06
		306	5.0	5	0.18	<0.2	13-Nov-06

Source) The Capacity Development of Environmental Monitoring at Directorates for Environmental Affaires in governorates in the Syrian Arab Republic, Progress Report (4), February 2007, JICA, Ministry of Local Administration and Environment the Syrian Arab Republic

Figure 3.4.10 River Network of the Euphrates River

(6) Yarmouk Basin

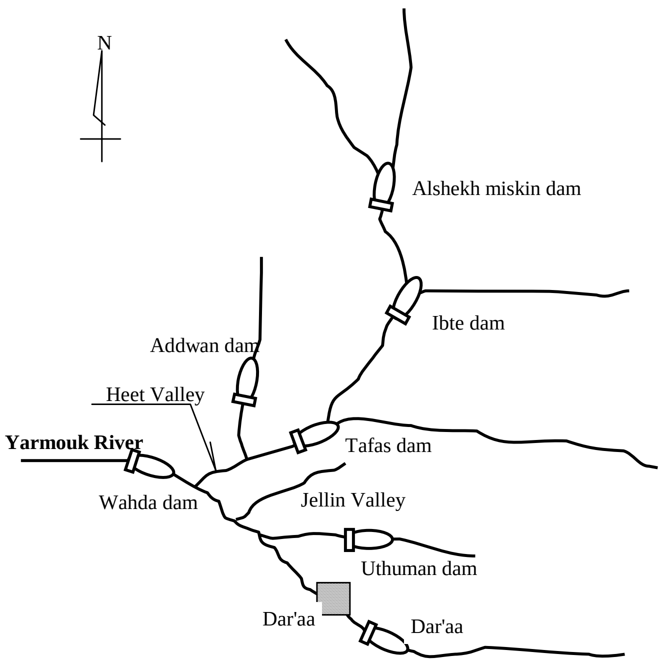
The Yarmouk River basin contains Yarmouk River, its tributaries and some dams. The Yarmouk River flows between the boundary of Syria and Jordan.

Water quality conditions of Wahda dam and Yarmouk River's tributaries are shown in **Table 3.4.6.** Judging from this Table, there is pollution.

Table 3.4.6 Water Quality Data of Yarmouk River's Tributaries (Dar'aa)

Location	Date	BOD (mg/l)	NH_4(mg/l)	NO_3 (mg/l)
Addwan Dam	1 Feb '07	30	0.27	24.20
Tafas Dam	1 Feb '07	20	0.59	53.68
Da'raa Dam	7 Feb '07	20	0.28	19.80
Wahda Dam	1 Feb '07	-	0.52	11.88
Jellin Valley		20	0.55	17.60
Heet valley		20	0.39	19.80

Source) Dar'aa Governorate

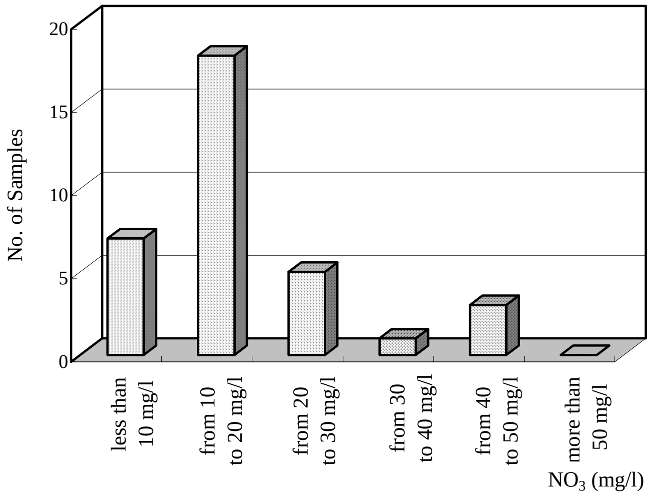


As Wahda dam will be one of the important water sources for Jordan in future, reduction of pollution load may be required not only for domestic use but also to prevent Wahda dam water from eutrophication and further deterioration in water quality. This may need bilateral cooperation between Syria and Jordan.

Groundwater Contamination

The concentration of Nitrate Nitrogen in some drinking water sources is higher in Dar'aa. However, it does not exceed the WHO guideline for drinking water, and the situation is not as serious as in Rural Damascus.

Based on the water quality analysis from Oct. 2004 to Jun. 2006, Nitrate Nitrogen (as NO_3) concentration of over 40 mg/l has been observed only in 3 samples out of a total of 34 samples. (See **Figure 3.4.11**)



Source) Dar'aa Governorate

Figure 3.4.11 Water Quality Data of Groundwater in Dar'aa

(7) Al Badia Region

Al Badia Region has no river with water flow throughout a year, and it seems that there is no water quality pollution problem by domestic, commercial and industrial wastewater.

3.4.4 Major Pollution Sources

The pollution of drinking water sources and public water bodies is caused by not only the pollution loads from point sources but also from the natural conditions such as meteorological, geographical, topographical, and social conditions.

Firstly, this section discusses the main pollution loads coming from population and industrial activities. These parameters are the basic values for estimating pollution loads derived from human activities, and will represent most of the total loads from these same activities. Characteristics of these parameters by Governorate are summarized as below.

<Population>

According to the statistical data, the population of Syria is approximately 18.7 million, Aleppo has the largest population of 4.2 million (23%) , followed by Rural Damascus with population of 2.4 million (13%) and Damascus with 1.6 million (9%). The total population of Damascus and Rural Damascus (Greater Damascus) is at the same level as that of Aleppo. (See **Table 3.4.7** and **Figure 3.4.12**)

The population in each hydrological basin is assumed to be the sum of the Governorate they belong to, as follows:

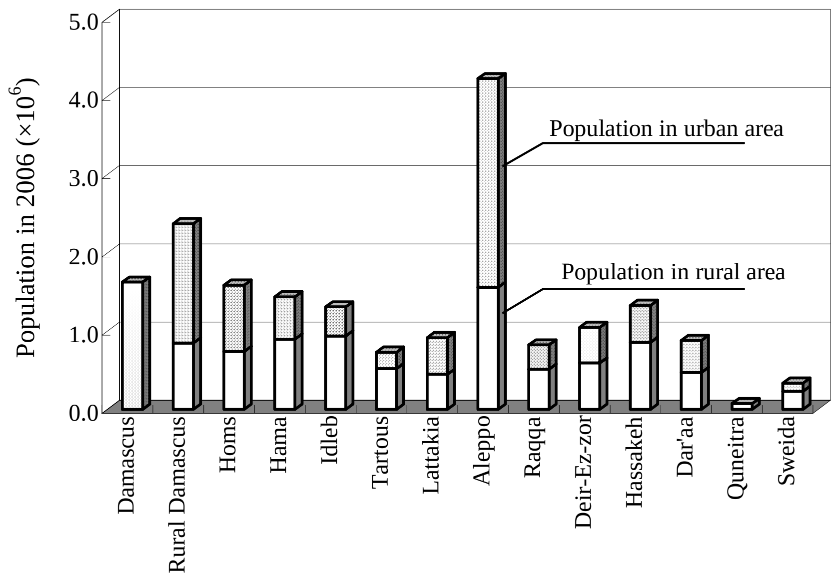
Name of Basin	Name of Governorate
Barada & Awaj River basin	Damascus and Rural Damascus
Orontes Basin	Homs, Hama and Idieb
Coastal Region	Tartous and Lattakia
Tigres & Khabour Basin	Hassakeh
Euphrates & Aleppo Basin	Aleppo, Raqqa and Deir-Ez-zor
Yarmouk Basin	Dar'aa, Sweida and Quneitra
Al Badia Region	Omission

The population of the Euphrates River basin is approximately 33% (including Aleppo 23%), of the seven basins stated, while those of Orontes River basin, Barada /Awaj River basin, Mediterranean Sea basin, and Tigres & Khabour River basin and Yarmouk River basin are 23%, 21%, 9% and 7%, respectively. (See **Table 3.4.7** and **Figure 3.4.13**)

Table 3.4.7 Population (2006)

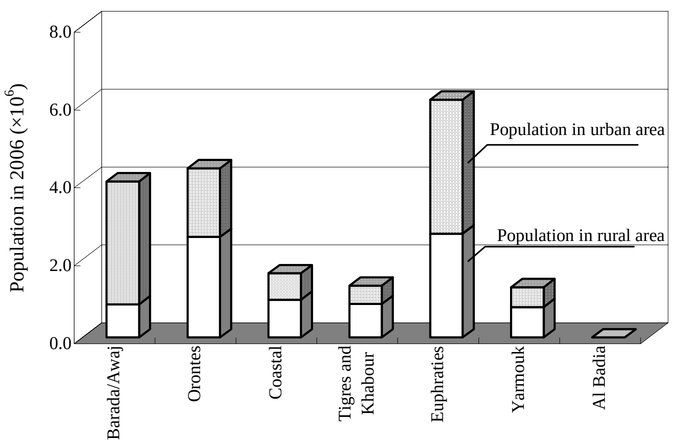
Basin	Governorate	Population (×1,000)			
		Total		Rural	Urban
Barada/ Awaj Basin	Damascus	1,628	8.7 %	-	1,628
	Damascus Rural	2,377	12.7 %	848	1,529
	Sub-total	4,005	21.4 %	848	3,157
Orontes Basin	Homs	1,591	8.5 %	740	851
	Hama	1,441	7.7 %	901	540
	Idleb	1,310	7.0 %	940	370
	Sub-total	4,342	23.2 %	2,581	1,761
Coastal Region	Tartous	730	3.9 %	522	208
	Lattakia	917	4.9 %	447	470
	Sub-total	1,647	8.8 %	969	678
Tigres & Khabour Basin	Hassakeh	1,329	7.1 %	858	471
	Sub-total	1,329	7.1 %	858	471
Euphrates & Aleppo Basin	Aleppo	4,230	22.6 %	1,561	2,669
	Raqqa	824	4.4 %	513	311
	Deir-Ez-zor	1,048	5.6 %	593	455
	Sub-total	6,102	32.6 %	2,667	3,435
Yarmouk Basin	Sweida	337	1.8 %	232	105
	Dar'aa	880	4.7 %	474	406
	Quneitra	75	0.4 %	75	-
	Sub-total	1,292	6.9 %	781	511
-	Total	18,717	-	8,704	10,013

Source) Ministry of Statistic



Source) Ministry of Statistic

Figure 3.4.12 Population by Governorate (2006)



Source) Ministry of Statistic

Figure 3.4.13 Population by River Basin (2006)

<Gross output of manufacturing industries>

According to statistical data, the Gross output of manufacturing industries（2004）of Syria is approximately 460 billion SP, with Rural Damascus having 147 billion SP (32%) which is the largest gross output by Governorate, the next is Aleppo with 122 billion SP (27%) of and Homs with 44 billion SP (10%). (See **Table 3.4.8 and Figure 3.4.14**)

The gross output of Barada/Awaj basin is approximately 41% and that of the Euphrates River basin is 31%, these two basins accounting for 72% of all. (See **Figure 3.4.15**)

Table 3.4.8 Gross Output of Manufacturing Industries（2004）

Basin	Governorate	Gross output of manufacturing Industries (million Sp/year)			
		Private sector	Public sector	Total	
Barada/ Awaj Basin	Damascus	25,364	16,800	42,164	9.2 %
	Damascus Rural	70,435	76,431	146,866	31.9 %
	Sub-total	95,799	93,231	189,030	41.1 %
Orontes Basin	Homs	17,515	26,464	43,979	9.6 %
	Hama	12,154	16,427	28,581	6.2 %
	Idleb	5,648	5,142	10,790	2.3 %
	Sub-total	35,317	48,033	83,350	21.1 %
Coastal Region	Tartous	6,799	2,257	9,056	2.0 %
	Lattakia	11,809	7,147	18,956	4.1 %
	Sub-total	18,608	9,404	28,012	6.1 %
Tigres & Khabour Basin	Hassakeh	5,201	2,571	7,772	1.7 %
	Sub-total	5,201	2,571	7,772	1.7 %
Euphrates & Aleppo Basin	Aleppo	80,255	42,099	122,354	26.6 %
	Raqqa	3,024	1,589	4,613	1.0 %
	Deir-Ez-zor	3,987	12,774	16,761	3.6 %
	Sub-total	87,266	56,462	143,728	31.2 %
Yarmouk Basin	Sweida	1,551	1,589	3,140	0.7 %
	Dar'aa	4,885	0	4,885	1.1 %
	Quneitra	158	0	158	0.0 %
	Sub-total	6,594	1,589	8,183	1.8 %
-	Total	248,785	211,290	460,075	100.0 %

Source) Private factory Ministry of statistic
Public factory Total amount of product is quoted from Statistical Abstract 2006.
The Study Team estimated output values by Governorate.

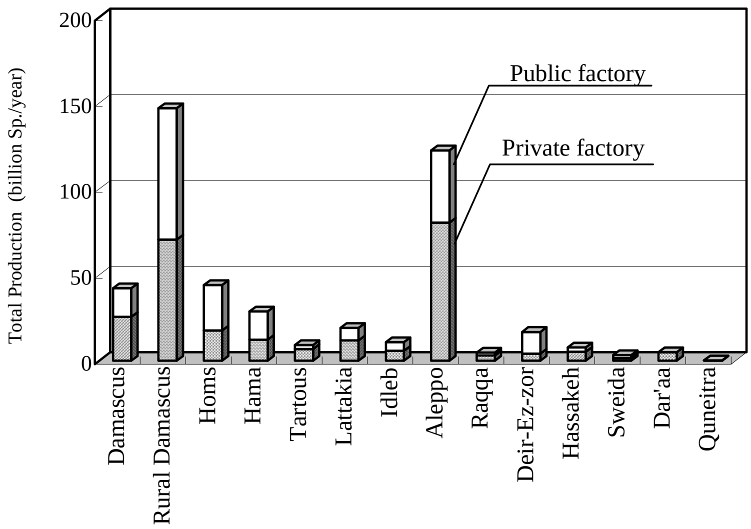


Figure 3.4.14 Gross Output of Manufacturing Industries by Governorate（2004）

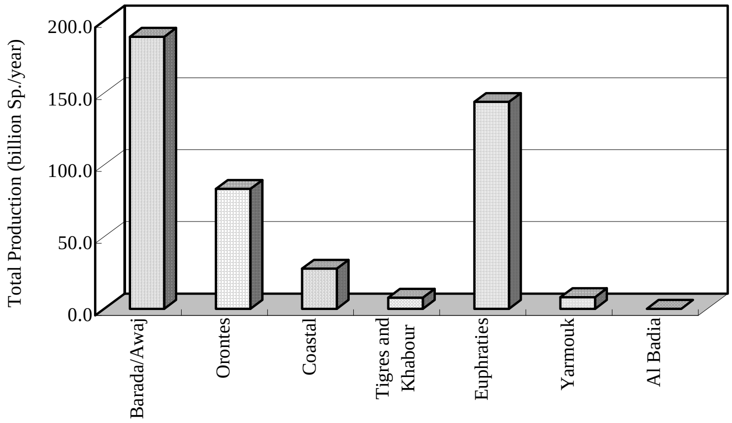


Figure 3.4.15 Gross Output of Manufacturing Industries by River Basin（2004）

This section will describe the water pollution problem, its background and main pollution loads by basin:

(1) Barada and Awaj River Basin

As mentioned earlier, the features that seem to accelerate water quality problem in the Barada and Awaj River basins include: (1) large population and industrial production activities; (2) limited precipitation; and (3) high ratio of water utilization for irrigation.

The estimated main pollution problems and its sources for the Barada and Awaj River are summarized below.

- Industrial wastewater (wastewater exceeding the effluent water quality standards)
- Domestic and commercial wastewater (out of sewerage service area or not connected to the wastewater system)

Although the mechanisms behind groundwater pollution/ contamination are not clear, the main pollution sources that cause groundwater pollution are summarized as shown below:

- Infiltration by river water, which is polluted by domestic, commercial and industrial wastewater.
- Infiltration by irrigated water, which is polluted by domestic, commercial and industrial wastewater.
- Infiltration by irrigated water, taken from treated sewage at Adraa STP
- On site treatment facilities (with penetration type) of domestic wastewater
- Concentration of inorganic substances and re-infiltration of the groundwater by irrigation.

Other causes of pollution are:

- Infiltration by domestic, commercial and industrial wastewater, coming from leakage in the sewer pipes or coming out from the sewerage system area.
- Infiltration into the groundwater of fertilizer elements.

(2) Orontes Basin

Orontes basin has large population and high industrial production activities. Wastewater from industrial, domestic and commercial activities seems to accelerate water quality problems in Orontes River.

(3) Coastal Region

In the coastal basin, two water pollution problems have occurred. Firstly, there is the bacteriological contamination of marine waters which could mainly be caused by untreated wastewater discharged from sewer outfalls. Secondly, there is the pollution of drinking water sources which may come from the following sources:

- Untreated wastewater from small-scale olive pressing factories
- On site treatment facilities (with penetration type) of domestic wastewater and untreated domestic wastewater
- The pollution problems of the water sources are hastened by the combination of following conditions. The number and locations of small-scaled olive pressing factories; The geographical features and geological structure of the basin, that of having a precious terrain and a gravel layer on the bed of clays.
- The exploited area of each well/ spring may not be that wide.
- Wastewater filters into the gravel layer reaching rapidly to the water sources.
- The gravel layer is thin, therefore does not have enough thickness for purification.
- The groundwater source in this basin is assumed to be shallow groundwater aquifer or riverbed water.

It seems that pollution problem has occurred by combined effect of the above pollution sources and regional conditions.

(4) Tigres & Khabour Basin

It seems that there is no water pollution problem in this basin except city area such as Hasakeh and Qameshili. Estimated main pollution sources concerning pollution problems of Tigres & Khabour Basin are domestic, commercial and industrial wastewater in city area.

(5) Euphrates & Aleppo Basin

Since the Euphrates River has a large volume of water flow, its environmental capacity such as allowable pollution loads and self-purification capacity is also large. Therefore, it seems that the existing water quality condition of the Euphrates River can be maintained at least, if the pollution loads from main urbanized areas in the basin are restricted. The details will be examined by conducting water quality simulation and evaluation of pollution load reduction plan.

Estimated main pollution sources are summarized below.

- Domestic and commercial wastewater in main cities such as Deir-er-zor and Raqqa.

- Public factories that have large amount of pollution load, such as paper factory and sugar factory.

(6) Yarmouk Basin

Water quality problems of surface and groundwater in the Yarmouk basin are limited to certain areas only. Therefore, it is necessary to carry out a detailed survey for these areas. At present, it seems that the main pollution sources of Yarmouk River are domestic, commercial and industrial wastewater from the Dar'aa city area.

In summary, the sources of pollution in each basin are shown in **Table 3.4.9**.

Table 3.4.9 Speculated Main Pollution Sources of Water Quality Problems

Name of River Basin	Water pollution /contamination problems	Speculated Main Pollution Sources
Barada and Awaj River Basin	Pollution of surface water for irrigation	• Domestic and commercial wastewater • Public factories which have large amount of pollution load
	Pollution of groundwater for water supply and irrigation	• Infiltration by river water, polluted by domestic, commercial and industrial wastewater. • Infiltration by irrigated water, polluted by domestic, commercial and industrial wastewater. • Infiltration by irrigated water, treated by sewage treatment plant • Treatment facilities (on-site facilities with penetration type) of domestic wastewater
Orontes Basin	Pollution of surface water for irrigation	• Domestic and commercial wastewater (outlet of sewer pipe) • Public and private factories which have large amount of pollution load
Coastal Region	Pollution of water sources for water supply	• Widely scattered small-scale olive pressing factories • Treatment facilities (on-site facilities with penetration type) of domestic wastewater and untreated domestic wastewater
	Water pollution of sea area (bacteriological contamination)	• Domestic and commercial wastewater from sewer pipe without treatment.
Tigres & Khabour Basin	Pollution of water sources for irrigation	• Domestic and commercial wastewater (outlet of sewer pipe) • Public factories which have large amount of pollution load
	Water pollution of living environment	
Euphrates & Aleppo Basin	Pollution of water sources for water supply	• Domestic and commercial wastewater (outlet of sewer pipe) • Public factories which have large amount of pollution load
	Water pollution of living environment	
Yarmouk Basin	Pollution of groundwater for water supply	• Domestic, commercial and industrial wastewater
	Pollution of surface water for irrigation	

CHAPTER 4 INSTITUTIONAL AND ORGANIZATIONAL FRAMEWORK OF SEWERAGE SECTOR

4.1 Institutional Framework

The present institutional framework of the sewerage sector in Syria is rather complex. In principle, the sewerage issues are governed by two central authorities, i.e. the Ministry of Housing and Construction (MHC) and the Ministry of Local Administration and Environment (MLAE).

The MHC, has a Sewerage Directorate which is responsible for water supply and wastewater issues in all regions of Syria. Its main tasks include: design of sewage treatment plants and main sewer networks as well, approval of the plans prepared by other organizations and supervision of construction projects.

The MLAE also has a directorate working with sewer networks and treatment plants for small villages (less than 4,000 inhabitants). Its role is to approve designs of pipelines, treatment plants and construction contracts.

The 14 Governorates, under auspices of the MLEA are important regional administration bodies responsible for planning and implementing all governmental tasks at regional and local levels. They play an important role in offering services, especially for small local authorities, who do not have the necessary technical competence of their own. The Governor (Mohafez) represents the central executive authority in the Governorate and supervises and approves work plans for all ministers at the local level including wastewater projects. The Governorate and its municipalities have their own budgets and undertake investments in the field of wastewater and waste management, mainly for small sewer networks which they will be phasing out in the near future and transferring them to the Public Establishment of Drinking Water and Sewerage (Establishment) in each Governorate.

In each Governorate, there is an Establishment, which was formed in accordance with the Minister of Housing and Construction Decree No. 14/1984 for the administrative control and development of the water and sanitation services. Its main task is to ensure adequate water supply and sanitation services in the Governorate, in general; and to plan, implement and operate new projects and maintain existing facilities, in particular. At present, all potable water and wastewater projects already executed or under execution are under the control of the Establishments across Syria, although several large central projects are still under the responsibility of the MHC. The Sewerage Companies (Companies) under these Establishments have been set up in cities which have sewage treatment plants (STPs), for implementing O&M of their sewerage facilities, i.e. STPs and sewer networks. As of the end of 2006, five Sewerage Companies have been established in Damascus, Aleppo, Homs, Hama and Lattakia (STP is not yet constructed in Lattakia), respectively and in addition, a Prime Minister Decision has already been issued to set up the Sewerage Company for Rural Damascus. These Establishments and Companies are operating on governorate level. While they are independent of the local administration, they coordinate with them in order to provide services in newly developed areas. They are guided and controlled by the MHC rather than by local authorities.

In summary, the segregation of responsibilities for sewerage works between these authorities can be described as shown in **Table 4.1.1**.

Table 4.1.1 Demarcation of Responsibilities for Sewerage Works

Type of municipalities	Planning	Construction			Operation & Maintenance	
		Sewage Treatment Plants	Trunk sewers	Networks	Before Companies set-up	After Companies set-up
Regional areas & Cities	MHC	MHC	MHC	Municipalities + MLAE*	Municipalities*	Sewerage Companies
Small towns and villages	Municipalities + MLAE*	Municipalities + MLAE*	MHC	Municipalities + MLAE*	Municipalities*	Sewerage Companies

Note) The role of MLAE and municipalities will be shifted gradually to MHC and Establishments.

The basic framework for fund allocation to the sewerage projects is determined every five years in the National Five-Year Plan, and their annual budget is allocated within said plan. The MHC prepares the annual investment budgets and recurrent budgets for construction/operation of sewerage facilities. The State Planning Commission (SPC) has approved the investment budgets so far, while the recurrent budgets have been approved by the Ministry of Finance (MOF);.both the investment and recurrent budgets are to be approved by the MOF from 2008.

Prior to the budget decision, municipalities and towns in a Governorate submit requests to the Governor who is affiliated with the MLAE, for the construction of a sanitation system or the extension of the existing system. These requests are referred to the Establishment which should carry out the relevant studies and design work, and prepare the necessary tender documents, except for the portion related to sewage treatment. This is normally studied and designed by the Directorate of Sewerage in the MHC, which also supervises the construction of the treatment plants.

The Directorate of Sewerage in MHC receives a significant number of requests from all Governorates of Syria every year, as there are some 1,300 towns and villages who rely on the Directorate for developing their sanitation services. The Directorate does its job by dealing with all the aspects of the projects except for the financing of sewer networks as this is the job of the MLAE, while the MHC finances the construction of the treatments plants.

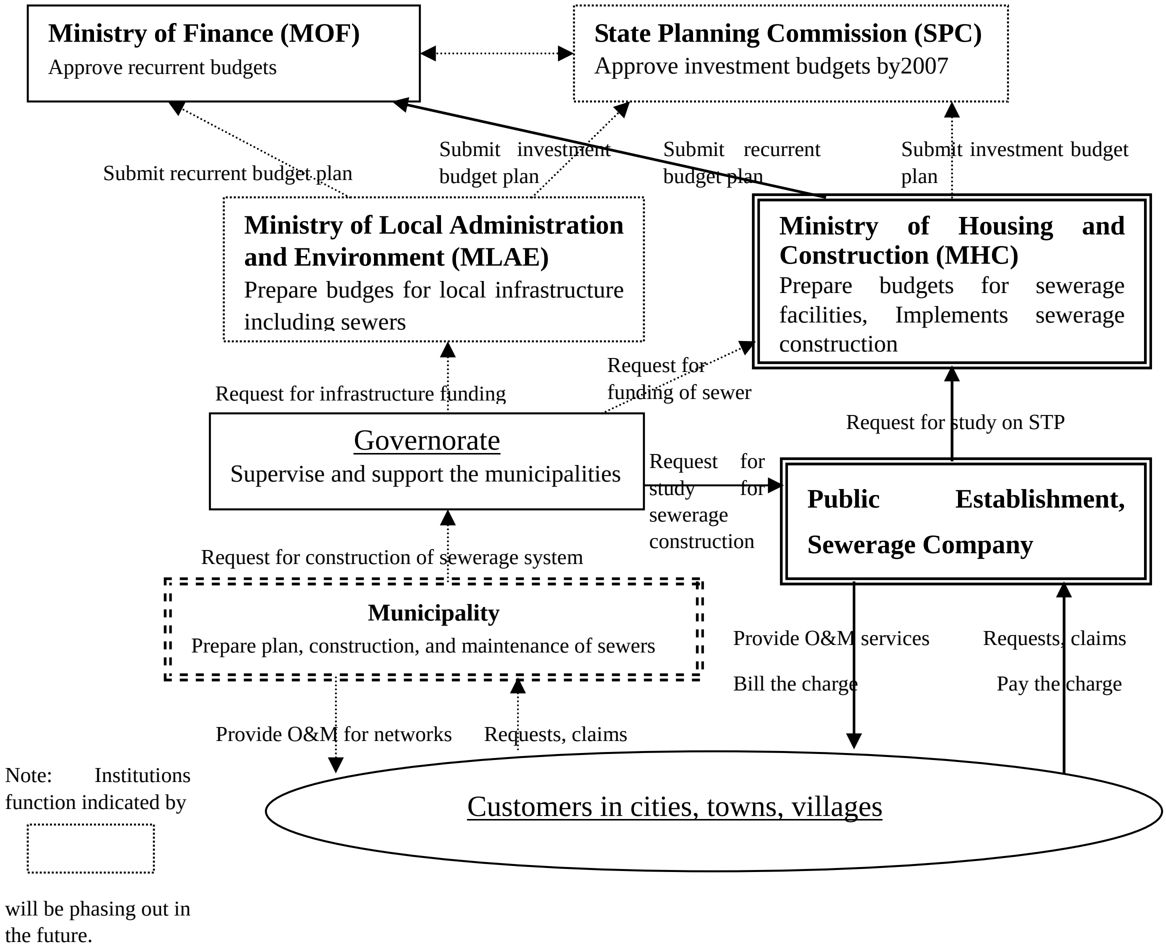


Figure 4.1.1 Institutional Relationship between Relevant Organizations

4.2 Organization of Sewerage Sector

4.2.1 Ministry of Housing and Construction (MHC)

The MHC is responsible for potable water and sewerage systems at the national level, including its management, operation, and maintenance. It also defines sector policies and water tariffs, which are applicable to the whole country when approved by the Prime Minister.

The Ministry is also in charge of the whole project cycle: identification, planning, financing (according to the five-year and annual investment plans), and implementation. However, the capacity to monitor project implementation from the technical and financial points of view is rather limited.

The MHC performs its duties in the water sector through 14 Establishments, each responsible for one Governorate. Their responsibilities include operation, supervision, and maintenance of water supply systems in the service area. The total number of staff working in the Ministry and in the 14 Establishments is estimated to be over 20,000 in 2006.

Recently, a re-organization process was initiated by the Ministry in an attempt to advance and participate in the modernization process required by the highest levels of the government. In the new organization shown in **Figure 4.2.1**, two functions of the Ministry, i.e. "housing construction, and regional planning" and "potable water and sewerage services", were separated and turned over to vice ministers who are still linked directly to the Minister. A third vice minister is responsible for administrative, legal and financial affairs, a support function that backs-up the entire Ministry.

The sewerage directorate is of special relevance to sewerage management.

Directorate of Sewerage

This directorate is responsible for planning sewerage schemes, the overall supervision of sewage projects that the Directorate has studied, and the design and supervision of sewage treatment plants (STPs). It has five departments (administration, survey, STP, execution, inspection and studies) and one follow-up unit with 50 staff members. The STP department is in charge of studying, designing and checking of the STP plans, while the follow-up unit is responsible for supervision of sewerage systems under construction or operation, in cooperation with all departments. Although the sewerage sector is officially the responsibility of the MHC, the sewer networks are still the responsibility of the municipalities in the Governorates where the Company is not established. As mentioned earlier, only those cities where sewage treatment plants are operating, have the separate Companies under the Establishments in the relevant Governorate. Therefore, most of the planning and the design of sewer networks are carried out by the municipality of the town concerned. The plans and design of sewer network have then to be approved by the Sewerage Directorate at the MHC before tenders are issued.

Although the Directorate handles the planning and design of sewerage facilities nationwide, the actual works are contracted out to the General Company for Engineering and Consulting (GCEC). Therefore, the staff of the Directorate is not fully familiar with the planning and design technologies of the sewerage facilities. There are no formal technical guidelines available, and the reviews are conducted on the personal experience of each staff. Morever, the design documents turned over to the GCEC are not properly documented and/or maintained as should be.

The organization of the Directorate is shown in **Figure 4.2.2**.

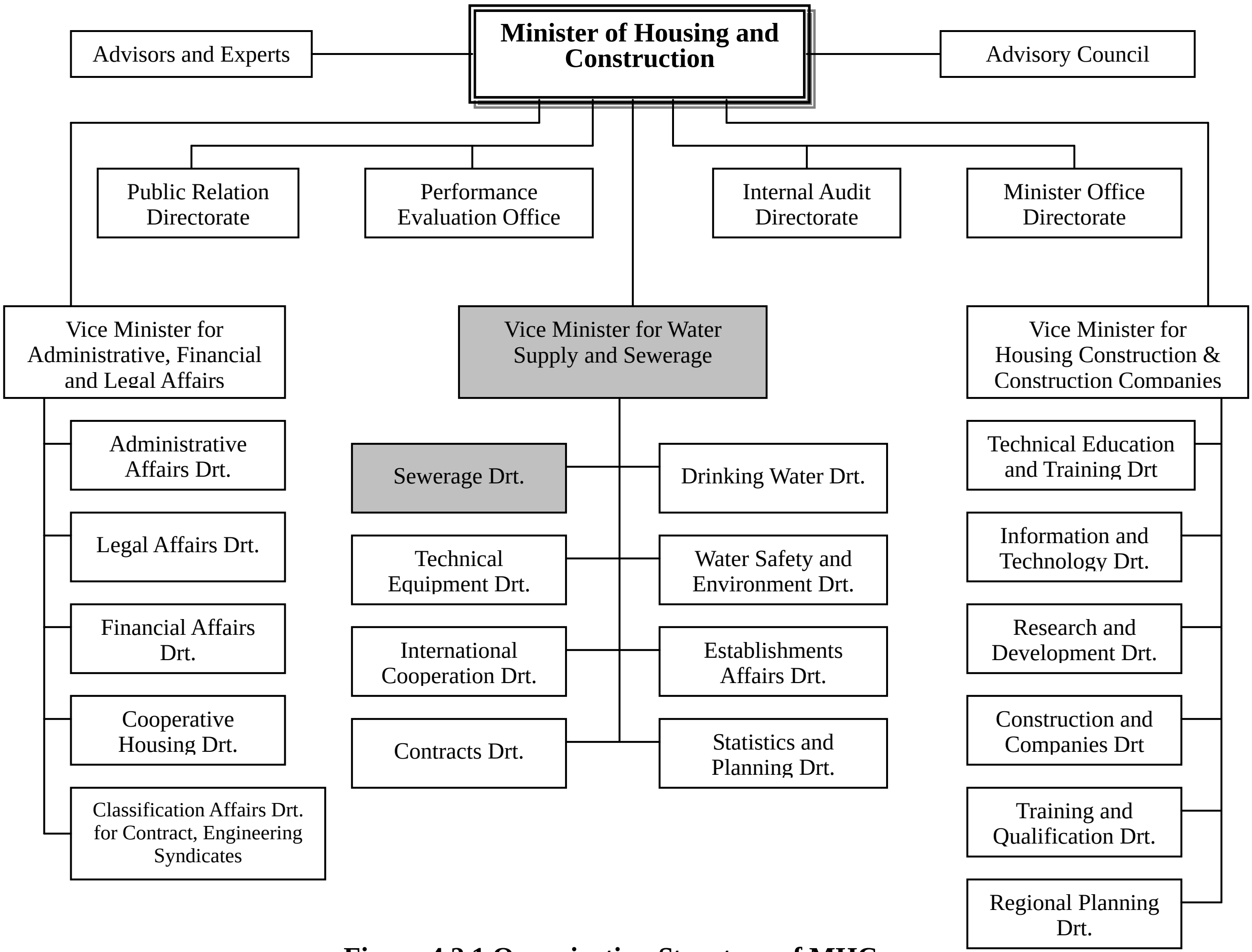


Figure 4.2.1 Organization Structure of MHC

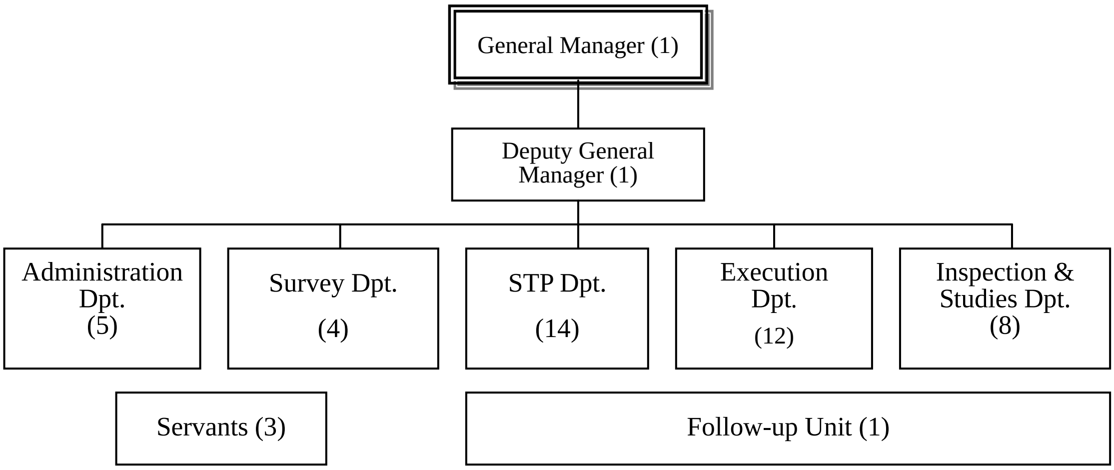


Figure 4.2.2 Organization Structure and Staff Number of Sewerage Directorate

4.2.2 General Establishment of Potable Water and Sewerage (Establishment)

The General Establishment of Potable Water and Sewerage (Establishment) is a governmental organization established in accordance with the Minister of Housing and Construction Decree No. 14/1984, and responsible for potable water supply and sanitation in its Governorate. In the Governorate where the Sewerage Company exists, however, the Establishment only deals with potable water issues. At present, nine (9) Governorates do not have the Sewerage Company yet. Water supply services throughout Syria are thoroughly provided by the 14 Establishments, while the sewerage service administration is rather fragmented. Their revenues from water fees are very low except for the few limited Establishments; the reasons being the imposition of a tariff structure, the high percentage of unaccounted for water, and the inadequacy of the O&M infrastructure

The organization structure of a typical Establishment without a Sewerage Company (Rural Damascus; however, the Decision of the Prime Minister to set up the Company was issued) has 12 directorates headed by the General Director, with about 2,070 staff members as follows:

1. The General Director office
2. Directorate for administrative affairs, legal affairs and human resources
3. Directorate for planning and statistics
4. Directorate for the interior supervision
5. Directorate for designs and studies for the water supply and wastewater projects
6. Directorate for checking and execution
7. Directorate for investment and maintenance for the water supply and wastewater projects
8. Directorate for the subscribers' affair
9. Directorate for financial affair
10. Directorate for calculation
11. Directorate for qualifying, training and scientific research
12. Directorate for information and technology
13. Directorate for economic units
14. The new established companies

The service area of the Establishment is covered by dozens of Water Economic Units (branch offices), which are in charge of services within their respective areas. They are responsible for regional water supply, O&M of the infrastructure water metering and collection of water fees.

This Establishment has Directorates which deal with the study and execution of sewerage projects; however, it lacks proficient sewerage engineers to implement new projects. Recently, a directorate-wide Project Management Unit was set-up, in order to manage a new water supply and sewerage project financed by the EIB. A typical organization chart of an Establishment is shown in **Figure 4.2.3**. As to the number of officers in each Establishment, refer to **Table**

4.2.1:

Table 4.2.1 Number of Officers in each Establishment

No.	Governorate	Number of Officers
1	Lattakia	Not Available
2	Tartous	Ditto
3	Deir-Ez-zor	1,400
4	Hassakeh	1,400
5	Raqqa	850
6	Dar'aa	1,535 (250)
7	Rural Damascus	850 (54)

Note) (250) means the number of engineers

4.2.3 Sewerage Company (Company)

As stated earlier, five Sewerage Companies (Companies) have been set up in Damascus, Aleppo, Homs, Hama and Lattakia, respectively. In addition, a Prime Minister Decision has already been issued to set up the Sewerage Company for Rural Damascus. The typical organization chart of Establishment is shown in **Figure 4.2.4** with the Lattakia company as an example.

Such c ompanies exist only in the Governorate Centers where STPs are in operation. They carry out minor construction such as expansion of networks upon the order of the local administration, and O&M of all the sewerage facilities including STPs. One of the important O&M works should be the monitoring of industrial wastewater discharged to the sewer networks, to check whether it conforms to the SASMO 2580/2002 (Table 3.5). However, such activities have not been practiced so far, and this could pose a risk for the proper operation of STPs and production of environmentally safe treated sewage.

The Damascus Sanitary Drainage Company (DSDC) was established in 1995 & was separated from the Sewerage Technical Directorate of Damascus City, when Adraa STP was constructed. Since then, engineers with experience on sewerage construction have been gradually transferred to the Company, resulting in the increase of its staff numbers up to 814 as of 2006, with a breakdown by the following educational background. Refer to **Table 4.2.2**.

Table 4.2.2 Distribution of DSDC Staff by Educational Background

Educational Background	Staff Numbers	Specialties
University	68	Science, Civil, Architecture, Electric, Mechanical, Agriculture, Basic science, Natural Science, Human Science, Economics, Law
Intermediate Institute	77	Sanitary, Chemical, Industrial, Banking, Agriculture, Commercial, Technical Control, Application Industry
General High School	37	Bookkeeping
Technical High School	30	Industrial, Commercial
Training School	2	-
Preparatory School and less	600	-
Total	814	

The DSDC is subordinate to the Damascus Water and Sewerage System Authority (DAWSSA), and its budget is controlled by DAWSSA. Its revenues consists of 82.0 million SP (15%) of customers' water bills, 11.2 million SP (2%) of repair fees, 74.2 million SP (13%) of connection and cleaning fees. These revenues cover 60% of the O&M costs (excluding depreciation and Tax), and the remaining 40% are covered by the government subsidy. Depreciation and Tax, which is almost equal to the O&M costs are also covered by the government.

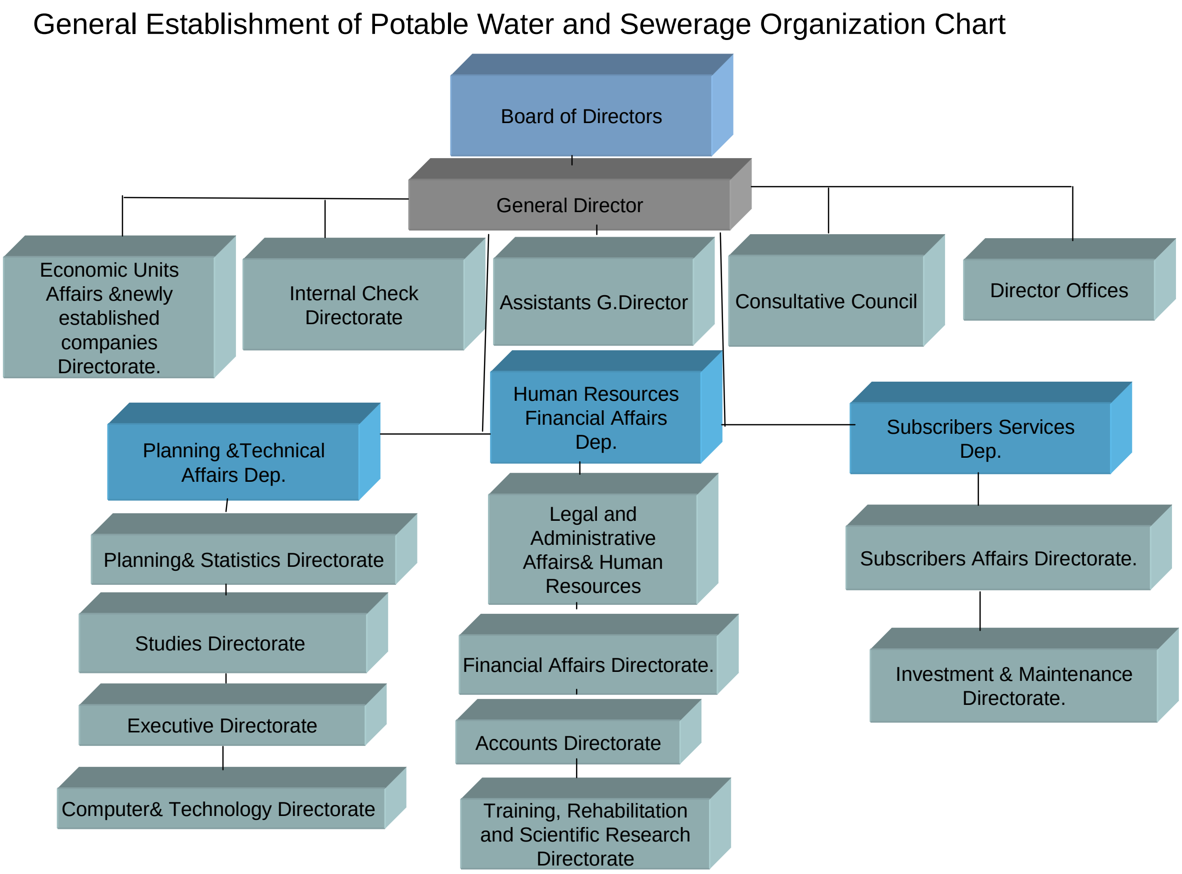


Figure 4.2.3 Organization Chart of Establishment

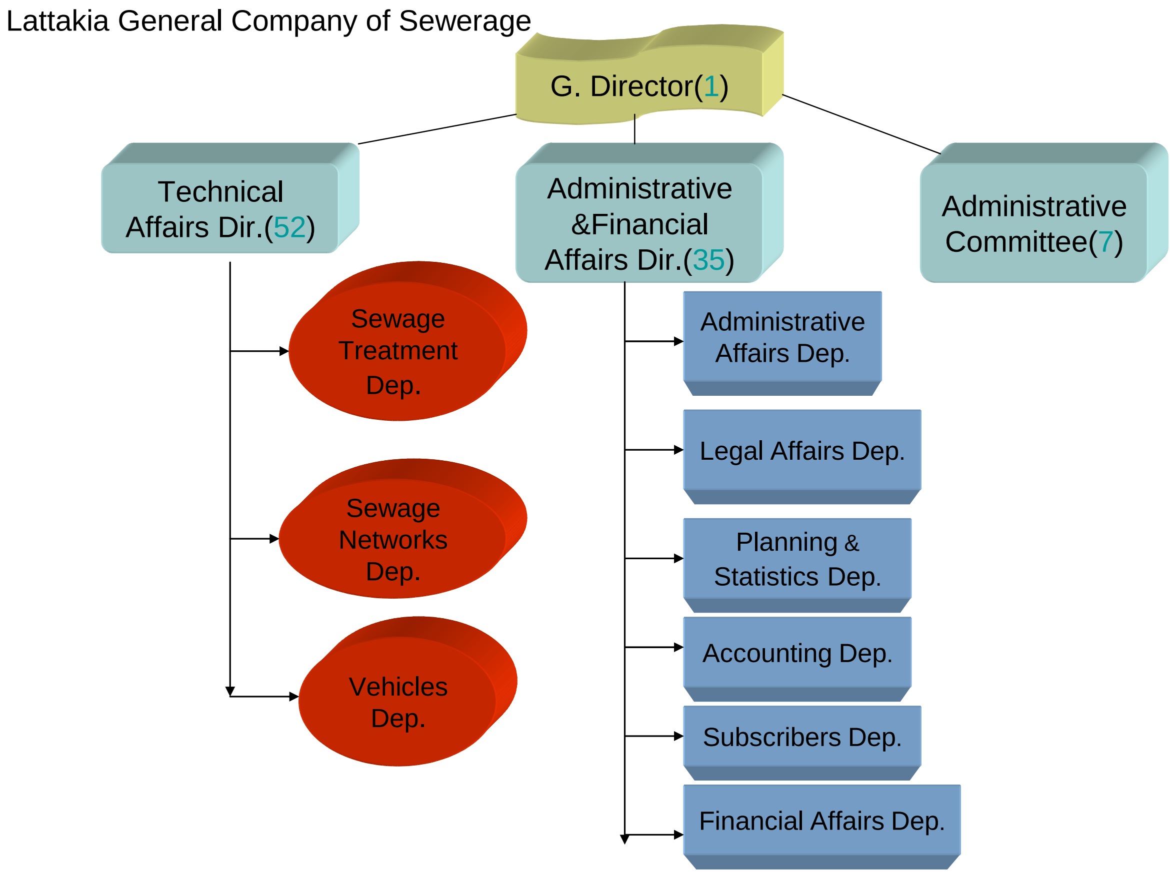


Figure 4.2.4 Organization Chart of Company

In general, due to lack of knowledge and skills in the O&M, the staff 's main activity is dealing with customer complaints, even with the awareness of the O&M importance. Furthermore, they are also conscious of the necessity to seek new treatment technologies that are more suitable to reusing the treated sewage for agricultural and other purposes however they are constrained with their lack of abilities.

One of the important O&M works should be the monitoring of industrial wastewater discharged to the sewer networks and if it conforms to the SASMO 2580/2002 (**Table 3.3.2**). It is the responsibility of the treatment plant in Adraa. Analysis of industrial water quality has sometimes been carried out in DSDC, however, instruction to the factory has never been provided so far, and this could be a risk for the proper operation of the STP and production of environmentally safe treated sewage.

The present organization structure of DSDC is shown in **Figure 4.2.5**.

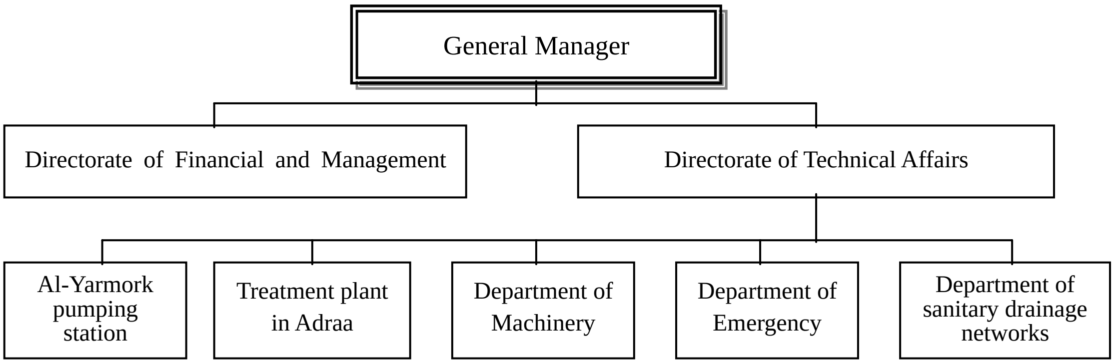


Figure 4.2.5 Organization Structure of Damascus Sanitary Drainage Company

4.2.4 Other Relevant Institutions

(1) General Company for Engineering and Consulting (GCEC)

The GCEC, founded in 1980, is a 100% Government owned company and controlled by MHC. The minister of MHC chairs the board of GCEC. It deals with the study and planning, design, design review and construction supervision of public projects. As of June 2007, the number of employee are 2,418 including 840 of engineers, 934 of technical assistants. The company's structure is as follows: the internal inspection directorate, administrative directorate and technical directorate. Under the technical directorate are the following sub-divisions: architectural, structural, electrical, mechanical, urban and rural planning, gas and oil, transport and roads, instrumentation, topographical survey, and the water and sanitary engineering divisions. The GCEC has branch offices in Homs, Aleppo, Lattakia and regional centers in Dar'aa, Sweida, Hama, Tartous, Idleb, Hassakeh, Qunetra.

The amount of projects (study, design, supervision) carried out in 2006 was SP 951 million, most of which are public projects ordered by governmental institutions. About 20% of the engineering study in Syria is implemented by GCEC.

The sewerage study and design projects are dealt with by the water and sanitary engineering division. From 1998, GCEC has conducted the preparation of Master Plans for Dar'aa, Homos, Hama, Aleppo, Tartous, Sweida and Qunetra. GCEC sometimes works with foreign consultants from Malaysia, Germany, Turkey, Britain, and Iran. The major projects executed recently include designs of STPs in Homs, Hama, Dar'aa, Rakka, Deir-Ez-zor and Hassakeh.

In the 90s, Russian experts used to associate with GCEC in planning and designing STPs, and from then onwards, Russian guidelines have been used for the facility design. Recently, American technical know-how is being applied. The Study Team observed that the quality of their products is poor (e.g. regional M/P in the Governorate) in comparison to others, and their planning and design manner is antiquated.

(2) University of Damascus

The MHC sometimes commissions sewerage studies and designs to the University of Damascus. The University has about 15 local experts in the water and sanitation field. It is likely that when the GCEC staff is in full operation, the MHC will entrust the work to the University. Approximately, 30% of the study and design work of MHC is commissioned to the University, while GCEC takes the other 70%.

4.3 Issues and Challenges in Water and Sewerage Sector

The 10th Five-Year Plan (10th FYP) points out the following issues in the water and sewerage sector in Syria:

(1) Water Sector

- Excessive physical and administrative water losses;
- Leakage of sanitary sewage to a number of water sources which leads to its pollution and prevents its usage as a safe source of potable water;
- Illegal connections to water networks as a result of illegal housing and delay in the issuance of legislative acts which bans such actions;
- Expansion in drilling of illegal water wells which have negative impacts on the groundwater resources;
- Lack of economic feasibility studies for most potable water projects;
- Increase in population growth rates which cannot be sustained by the limited water resources;
- Old equipment and machinery used for the drinking water sector;
- Weakness in the technical studies for implementation of most water projects due to lack of expertise;

- Increase in operational costs due to the rise in electricity and fuel fees which increases the budget of establishments and results in financial deficits;
- The low levels of water tariff which did not change since the year 2000 and the increase in cost of potable water production which results in the imbalance between revenues and expenses, and deficit in budget;
- Efficiency problems and defects in water meters in addition to a weak collection system;
- Multiplicity of parties involved in the water sector and overlapping responsibilities
- Centralization in decision making;
- Weak role of water users in the planning of water and wastewater projects;
- Lack of policy for the allocation of water resources for different usage groups; and
- Lack of trained administrative personnel.

(2) Sewerage Sector

- A number of organizations are involved in the sewerage projects whether in studies or execution or administration all at the same time however lacking coordination and integration which leads to many problems;
- Lack in efficiency of the sewer networks
- Lack of optimal performance and operation for present sewage treatment projects
- Delays in the implementation of sanitary sewage projects against the planned schedule
- Delay in the execution of certain sanitary sewage projects (studies, tendering, implementation) which has a negative impact on economic feasibility of these projects after commissioning
- Lack of environmental impact assessment for most projects
- Lack of studies and designs due to lack of technical expertise in this domain
- Lack of qualified Staff in the sewerage field
- Lack of pre-treatment units in health, agricultural and industrial installations which reflects negatively on the performance of municipal wastewater treatment plants

The 10th FYP envisions that in the next 20 years it will “Provide services that satisfy people’s needs through highly efficient Establishments which manage and preserve water sources designated for drinking purposes in order to ensure all citizens’ rights for safe drinking water and treated sewage”.

The objectives for the 10th FYP are summarized as follows:

1. To provide safe drinking water and treated sewage for rural and urban population centers and their developing areas, based on the principle of integrated and sustainable resources between all water users within the hydraulic basin
2. To reduce water losses in drinking water establishments
3. To provide customers with quality services funded through cost recovery for operation and maintenance, applied gradually, based on subsidies between different segments of society

in a governorate served by a single establishment

4. To establish the organizational framework which gives the largest possible authority figures in the management of human and financial resources for the administration of establishments, and enables them to take decisions at the lowest administrative level
5. To establish the organizational framework which coordinates the tasks between the organizations responsible for water supply, water distribution, sewage collection, sewage treatment, and wastewater reuse under a single administration or organization; and to establish the organizational framework for the participation of the private sector in the execution of specific tasks.
6. To provide professional development for all workers in the sector which would enable them to execute their tasks with efficiency and effectiveness, and train them to perform advanced tasks, and provide them with the appropriate work environment which guarantees that competent personnel with continue working in this sector
7. To provide communication and the implementation of the participatory approach in the preparation of plans and funding of projects for population centers which will be supplied with drinking water and wastewater services

In order to achieve these goals and objectives in the water and sewerage sector, the 10th FYP requires the following institutional and legislative reform at the national government and lower administrative levels.

＜On the government level＞

- Revision of existing legislations in order to give the water and wastewater establishments higher power in the management or their financial affairs, human resources, accounting, purchasing and contracts
- Issuance of legislative acts to unify the public institutions with jurisdiction over wastewater collection and treatment and reuse of treated wastewater

＜Reforms required from the Ministry of Housing and Construction＞

- Issuance of a ministerial decree to re-organize the water and wastewater establishments in order to achieve the adopted policies and objectives (currently carried out through GTZ water program in both Rural Damascus and Aleppo)
- Establishment of the institutional framework organizing relationships between the sector's organizations, and between these organizations and the private sector
- Revision of the by-laws of the establishments

＜Reforms required from the water and wastewater establishments＞

- Turn over of control for decision making in the establishments to the lowest administrative level

As to details of the 10th FYP, refer to **Appendix 4.1**.

4.4 Sector Reform Projects being Implemented by Other Donors

From 2006, GTZ has been providing the MHC with advisory services for its institutional reform entitled, "Institutional Support to the Water Sector", which will be continued until 2008. The contents of the services include 1) Monitoring and evaluation, 2) Economic and financial management, 3) Management of strategic planning and communication, 4) Project development and management, and 5) Human resources development.

1) Monitoring and evaluation (M&E)

- Assessment of optimum status of M&E entity and promotion of Performance Indicators (PI)
- Review, analysis and formatting of indicators
- Piloting of indicators monitoring assessment of its impact and effectiveness
- Piloting of software of the performance indicator (PI) by the GTZ experts in Yemen who are to visit the ministry during the last week of January 2007.

Achievements: GTZ is currently working with SPC and MHC to establish a comprehensive system of indicators to monitor the implementation of the FYP. In parallel, the two GTZ institutional support projects in Rural Damascus and Aleppo are introducing appropriate indicators at the local level for technical monitoring. At the central ministry level, GTZ is still in the preliminary stage in discussing with the Ministry as to the appropriate indicators needed for the ministry work in its adapted role as a regulator of the sector.

2) Economic and financial management

- Analysis of current economic and financial legislations, processes and procedures, and work flows in the MHC
- Upon getting results from the latter, a series of activities will be initiated addressing the theme's targets
- Carry on long term and comparative water tariff studies
- Introduction and piloting of marked based mechanisms and self-regulation

Achievements: A short-term study for water tariff restructuring is already completed. The Ministry and GTZ are currently working on drafting a scenario for the new water tariff structure in order to contribute to meeting targets of cost recovery as stated in the FYP. (Subsequent topics are presented later.) In conjunction, GTZ has prepared a short assessment study of the existing financial management system at the ministry level. The study listed long and intermediate measures which are currently being reviewed by the Ministry.

A study and training scheme is currently ongoing with the objective of strengthening the

MHC procurement system including preparation of tender documents, pre-qualification of tenders, evaluation of offers and drafting of contracts.

3) Management of strategic planning and communication

- Carrying out situation analysis and proposal of scenarios for MHC re-organization
- Provision of support for the establishment of the modernization entity
- Provision of training and piloting of water demand management tools
- Establishment of a library/database of information and knowledge produced/acquired by the MHC

Achievements: GTZ carried out a short assessment study concerning the re-organization of the Ministry and assessed the proposed organization chart. The draft is under discussion with various directorates (Details are presented later). As a direct measure, GTZ support is extended to establish the International Cooperation and Environmental Planning Directorate.

A study for drafting the Information Technology Strategy for MHC with expected date of completion last November 2007 is still on-going.

4) Project development and management

- Provision of training on project planning, development and management
- Establishment of a Planning & Management for the Environment group in order to manage tasks such as EIA studies, spatial management such as land use
- Implement two training sessions for the MHC and placing the right staff in project proposal writing and development.
- Establish a work team for the assessment of environmental work requirements and drafting environmental management set up at the ministry.

Achievements: There is ongoing preparation for training at the ministry level to introduce EIA and Syrian Implementation Procedures that include EIA Expert Licensing and EIA Public Consultation.

On the other hand, GTZ has finished the first stage of land use plan in Rural Damascus with the MLAE. The plan includes the zoning of drinking water catchment areas and their vulnerability to surface pollution. This shall prove to be a useful tool for the Establishment in protecting their water sources.

A short study has also been completed assessing the need for software for the design of sewer network systems.

5) Human resources development

- Promotion of learning culture for office management, IT utilization in work processes, English language and basic computer skills

- Commencement of in-service training for MHC young staff with GTZ working team

Achievements: English language courses have been carried out for the ministry staff after GTZ made the arrangement with the British Council in Damascus. In addition, both GTZ components with Rural Damascus and Aleppo started using the GIS system for better planning of utility services, an example of which is the automation to water billing. The GTZ and the ministry is preparing a workshop for the General Director of Establishments to discuss a possible sustainable approach to GIS implementation including institutional, legal, financial and technical requirements and the possible effects when making use of such a system.

Cost Recovery Area

As earlier stated, GTZ has been providing MHC with the required technical assistance and will continue to do so, in order to strengthen MHC in fulfilling their roles as a regulatory authority with key water sector stakeholders:.

The following topics are the main areas to be further tackled with support from GTZ:

1. Identify the relevant institutional counterparts at Directorate level. Assess their organizational role within the Ministry in managing the restructuring, implementation and monitoring of the water tariff. Consider the needed capacity building measures and provide necessary guidance in this regard.

2. Communications with the Ministry of Social Affairs & Labor shall be initiated to learn of their recent experience on welfare mapping. The government then plans for direct cash subsidies to households and makes the necessary changes on water tariff at regional level, if any. The government will also take into consideration the salaries of the public sector salaries and therefore will not stop subsidizing costs of water services. efforts will be made to address this important issue.

3. In light of the contention that most water consumption is made at a rate of 10 to $20m^3$, the Subscriber Offices together with the General Establishments shall re-measure the water consumption ratios made in the existing blocks.

4. Adhere to indicative cost recovery figures enlisted in the 10^{th} FYP (i.e. 100% for water service and 50% for sewerage service against O&M costs) that are to be achieved at the end of 2010 taking into consideration the two scenarios: with or without depreciation values.

5. Review the consumption figures in liters per person per day in light of the indicative

figures provided in the FYP and clearly distinguish between design and consumed figures.

6. Assess the number, legal status, billing conditions of house connections without meters and of those with meters that do not register any consumption. Analyze the relevant impacts of a flat rate to be introduced for non-metered connections.

7. Review the most recent balance sheets of a representative sample of General Establishments. Show the Establishment's current expenditures, financial revenues due to water billing and resulting deficits. Taking into considerations that current balance sheets are cash oriented and do not reflect credits amounts of uncollected revenues and in consonance, revenues of issued bills of previous years that are entered into present balance sheets. Provide water tariff scenarios to minimize these deficits taking into consideration the methodology provided in the internal water tariff restructuring prepared by the Ministry in 2005.

8. Assess the impacts of activating the Unified Exploitation System for Establishments effectuated in 2005. This defines certain house connection fees that have already increased revenues contributing to higher cost recovery. However, the impacts of this cash surplus and its relevance to better O&M costs have not yet been addressed clearly.

9. Propose a price index model that could be introduced and managed by the Ministry for achieving yearly water tariff adaptation/adjustments to cater for future scenarios in increase to full cost recovery or dramatic price changes or staff salaries.

10. Discussions on the advantages and disadvantages of utilizing normative or actual figures and their impacts shall be discussed as a multi-tier approach that considers social, political and technical aspects.

Re-organization of MHC

With the adoption of and to meet the "Social Market Economy"[1] model, the government institutions in Syria need to be reformed. The requirements are to:

- Shift the role of the government to become a regulator of the market
- Encourage markets and market-based initiatives
- Strengthen relationship with customers and introduce customer-oriented measures
- Fundamentally re-organize institutions in a way that paves the way to the introduction of new policies and procedures allowing for a greater managerial flexibility, etc.

[1] The shift towards the social market economy means using market tools and re-defining the government intervention as the regulator of the market performance and as the provider of public services.

Under these circumstances, the MHC has initiated a re-organization process as an attempt to improve and participate in the modernization process required by the highest levels of the government, as mentioned in Section 4.2. However, in light of the required transition towards the social market economy, and the new regulatory role of the Ministry embedded in the FYP, the Ministry needs to embark on a more in-depth and systematic re-organization processes.

The basic concept of this re-organization is to separate the roles of the five main players involved in the water sector (i.e. MHC, MLAE, MOI, Ministry of Industry, Ministry of Agriculture and Agrarian Reform) into specialized segments. In other words, the MHC is the sole institution responsible for providing drinking water to public and managing wastewater, through execution and coordination of water and wastewater projects with the Establishments spread geographically across the country.

Furthermore, the Ministry in this context interacts with policy makers to establish national priorities; talk to other players in order to monitor the performance of the sector as a whole; and interacts with customers to get their priorities and inputs. **Figure 4.4.1** shows an structure of the “new Ministry”.

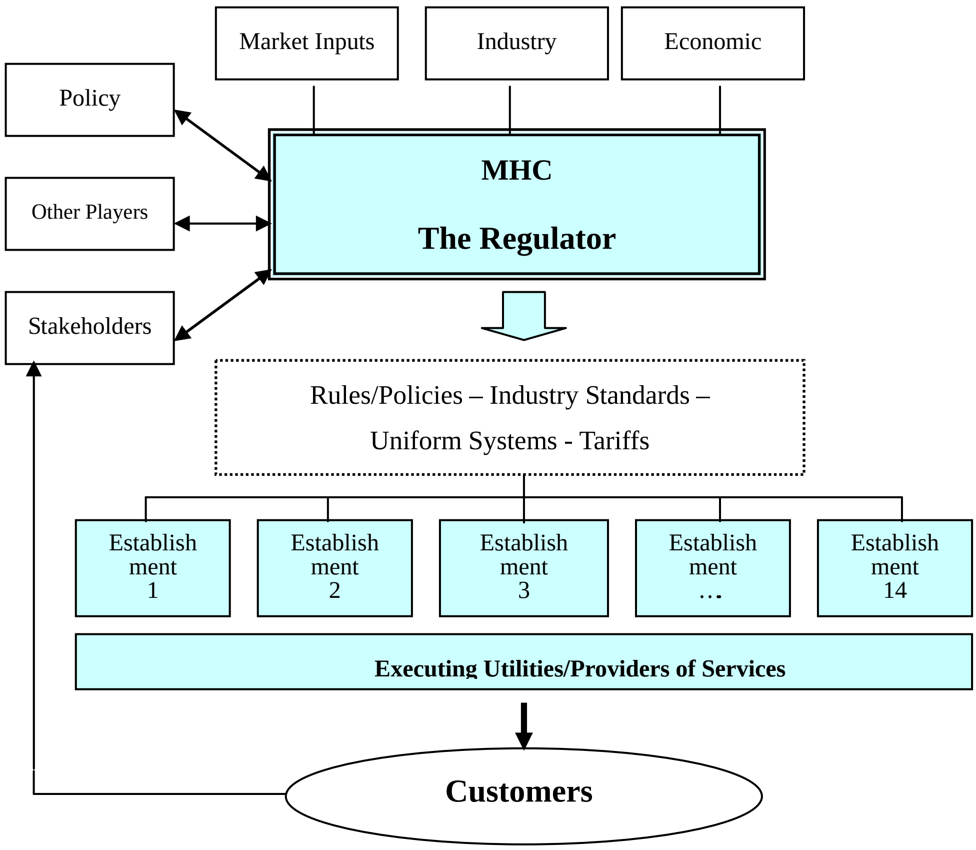


Figure 4.4.1 MHC as a Regulator and the Regulatory Environment

A report supporting the re-organization of MHC is under preparation by GTZ. The report will analyze success factors and constraints for creation of the new Ministry and provide recommendations for possible immediate actions and quick solutions from the following perspectives:

- Quality of service
- Relationship with external parties
- Structure of the new organization
- Human resources development
- Internal and external communications
- Administrative/accounting systems to be set up

4.5 Observation from the JICA Study Team

The Study Team feels that the currently fragmented and overlapping administrative structure and the weakness of economic and financial system in the water and sewerage sector must be remedied without delay. So far, the major problem in implementing the sewage works in Syria has been that the person responsible for construction, operation of sewage treatment plants (MHC, Establishments) differs from the person in charge of sewer networks (Governorates or municipalities). This results in the lack of coordination affecting a smooth and effective construction of the sewerage facilities as a SYSTEM. It should be noted that the sewerage system functions only when both the treatment plant and sewer network are completed. The Syrian side should be aware that in the absence of treatment plants, expanding the sewer networks merely brings about further contamination of water resources. In other words, the expansion of networks is a negative investment in the view point of the water resources preservation.

However, the 10th FYP clearly states that the water and sewerage services administration will be unified under the MHC and the organization shall be restructured to split its functions into Regulator (central Ministry) and Executor (Establishment). Furthermore, the FYP states that it shall reform the Establishments so that all the water and sewerage services in Syria are provided through the highly efficient Establishments, and that said Establishments will no longer be regulated and shall instead be self-managed.

As these purposes are incorporated in the FYP, the GTZ is currently providing technical support to the MHC in order to meet the requirements. It would seem that majority of the legislative, institutional framework surrounding the water and sewerage sector would be implemented through the GTZ's support.

In this regard, The Study Team considers that this Study should focus on the institution and capacity building of the Executor for the sewerage projects, such as, the sewerage directorate of the Establishments and the Sewerage Company. This Study will provide proposals and recommendations on the necessary organizational structure and management plan for the executing agency in the seven targeted Governorates, as well as on the necessary technical assistance scheme.

Details are discussed in Chapter 10.5 and 10.6 in Master Plan.

CHAPTER 5 PRESENT CONDITIONS OF EXISTING SEWERAGE SYSTEM

5.1 Present Status of Sewerage Sector, existing Facilities and Plans

5.1.1 Present Status of Sewerage Sector

Table 5.1.1 shows the major management issues involving central Ministries and their Governorate branches, which are common in the sewerage sector.

Table 5.1.1 Major Management Issues on Sewerage Sector

- Numerous organizations are involved in the sewerage projects (whether in studies or execution or administration) all at the same time, however, lacking coordination and integration which leads to other problems and to waste
- Inefficiency of the sewer networks
- Faulty operations for the present sewage treatment projects
- Delay in the implementation of sanitary sewage projects against the planned schedule
- Delay in the execution of certain sanitary sewage projects (studies, tendering, implementation) which has a negative impact on the economic viability of the project
- Lack of environmental impact assessment for most projects
- Due to the lack of technical expertise, the studies and designs are not satisfactory made
- Lack of qualified staff
- Lack of pre-treatment units in health, agricultural and industrial installations which reflects negatively on the performance of municipal wastewater treatment plants

5.1.2 Present Status of existing Facilities and Plans

Table 5.1.2 shows the summary of relevant data on sewerage development project:

Table 5.1.2 Summary of Relevant Data on Sewerage Development Project (1/3)

Governorate/ Referring Page	River Basin Flows to	2004 Census Population	Major Pollution Sources	Existing Sewerage Development Plan	Existing Sewerage Facilities	Studies Conducted by Donor Agencies
Lattakia/ **5-5**	Mediterranean Sea	879,551	Domestic and Industrial Wastewater	Regional plan prepared by GCEC/ **5-6**	Sewer Network/ **5-5**	EU for Lattakia City STP/ **5-6**
Tartous/ **5-8**	Ditto	701,395	Same as above	Same as above/ **5-9**	Sewer Network and two private STP/ **5-8**	EU for Tartous and Banias STP, Rehabilitation of Wastewater Treatment Plant of Oil Refining Facility in Banias/ **5-9**
Deir-Ez-zor/ **5-12**	Euphrates River	1,004,747	Domestic, Industrial and Hospital Wastewater	None/ **5-13**	Sewer Network/ **5-12**	None/ **5-13**

Table 5.1.2 Summary of Relevant Data on Sewerage Development Project (2/3)

Governorate/ Referring Page	River Basin Flows to	2004 Census Population	Major Pollution Sources	Existing Sewerage Development Plan	Existing Sewerage Facilities	Studies Conducted by Donor Agencies
Hassakeh/ **5-14**	Euphrates River	1,275,118	Domestic and Agricultural Wastewater	None/ **5-16**	Sewer Network and one STP/ **5-14**	None/ **5-16**
Raqqa/ **5-17**	Euphrates River	793,514	Same as above	None/ **5-18**	Sewer Network and five STPs/ **5-17**	Spanish Government for Raqqa STP/ **5-18**
Dar'aa/ **5-19**	Yarmouk River	843,478	Domestic and Industrial Wastewater	Regional plan prepared by GCEC/ **5-20**	Sewer Network/ **5-19**	GCEC: F/S for Muzerib/ **5-21**
Rural Damascus/ **5-22**	Barada/Awaj River	2,273,074	Same as above	None/ **5-25**	Sewer Network and two STPs/ **5-22**	The World Bank: F/S for Sewerage System of Barada & Ghouta Ghabitah Area/ **5-25**
						KfW: F/S for Sewerage System of five Communities: Yalda, Babyla, Bait Sahem, Aqraba and Saieda Zeinab/ **5-25**
						UNRWA: F/S for Water Supply and Sanitation System of two Palestine Refugee Camps of Khan Dannoun and Khan Ehieh/ **5-26**
						EIB: Pre-F/S Study for Sewerage System of Zabadani Area/ **5-26**
						Malaysian Government: Technical and Financial Assistance **5-28**
Aleppo/ **5-29**	Euphrates River	4,045,166	Domestic and Industrial Wastewater	Regional plan prepared by GCEC/ **5-31**	Sewer Network and one STP/ **5-29**	None/ **5-31**

Table 5.1.2 Summary of relevant Data on Sewerage Development Project (3/3)

Governorate/ Referring Page	River Basin Flows to	2004 Census Population	Major Pollution Sources	Existing Sewerage Development Plan	Existing Sewerage Facilities	Studies Conducted by Donor Agencies
Hama/ **5-32**	Orontes River	1,384,953	Domestic and Industrial Wastewater	Regional plan prepared by GCEC/ **5-33**	Sewer Network and one STP/ **5-32**	None/ **5-33**
Homs/ **5-34**	Orontes River	1,529,402	Domestic and Industrial Wastewater	Regional plan prepared by GCEC/ **5-36**	Sewer Network and one STP/ **5-34**	None/ **5-36**
Idleb/ **5-37**	Orontes River	1,258,427	Domestic and Industrial Wastewater	Regional plan prepared by GCEC/ **5-38**	Sewer Network and one STP/ **5-37**	None/ **5-38**
Sweida/ **5-39**	Yarmouk River	313,231	Domestic and Industrial Wastewater	Regional plan prepared by GCEC/ **5-40**	Sewer Network/ **5-39**	None/ **5-40**
Qunetra/ **5-41**	Yarmouk River	66,627	Domestic and Industrial Wastewater	Regional plan prepared by GCEC/ **5-42**	Sewer Network/ **5-41**	None/ **5-42**
Damascus/ **5-43**	Barada/Awaj River	1,552,161	Domestic and Industrial Wastewater	None/ **5-47**	Sewer Network, one STP, one PS/ **5-43**	None/ **5-47**

Note) **Page number** (for example : **5-5**) described in column of "Governorate", "Existing Sewerage Development Plan", "Existing Sewerage Facilities" and "Studies conducted by Donor Agencies" means "**page to be referred**" to for relevant information.

For major issues related to sewerage sector, projects, facilities and plans, refer to the following pages:

Major Issues		**Page**
Table 5.2.33	Sewage Treatment Plant	**5-48**
Table 5.2.34	Trunk Sewer and Sewer Network	**5-48**
Table 5.2.35	Existing Sewerage Development Plan	**5-49**
Table 5.2.36	Planning Procedure	**5-50～52**
Table 5.2.37	Project Priority	**5-53**
Table 5.2.38	Data Management	**5-53**
Table 5.2.39	Design Standard	**5-54**
Table 5.2.40	Topographic Data	**5-54**
Table 5.2.41	Human Resource Development	**5-54**
Table 5.2.42	Relevant Laws	**5-55**
Table 5.2.44	Administrative Demarcation	**5-55**

5.1.3 Outline of Regional Plan

Sewerage development plan covers whole Governorate area called “Regional Plan” have been developed by GCEC for nine Governorate listed below:

Governorates where “Regional Plan” have been prepared
Lattakia, Tartous, Dar’aa, Aleppo, Hama, Homs, Idleb, Sweida and Qunetra Governorate

This plan was supposed to have been submitted to MHC headquarter and to have been transferred to each Establishment thru MHC. However, plans have not been maintained appropriately both in MHC headquarter and nine Establishments. According to the general plan and documents kept in digital file found in MHC headquarter, the plan covers whole Governorate area by huge length of trunk sewers and numerous STPs.

Centralized or decentralized sewerage system whatever, sewage collection and treatment by sewerage system is only advantageous in urban areas with densely constructed housings and large population. Among the whole governorate area, there must be some rural areas with scattered housings. As excessive construction period and budget is needed to cover the whole Governorate area by sewerage system, “Regional Plan” is not feasible.

Abovementioned rural areas shall be served by On-site System. Contents of each “Regional Plan” is described in **5.2**.

5.2 Present Conditions of Existing Sewerage Facilities, Current Status of Existing Sewerage Development Plans and Major Issues

5.2.1 Lattakia Governorate

(1) Existing Sewerage Facilities

The Lattakia Governorate is the main area of Industrial and Tourism activities along the Mediterranean Sea Basin. A district map is shown in **Figure 5.2.1** to further illustrate. The Lattakia Governorate is composed of four major districts, namely Lattakia, Jable, Al Hafeh and Al Querdaha which are also comprised of several sub-districts and many communities as shown in **Table 5.2.1**.

The General Establishment of Sewerage was founded in 2004.

Figure 5.2.1 District Map of Lattakia Governorate

Table 5.2.1 Breakdown of Sub-districts contained and Sewerage Service Ratio in Lattakia Governorate (1/2)

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Lattakia	1	Lattakia Center and Surrounding Communities	27	90%
	2	Al Bahlawia	21	90%
	3	Rabie'a	24	60%
	4	Ain Al Baida	22	95%
	5	Kast al Ma'af	19	50%
	6	Kasab	5	90%
	7	Hanadi	13	85%
2. Jableh	1	Jableh Center and Surrounding Communities	24	85%
	2	Ain Al Sharqiya	31	90%
	3	Ktail biya	38	90%
	4	Ain Sh Kak	16	70%
	5	Dalia	15	80%
3. Al Haffeh	2	Slunfeh	28	90%
	3	Kansaba	36	60%
	4	Mzeraa	30	90%
	5	Ayen Teneh	13	90%

Table 5.2.1 Breakdown of Sub-districts contained and Sewerage Service Ratio in Lattakia Governorate (2/2)

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
4. Al Qerdaha	1	Al Qerdaha Center and Surrounding Communities	51	80%
	2	Harf Al Msaitra	9	75%
	3	Fakhora	24	85%
	4	Jawbet Boghal	11	60%

Note) Sd = Sub-district

Although there is no existing STP at present, sewer network has been developed throughout the Governorate and their service ratios in major cities are shown in the table above.

There are 13 sewage outlets facing the Mediterranean Sea, with the largest one a triple box culvert. The Project Team observed that a huge volume of raw sewage discharge from one of the box culverts as well as those collected from vacuum tankers was discharged into the sea. Several pumping stations are currently under construction, and they are designed to send the sewage to the trunk sewer which conveys collected sewage to the proposed STP.

The contract for the construction of Lattakia City STP, between the French OTV Company and the Syrian government, was cancelled due to political restrictions. While the construction of the STP was included in the EU's "Protecting Mediterranean from Land-Based Pollution Program" and money from the French was available, the Syrian government opted to cancel the said agreement, leaving them in cooperation with the GCEC, to construct the Lattakia STP using their own budget through a design completed by GCEC. A bid announcement for the turn-key contract was made and numerous offers were delivered from domestic and overseas contractors; the MHC is now evaluating them.

(2) Existing Sewerage Development Plans

A regional plan was prepared by GCEC in 1985. It comprises of documents and drawings which are listed in **Table 5.2.2 and 5.2.3**

Table 5.2.2 Documents comprised the Regional Plan

Design Items	Contents
Summary	Location, climate condition, soil characteristics, population projection, health and education status
Water Supply in Lattakia Governorate	Water resources, loss and leakage ratio, average per capita water consumption
Sewerage System in Lattakia Governorate	List of existing and proposed sewer network, selection of sewage treatment methods, design of proposed sewage treatment plant

Table 5.2.3 Outline of the planned Sewerage Facilities in Lattakia Governorate

Name of STP	Beginning Diameter (mm)	End Diameter (mm)	Length (m)	Population at 2030
Lattakia main treatment plant	Unknown	Unknown	-	742,000
Al- Kurdaha	Unknown	Unknown	16,000	25,000
Jableh	Unknown	Unknown	-	107,000
Al- Ghanimeh, Khan Al- Jouz	Unknown	Unknown	5,700	1000
Kersana, Al- Shamieh	Unknown	Unknown	4,700	20,000
Bsendyaneh	Unknown	Unknown	10,000	13,000
Al- Shabatlieh	Unknown	Unknown	4,500	20,000
Ein Al- Hour, Marj Al- Zawie	Unknown	Unknown	5,500	10,000
Al- Burjan	Unknown	Unknown	20,200	67,000
Hammam Al- Karahleh	Unknown	Unknown	4,000	12,000
Al- Hwez	Unknown	Unknown	20,100	57,000
Zama	Unknown	Unknown	10,300	42,000
Al- Rwemieh	Unknown	Unknown	7,500	24,000
Al- Safrakieh	Unknown	Unknown	1,800	4,000
Al- Baseet	Unknown	Unknown	10,000	32,000
Kasab	Unknown	Unknown	2,000	10,000
Terjanou	Unknown	Unknown	6,000	8,000
Al- Boody	Unknown	Unknown	5,500	25,000
Al- Dammat	Unknown	Unknown	8,000	11,000
Slunfeh	Unknown	Unknown	5,000	8,500
Bustan Al- Basha	Unknown	Unknown	4,000	8,000
Al- heffe	Unknown	Unknown	1,000	25,000
Ein Al- Laban Al- Jnedrieh	Unknown	Unknown	7,000	10,000
Al- Mzeraa	Unknown	Unknown	500	5,000
Al- Fakhoura	Unknown	Unknown	9,000	15,000
Fedyo	Unknown	Unknown	6,000	24,000
Al- Awwamieh	Unknown	Unknown	8,000	20,000
Tlaro	Unknown	Unknown	1,800	10,000
Salma	Unknown	Unknown	500	15,000
Baabda	Unknown	Unknown	4,000	12,000
Bait Ana	Unknown	Unknown	2,500	3,000
Al- Seraj	Unknown	Unknown	5,500	2,400
Al- Ghamam	Unknown	Unknown	2,800	2,300
Bhamra	Unknown	Unknown	1,100	4000
Al- Jawzieh	Unknown	Unknown	6,700	20,000
Total including Lattakia and Jableh Cities			208,900	1,423,200

"Drawings" are comprised of the followings:

- A general plan with trunk sewer routes and STP locations covering the whole Governorate Area
- A sewer pipe plan and longitudinal profile
- A manhole standard structure drawing

However, as general plan and sewer pipe plan do not contain any detailed topography and no pipe number was displayed, making it difficult to differentiate the drawn sewer pipe.

As a considerable amount of time has passed since the regional plan was drawn up, basic designs and frameworks and aspects such as population and water consumption have already changed. Add to this is the fact that numerous sewerage facilities have already been constructed. Therefore, the existing regional plan should be fully reviewed and modified.

5.2.2 Tartous Governorate

(1) Existing Sewerage Facilities

The Tartous Governorate is located adjacent to the Lattakia Governorate in the South and is comprised of five major districts each of which comprise several sub-districts. A district map is shown in **Figure 5.2.2** to further illustrate this. The Department of Sewerage will be organized within the General Establishment of Drinking Water and Sewerage. The General Establishment of Sewerage will be formed upon the completion of STP for Tartous City. At present, the Directorate of Technical Affairs of Tartous Governorate is managing sewerage works.

Sewerage coverage ratios are shown in **Table 5.2.4**.

Figure 5.2.2 District Map of Tartous Governorate

Table 5.2.4 Breakdown of Sub-districts contained and Sewerage Service Ratio in Tartous Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Tartous	1	Tartous Center and Surrounding Communities	52	85%
	2	Arwad	1	95%
	3	Hamidiya	11	72%
	4	Khrbet Ghazai	13	45%
	5	Swd Akhwabe	29	98%
	6	Safsafeh	18	66%
	7	Al Karimeh	12	91%
2. Banyas	1	Banyas Center and Surrounding Communities	34	99%
	2	Rawda	12	95%
	3	Anazeh	18	90%
	4	Kadmous	23	90%
	5	Talin	8	60%
	6	Al Tawahin	11	70%
	7	Hamam Wasil	12	90%
3. Safita	1	Safita Center and Surrounding Communities	40	86%
	2	Mashta Al Helo-Hazour	27	95%
	3	Ras Al Khashofeh	20	95%
	4	Al Sesneih	21	95%
	5	Al Barqieh	10	95%
	6	Sabbeh	10	95%

Table 5.2.4 Breakdown of Sub-districts contained and Sewerage Service Ratio in Tartous Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
4. Drekeish	1	Drekeish Center and Surrounding Communities	24	80%
	2	Jnenet Rislan	16	67%
	3	Hameen	9	95%
	4	Dwer Rislan	19	85%
5. Al Sheikh Bader	1	Sheikh Bader Center and Surrounding Communities	26	65%
	2	Brmanet Al Mashaikh	17	95%
	3	Kamsia	18	90%

Note) Sd = Sub-district

There are two existing STPs in the Tartous Governorate – the Al Rimal Al Dahabiya STP with a capacity of 1,400 m^3/day and the Al Shera'a STP with a capacity of 70 m^3/day. Both are private STPs serving a resort compound built along the beaches in the Tartous district. Most of generated raw sewage are discharged into the Mediterranean Sea through 60 sewage discharge points. It is worthy to mention that several STPs are now under construction or are being studied for implementation. Civil works of Kharbet Almaza and Ta'nita STP are ongoing under the supervision of the Ministry of Local Administration and Environment. Both have a design plant capacity of 1,000 m^3/day and the extended aeration method was applied. The Safita, Ba'amra and Sesnieh STPs, meanwhile are currently being studied by the budget of Ministry of Housing and Construction.

Major industrial establishments are: (1) an oil refinery located in Banias (2) a Phosphate fertilizer shipping facility at Tartous Port (3) a thermal power plant in the district of Tartous and (4) olive oil factories situated all over the Governorate.

Similar to the construction of the Lattakia STP, the contract for the Tartous STP was also cancelled due to political restrictions. Thus, the Syrian government, alongside the GCEC had to construct the STP of the City. A bid announcement of the turn-key contract was made and numerous offers were delivered from domestic and overseas contractors with the MHC evaluating them.

(2) Existing Sewerage Development Plans

A regional plan was also prepared by GCEC in 1998 for Tartous city similar to the one of Lattakia. Twelve (12) STPs were included in the regional plan but it was modified due to the construction of a dam for water supply. Consequently, 38 more STPs with various plant capacities were proposed. The outline of the sewerage facility design is shown below.

Table 5.2.5 Outline of the planned Sewerage Facilities in Tartous Governorate (1/2)

Name of STP	Beginning Diameter (mm)	End Diameter (mm)	Length (m)	Population at 2030	Capacity (L / sec)	Treatment Method
Al-sesneia	300	500	6,000	15,000	120	Extended Aeration
Baamra	300	400	2,800	5,500	50	Extended Aeration
Jobar	400	600	23,000	53,000	350	Extended Aeration
Dalia-Hresouh	400	800	25,000	110,000	680	Extended Aeration
Tartous-Banias Line A	300	1,200	14,500	140,000	840	Extended Aeration
〃 Line B	400	800	9,000	41,000	280	Extended Aeration
Naher-Banias	400	500	11,000	43,000	295	Extended Aeration
Naher Al Jaam	300	300	9,000	19,000	145	Extended Aeration
Al-khansad Al-mosherfa	300	600	18,000	64,000	420	Extended Aeration
Raweel-Al hwash	400	800	20,000	90,000	560	Extended Aeration
Al-Dabbouseia Line A	300	600	12,000	21,000	160	Extended Aeration
〃 Line B	300	600	18,000	86,000	540	Extended Aeration
〃 Line C	300	600	9,500	87,000	550	Extended Aeration
〃 Line D	300	600	7,500	9,000	75	Extended Aeration
Tartous-Al hamedia	300	1,200	20,000	227,000	1,350	Extended Aeration
Safsafa	400	600	8,000	21,000	160	Activated Sludge
Bwedat-Al swekat	300	700	11,000	65,000	640	Activated Sludge
Wadi-Aloyon	400	700	22,000	60,000	400	Extended Aeration
Wadi-Aloyon Sendyana	300	300	5,400	11,000	90	Extended Aeration
Wadi-Aloyon Amreia	300	300	1,200	2,000	21	Extended Aeration
Wadi-Aloyon Rakma	300	300	500	5,200	48	Extended Aeration
Al-mitras Line K	300	700	10,075	60,000	400	Extended Aeration
〃 Line A	300	400	5,500	3,500	34	Extended Aeration
〃 Line A'	300	300	5,000	3,500	34	Extended Aeration
〃 Line B	600	600	4,050	24,000	170	Extended Aeration
〃 Line C	300	400	7,650	21,000	160	Extended Aeration
Al-Ghamka	400	1,100	23,000	162,000	720	Extended Aeration
Al-Sawmaau	400	500	17,000	25,000	120	Extended Aeration
Jndenit-Raslan	400	600	9,200	38,000	270	Extended Aeration
Al-Kolieaa Al-Dolbe	300	700	12,000	76,500	680	Extended Aeration
Beshraghee	300	400	9,000	25,000	280	Extended Aeration
Jwekhat-Al-kaf roon	300	300	2,000	4,000	38	Extended Aeration
Mashta-Kafroon	400	500	6,000	19,000	140	Extended Aeration
Mashta Al-aodaida	300	400	6,000	2,000	147	Extended Aeration

Table 5.2.5 Outline of the planned Sewerage Facilities in Tartous Governorate (2/2)

Name of STP	Beginning Diameter (mm)	End Diameter (mm)	Length (m)	Population at 2030	Capacity (L / sec)	Treatment Method
Al-kadmous (Sourani)	400	900	17,000	57,000	375	Extended Aeration
ditto (Hammam-Wasil)	300	400	9,800	14,000	116	Extended Aeration
ditto (Taaneeta)	300	800	12,000	115,000	790	Extended Aeration

5.2.3 Deir-Ez-zor Governorate

(1) Existing Sewerage Facilities

Situated downstream of the Euphrates River, the Deir-ez-zor Governorate has vast land beside the huge scaled cities of Deir-Ez-zor, Al Mayadeen and Abukamal. The distance between Deir-Ez-zor and Abukamal is about 120 km. Khabour River merges with the Euphrates River at the upstream of Al Mayadeen City. A district map is shown in **Figure 5.2.3** to further illustrate

Soil in this Governorate is classified as "sandy-clay" type. Due to the high groundwater table, trenching for pipe installation cannot be done. Because of this, the development of the sewer network is likely to be delayed.

Figure 5.2.3 District Map of Deir-Ez-zor Governorate

The sewer network service ratio is generally low as shown in **Table 5.2.6**.

Table 5.2.6 Breakdown of Sub-districts contained and Sewerage Service Ratio in Deir-Ez-zor Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Deir-Ez-zor	1	Communities Surrounding Deir-Ez-zor Center	14	85%
	2	Communities within Deir-Ez-zor Center	14	0%
	3	Bsaira	15	25%
	4	Tebne	11	2%
	5	Sour	16	20%
	6	Kasra	15	7%
	7	Mo Hasan	8	60%
	8	Khsham	8	1%
2. Abu Kamal	1	Abu Kamal Center and Surrounding Communities	10	80%
	2	Hajeen	6	25%
	3	Swseh	5	15%
3. Mayadin	1	Mayadin Center and Surrounding Communities	8	85%
	2	Zobian	10	30%
	3	Asharah	8	16%

Note) Sd = Sub-district

Insufficient budget also contributes to the low sewer network service ratio; therefore, the remaining communities are still served by On-site Facilities.

There is no existing STP in the area. Although the feasibility study and design of the sewage treatment plant for Deir-Ez-zor City has been already completed by the GCEC; its construction is not yet implemented.

The most serious issue is the discharge of raw sewage, which comprises of domestic sewage, industrial wastewater and hospital wastewater. The largest industrial wastewater source is the paper factory. While the factory has its own wastewater treatment plant, it still needs to be modified as the treated water is substandard.

Raw sewage is discharged into the channel through a box culvert with a dimension of 2000× 2000mm. The odor of the discharge is abhorrent or foul as observed by the Project Team. The construction of a PS was intended to direct incoming sewage through an interceptor trunk, collect sewage at other discharge points and stream to the STP site located five kms away from this PS.

The proposed STP site is in a desert area situated far from the community. Population growth is predicted to be low and the sewer network service ratio low as well. Sewage collection is seen to increase in the future, however. During to the winter season, with temperatures ranging from 3 to 4 degrees centigrade, the proposed site might not be enough to employ the Stabilization Pond Method. According to the GCEC plan, the Extended Aeration Method was adopted with the design plant capacity at 67,800 m^3/day.

The deterioration of the sewer network is another issue. Some pipes are over 50 years old. O&M activities of completed facilities have not been appropriately implemented due to the lack of sewerage system experts.

(2) Existing Sewerage Development Plans

Although no regional plan has been prepared, a sewer network has been designed by the GCEC. Design firms have been sourced out by the Governorate with the financial support of Ministry of Local Administration and Environment. The sewer network has been widely developed, serving most core areas in densely populated cities and towns.

There is no relevant study executed by foreign donor agencies, as well.

5.2.4 Hassakeh Governorate

(1) Existing Sewerage Facilities

Located along the Khabour River, the Hassakeh Governorate faces the national borders of Turkey and Iraq. The major industry here is agriculture and there are no serious industrial wastewater problems to speak of so far. A district map is shown in **Figure 5.2.4**.

Figure 5.2.4 District Map of Hassakeh Governorate

The existing STP is the Ras Al Ayn STP with a design capacity of 2,130 m^3/day, adopting the Aerated Lagoon Method. Due to the steady population growth, the STP shall be expanded in the near future. Although the study and design of the sewage treatment plant for Al-Hassakeh City has been already completed by the GCEC, its construction has not yet been planned. Since there is only one existing STP, most raw sewage is discharged into the tertiary canal of Khabour River through a circular pipe with a diameter of 800 mm and box culvert with dimensions of 800×800 mm. The discharge odor is not so repugnant compared to the latter discharges discussed. A sewerage service ratio is shown in **Table 5.2.7**.

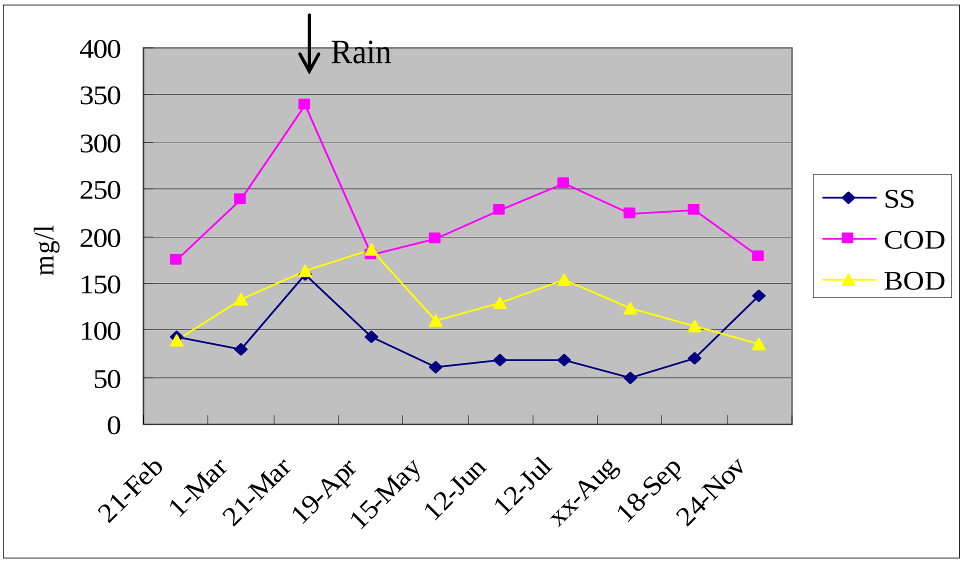
Table 5.2.7 Breakdown of Sub-districts contained and Sewerage Service Ratio in Hassakeh Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Hassakeh	1	Hassakeh Center and Surrounding Communities	263	42%
	2	Tal Tamer	136	49%
	3	Shadadeh	10	41%
	4	Markada	13	27%
	5	Al Areisheh	25	23%
	6	Be'er Al Helo Al Wardeih	108	39%
2. Qameshli	1	Al Qameshli Center and Surrounding Communities	127	37%
	2	Tal Hamees	172	33%
	3	A'amodah	157	33%
	4	Kahtaniya	115	42%
3. Malkyiah	1	Malkyiah Center and Surrounding Communities	125	49%
	2	Jawadiyah	57	46%
	3	Ya'robiyah	95	33%
4. Ras Al Ayn	1	Ras Al Ayn Center and Surrounding Communities	73	55%
	2	Drbasiya	161	24%

Note) Sd = Sub-district

As shown in the table, however, the sewerage service ratio is still low. Even at the Hassakeh Center, the service ratio is only at 42%. The soil classification is the main reason for the low ratio. Sandy-clay type of soil with high groundwater table makes pipe installation works difficult.

According to the actual survey on quality analysis at the sewage discharge points in the Hassakeh Center, concentration of SS, COD and BOD show higher value after rainfall. (Refer to **Figure 5.2.5**.) This means that pollutants settle at the bottom of the channel, or on the road when flushed by storm water. This is a major characteristic observed in the combined sewer system. Pollution concentration at peak flow is higher than that in low flow.



Note) Survey Date of Aug was not recorded

Figure 5.2.5 Pollution Load Transition in Sewage Discharge Point of Hassakeh Center

The consultant engineers in Syria believe that concentration during dry-season must be higher than during the rainy-season. Upon fixing the pollution load and calculating the STP inlet, the data came out the opposite.

What should be considered is the lifestyle of the Syrian people, as well as the behavior of the drainage and sewage systems including the understanding that the transport load might be different with the actual produced load, vis-à-vis what might be kept decomposing in the drainage or sewage systems.

Several cities namely Qamishly and Malikieh, located along the Jag River, discharge their raw sewage into this river, which happens to be a tertiary river of the Khabour River. Solid waste and the livestock's excreta from the cities are dumped at nearby sewage discharge points, which demonstrate the residents' poor awareness of proper water pollution control.

The Jag River flows from this city to the City of Al-Hassakeh for about 80 km. Within this distance, there are no communities. Making use of technology to utilize the river's natural purification function might be applicable as a type of treatment.

(2) Existing Sewerage Development Plans

No regional plan has been prepared but a sewer network has been designed by the GCEC under the order of the Governorate. Once the network design is completed, it will be submitted to the Ministry of Local Administration and Environment for their review and financial preparation.

There is no relevant study executed by foreign donor agencies, as well.

5.2.5 Raqqa Governorate

(1) Existing Sewerage Facilities

The Raqqa Governorate is situated in the upstream of the Euphrates River. The agricultural area of the Governorate is located downstream of the Asad Dam and upstream of Euphrates River. Eutrophication of the dam is in progress because of the discharge of domestic sewage and agricultural wastewater. A district map is shown in **Figure 5.2.6**.

The overall sewer network service ratio is about 60% and the remaining 40% is covered by on-site facilities. The detailed breakdown by cities is shown in **Table 5.2.8**.

Figure 5.2.6 District Map of Raqqa Governorate

Table 5.2.8 Breakdown of Sub-districts contained and Sewerage Service Ratio in Raqqa Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Raqqa	1	Raqqa Center and Surrounding Communities	73	60%
	2	Sabkha	26	80%
	3	Karameh	23	95%
2. Al Thawra	1	Thawla	4	75%
	2	Mandorah	24	90%
	3	Jarneah	38	5%
3. Tal Abyad	1	Tal Abyad Center and Surrounding Communities	46	70%
	2	Salouk	57	70%
	3	Ain Eisa	33	55%

Note) Sd = Sub-district

The deterioration of the sewer pipes is a major issue. A number of strong storms damaged the roads that led to pipe breakdowns. The most pressing concern is the discharge of raw domestic sewage, industrial and agricultural wastewater into the channels and rivers nearby.

There are five existing STPs designed and constructed by a private contractor through a turnkey contract. The Ministry of Local Administration and Environment supervised their designs and construction works. The outline is shown in **Table 5.2.9**.

Table 5.2.9 Outline of Existing STP in Raqqa Governorate

Name of STP	Plant Capacity (m^3/day)	Treatment Process	Current Operational Situation
Debse Afnan	1,000	Extended Aeration	Operation suspended Lacking administrative & technical Staff
Al Mansourah	1,000	Extended Aeration	Operation suspended Lacking administrative & technical Staff
Sabkha	1,000	Extended Aeration	Fairly good
Ma'dan	1,000	Extended Aeration	Operation suspended Lacking administrative & technical Staff
Al Karameh	1,000	Extended Aeration	Fairly good

Treatment flow of Al Karameh STP is as follows:

Grit Chamber⇒Return Sludge Mixing Tank⇒Aeration Tank⇒Sedimentation Tank⇒ Chlorination Channel

Note) The trough of the sedimentation tank was flooded and disinfection was not performed. Some O&M activities were inappropriate due to the lack of understanding in treatment mechanisms and functions.

Due to the lack of satisfactory O&M activities, the operation for the three STPs has been suspended and incoming wastewater is discharged to an agricultural channel nearby.

(2) Existing Sewerage Development Plans

No regional plan has been prepared but the sewer network has been continuously developed under the support of the Ministry of Local Administration and Environment.

Support from the Spanish Government for the Raqqa City STP construction was confirmed. The turnkey contract comprises of a review of the F/S, detailed design and construction works. Negotiations have been ongoing for more than one year and the Governorate is preparing for the Tender.

5.2.6 Dar'aa Governorate

(1) Existing Sewerage Facilities

The Dar'aa Governorate is situated along the south of the Damascus Governorate and is well known for its fertile crop field and tourism activities. A district map is shown in **Figure 5.2.7**.

Figure 5.2.7 District Map of Dar'aa Governorate

Water source used to be comprised of six springs and 380 groundwater wells; but 40 wells and two dams have been suspended as potable water source due to groundwater contamination by raw sewage discharge. Since raw sewage has been intensively applied in irrigation, the concentration of nitrogen and phosphate in the groundwater is relatively high. This issue is especially serious in the eastern part of Dar'aa.

A detailed sewer network service ratio is indicated in **Table 5.2.10**.

Table 5.2.10 Breakdown of Sub-districts ontained and Sewerage Service Ratio in Dar'aa Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Dar'aa Center	1	Villages within city center and surroudings	8	90 %
	2	Mzerib	8	90 %
	3	Bosra Al Cham	9	90 %
	4	Da'el	2	70 %
	5	Kherbet Ghazal	4	98 %
	6	Shajara	17	25 %
	7	Al Jyza	3	60 %
	8	Al Masyfra	4	20 %
2. Ezraa	1	Ezraa Center and Surrounding Communities	19	53 %
	2	Jasem	3	60 %
	3	Harrak	6	90 %
	4	Nawa	3	47 %
	5	Sheikh Mskeen	6	85 %
	6	Tseel	3	50 %
3. Al Sanameen	1	Al Sanameen Center and Surrounding Communities	17	80 %
	2	Masmeih	15	90 %
	3	Ghaba Gheb	12	3 %

Note) Sd = Sub-district

There is no existing STP in the Governorate. Civil work is under execution in Dar'aa and Da'el

STP by budgetary arrangement by Ministry of Housing and Construction. However, Mechanical and Electrical work is not yet planned.

Treatment flow of Dar'aa STP is as follows:

Sewage treatment (Extended Aeration Method)

Grit Chamber⇒Primary Sedimentation Tank⇒Mechanical Agitation Aeration Tank⇒Final Sedimentation Tank⇒Chlorination Tank⇒discharge into channel nearby

The design plant capacity is 21,800 m^3/day

Sludge treatment

Digestion Tank⇒Drying Bed : No "sludge thickening facility" was observed.

Extended aeration method was applied to Da'el STP as well. The design plant capacity is 16,000 m^3/day.

The Dar'aa STP is located on top of a hill approximately five kms away from city center. The STPs which are situated close to the city centers may be regarded as "nuisance facilities". In planning STPs, what should be positively considered are the financial resources needed for construction, including cost of the site itself; the wastewater transmission efficiency, and reuse of treated wastewater. It was noted that these were not observed in designing many facilities.

According to the Governorate engineer, there is no demand for treated water in the areas near to Dar'aa STP site, but where there are demands for reuse of treated water there are no sources. Considering this current situation, a decentralized system with small-scale STP supplies treated sewage to surrounding areas seems applicable. However, since part of the trunk sewer has already been completed and there are two STPs under construction, drastic re-planning is not feasible. Partial introduction of the decentralized system with maximum utilization of existing facilities is the practical option.

Typical industrial wastewater is generated from the olive oil factory and canned vegetable and fruit factory.

(2) Existing Sewerage Development Plans

There was a regional plan prepared by GCEC in 1997. The plan comprises of documents and drawings similar to that of the Lattakia Governorate. The outline of sewerage facility design is shown in **Table 5.2.11**.

Table 5.2.11 Outline of the planned Sewerage Facilities in Dar'aa Governorate

Name of STP	Beginning Diameter (mm)	End Diameter (mm)	Length (m)	Population at 2030	Capacity (L / sec)	Treatment Method
Jasem	400	700	11,900	60,000	450	Extended Aeration
Um Al Miaden	400	800	37,100	20,000	175	Extended Aeration
Sheikh Mskeen	400	700	30,100	32,000	254	Extended Aeration
Da'el	500	700	15,000	80,000	580	Extended Aeration
Sahem Al Golan	300	900	8,000	12,000	107	Extended Aeration

A feasibility study for Muzerib was prepared by the GCEC in February 2007. Muzerib is located northwest of Dar'aa City, about 10 kms away. There is an irrigation pond in the southwest of the city and raw wastewater is discharged into a river nearby. While it is ideal that an STP be constructed in this location, it was denied since the area is also laden with water sources. Based on the alternative study, the STP site will be situated in the east, four kms away from city center.

The wastewater of the Yaduda town which happens to be near the proposed STP site, will also be integrated into the system. The same shall be done with the town of Ataman which is also near the proposed site. Both of these towns have population of 9,000. Two PSs were planned to convey wastewater to the STP. The Extended Aeration Method is the treatment method to be used.

5.2.7 Rural Damascus Governorate

(1) Existing Sewerage Facilities

Surrounding the national capital of the Damascus Governorate, the Rural Damascus Governorate has the largest area among the 14 Governorates and has the 6th largest population in Syria at 1.6 million. Population growth here is the highest. Around 40% of the total industrial production comes from 16,000 factories situated there. A district map is shown in **Figure 5.2.8.**

For Rural Damascus, 33% of wastewater generated in this Governorate is pumped to the Adraa STP through Yarmok Pumping Station.

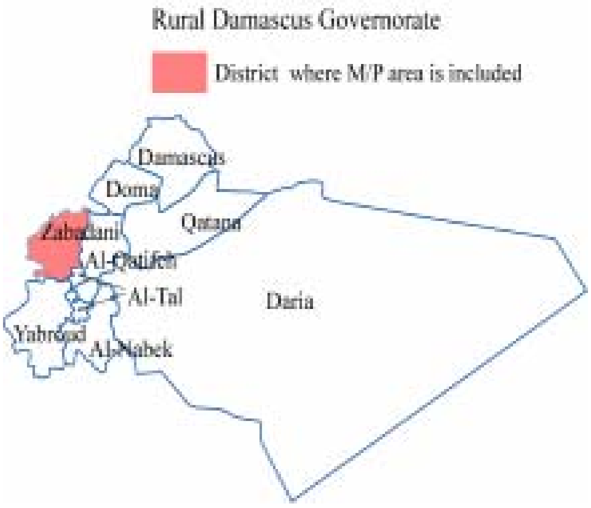


Figure 5.2.8 District Map of Rural Damascus Governorate

Wastewater pumped from the Damascus Governorate is treated and discharged to the farmlands of the Rural Damascus Governorate through several discharge canals. The quality of treated wastewater however, is not appropriate for irrigation. Farmers once tried to reuse the treated water, but the crops and vegetables died. Further introduction of additional treatment shall be taken into account to improve treated wastewater quality.

Though no regional study has been prepared, a sewer network has been designed and installed by the Governorate and by each city council. A detailed sewerage coverage ratio is described in **Table 5.2.12**.

Table 5.2.12 Breakdown of Sub-districts contained and Sewerage Service Ratio in Rural Damascus Governorate (1/2)

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Rural Damascus Center	1	Babyla	11	90%
	2	Al Keswe	1	40%
	3	Kafr Batna	2	40%
	4	Jaramana	6	70%
	5	Arbeen	23	100%
	6	Qodsaya	8	100%
	7	Mleha	7	98%
2. Doma	1	Doma Center	12	95%
	2	Harasta	3	100%
	3	Nashabieh	2	80%
	4	Haran Al Awameed	1	45%
	5	Ghzlanieh	18	55%
	6	Dhmeer	6	90%
	7	Sabe' Bair	9	0%

Table 5.2.12 Breakdown of Sub-districts contained and Sewerage Service Ratio in Rural Damascus Governorate (2/2)

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
3. Daria	1	Daria Center	3	95%
	2	Sehnaya	2	70%
4. Qatana	1	Qatana Center	16	75%
	2	Sa'sa	9	75%
	3	Bait Jin Farm	14	50%
5. Qotifeh	1	Qotifeh Center	3	60%
	2	Jairoud	4	75%
	3	Rohaibeh	4	60%
	4	Ma'lola	1	90%
6. Al Tal	1	Al Tal Center	7	95%
	2	Sednaya	5	90%
	3	Rankous	5	40%
7. Zabadani	1	Zabadani Center	7	57%
	2	Ain Fejeh	6	100%
	3	Madaya	6	51%
	4	Dimas	3	75%
	5	Serghaya	2	95%
8. Nabek	1	Nabek Center	5	50%
	2	Deir Atteih	4	65%
9. Yabroud	1	Yabroud Center	5	75%
	2	Asal Al Ward	2	50%

Note) Sd = Sub-district

There are two existing STP:

Qara STP

The community constructed a small-scale STP, with thedesign prepared by a private company. The Stabilization Pond Method was employed and the design capacity is 600 m^3/day. Reportedly, treatment efficiency is unfavorable.

Harran Al Awameed STP

An experimental STP was constructed through the support of the GTZ in the year 2000. The Constructed Wetland Method was employed as the treatment method. Based on German experience, the plant was designed for 7,000 inhabitants (80% connected, incoming sewage rate = 300 m^3/day) on the basis that the area requirement of 0.5 m^2/capita confirms the suitability of constructed wetland (reed bed system) technology for the treatment of wastewater in Syria. Closely observing the following components:

- Social acceptance
- Relevant legal aspects
- Sustainability
- Operation and maintenance issue
- Economic suitability
- The reuse of the effluent for irrigation use

The treatment flow is as follows:

Incoming Sewage Pit⇒Submergible Pump⇒PVC Pipe⇒Screen⇒Sedimentation Tank⇒ Submergible Pump⇒Reed Bed⇒Effluent Pit⇒Discharge into irrigation channel

Note)
Incoming Sewage Pit : Very deep. Due to surface scum, sewage was not observed.
Sedimentation Tank : Sludge is periodically withdrawn by submergible pump installed in sludge pit and discharged into adjacent storage tank.
Reed Bed : Impermeable seat is installed under the bed for prevention of groundwater contamination.

Table 5.2.13 shows the wastewater quality analysis data performed in this plant. Although analysis was not completed by composit sampling, treatment performance looks excellent in terms of BOD /SS /COD. As to the anticipated nitrogen removal, it seemed unstable because outlet nitrogen concentration is relatively high. According to the analysis, current incoming wastewater volume is 400 m^3/d, exceeding the design capacity of 300 m^3/day, which can be attributed to the unstable nitrogen removal.

For the plant to cope with the growth of wastewater volume, it may be best expand and secure the land adjacent to the existing plant. Upon expansion of additional series, plant operation based on design area requirement of 0.5 m^2/capita and design plant capacity of 300 m^3/d is desirable to maintain sound treatment efficiency.

Table 5.2.13 Wastewater Quality Analysis Data in Harran Al Awameed STP

Date	2006/7/4		2006/3/5	Remarks
	Inlet	Outlet	Outlet	
Cond(μ c/cm)	2,330	2,370	2,060	
pH	7.1	6.9	609	
BOD(mg/l)	240	26	12	
NH_4(mg/l)		32.4	9	
DO(mg/l)	1.3	2.7		
T(℃)	24.3	24.6		
COD(mg/l)	780	80	18.2	
SS(mg/l)		27.2	27.2	
NO_3(mg/l)	50.6	42	14	
TN(mg/l)	46.3	40.6	17.5	
TP(mg/l)	0.49	0.82	1.98	
PO_4(mg/l)	2	3.5	6	
Q（m^3/D）	400	400	400	2006/7/4

Construction cost was 95,900 Euro, Running cost was 7,000 Euro per year.

Aside from these existing STP, another 12 STPs have been studied and designed by the Damascus University and documents needed for tendering have already been submitted to the MHC. Some of them are now under construction. Their current status is shown in **Table 5.2.14**. Mechanical and electrical works were not yet started.

Table 5.2.14 Current Status of STPs designed by Damascus University

No.	Name of STP	Completion ratio of Civil Construction Work
1	Dariya STP	0 %
2	Srghaya STP	0 %
3	Assal El Ward STP	65 %
4	Heganeh STP	95 %
5	Jdaidetel Ghass STP	80 %
6	El Tawanee & Jepaaden STP	80 %
7	Margel Soltan STP	80 %
8	Maydaa STP	75 %
9	Mayddaani STP	75 %
10	Der Macer STP	90 %
11	Beit Saber STP	90 %
12	Beit Jen STP	30 %

(2) Existing Sewerage Development Plans

While no regional plan has been prepared, several studies have, however, been implemented by different donor agencies, as follows:

1) The World Bank : Wastewater Strategic Planning and Priority Investment Study in Barada & Ghouta Gharbiyah

2) Feasibility Study with target year of 2025. Sewerage system plans for Barada & Ghouta Gharbiyah were prepared. Outline of proposed sewerage system is shown in **Table 5.2.15**:

Table 5.2.15 Outline of proposed Sewerage System by the World Bank

Areas	Proposed sewerage system plan
Barada Area	Out of 20 existing communities, 15 were selected as prioritized communities and are planned to be connected to the existing Adraa STP in Damascus through the existing main trunk sewer at Al Hammah..
Ghouta Gharbiyah Area	Out of 27 existing communities, 9 were selected as prioritized communities and are planned to be connected to the two proposed STPs. Stabilization pond method was employed to these two proposed STPs.

Actual project implementation has been suspended though, as the loan agreement has not been signed due to the several management constraints such as the adoption of new sewerage tariff, introduction of institutional framework for sustainable financial management and O&M of sewerage sector by cost recovery.

3) KfW : Water Sector Programme Barada Basin Demascus Rif Governorate

Feasibility Study with target year of 2025. Five communities, namely Yalda, Babyla, Bait Sahem, Aqraba and Saieda Zinab were selected as study area and several alternatives were compared in terms of economical and environmental efficiency. Decentralized system was chosen as the optimum plan and three STPs were planned in Babyla, Aqraba and Saieda Zinab. Extended aeration method was adopted for sewage treatment in all STP.

The disadvantages of the centralized treatment plant are manifold:

- High cost for wastewater conveyance;
- High cost for pumping treated effluent back to upstream irrigation areas;
- Increased resistance by residents close to WWTP site against treatment of wastewater from other areas;
- Increased risk to sewers crossing agricultural lands;
- Reduce choice for phasing; and
- Reduce choice for treatment technology.

Figure 5.2.9 shows the concept of decentralized sewerage system adopted.

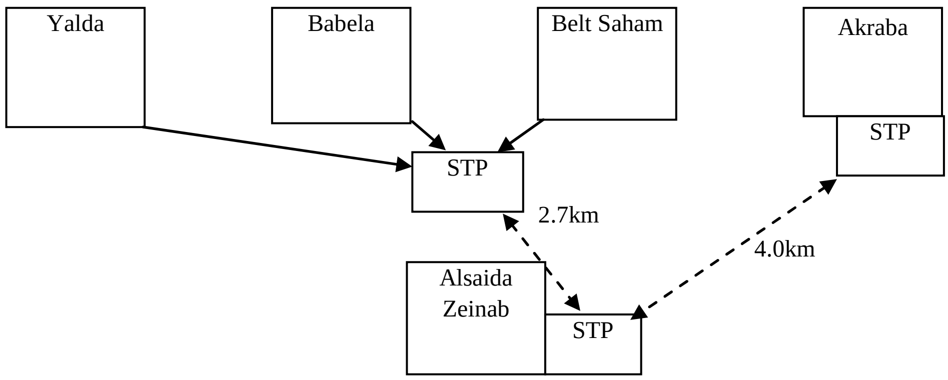


Figure 5.2.9 Schematic Diagram of Proposed Sewerage System

4) UNRWA : Water Supply and Sanitation in Support of Two Palestine Refugee Camps (Khan Dannoun and Khan Eshieh)

Feasibility Study with target year of 2025. This covers the Palestine refugee camps (Khan Dannoun and Khan Eshieh) and their surrounding communities, where two STPs were proposed at Al Keswa and Artous. Extended aeration, sand filter and UV radiation are to be employed for sewage treatment. Sand filter will be introduced as countermeasure for the helminth eggs.

5) Pre-feasibility Study for Zabadani Water and Wastewater Project

This Project is financed by the European Investment Bank (EIB) within the EU framework contract. The consultant who won the project is PLANGROUP (Plancenter Ltd from Finland) and the target year for the study is 2025.

The objective of the project is to protect the Barada River through wastewater treatment and to improve water and wastewater services within the towns (Zabadani, Bluden, Madaya, Bukkein, Hosh Bujd, Rawdah and Ain Hour) located in the catchments area of the Barada River.

The area is popular due to its mild climate during the summer season and the influx of tourists during this season is significant. It has been estimated that the population doubles during the summer months, from May-September.

The amount of wastewater discharged to public sewers is estimated in **Table 5.2.16**. It is projected to increase four times in 2025 compared with that in 2005.

Table 5.2.16 Amount of Wastewater discharged into Public Sewer

(Unit : m^3/day)

Year / Season	2005	2025
Winter	5,378	19,368
Summer	11,701	44,268

In this study, a separate system is recommended. The existing collection system is inadequate therefore, the planned improvement is based on upgrading/ reinforcing the existing facilities in order to convert to storm collection and for a new sewerage system to be planned to collect domestic wastewater only. The proposed work will comprise of the construction of domestic sewerage system applying PVC pipes with flexible joints to accommodate the flow generated in the year of 2025.

One central sewerage treatment plant (STP) is considered to be the most feasible alternative for treatment of all wastewater discharged in the area.

The selected sewerage treatment technology is the activated sludge process with anaerobic, anoxic and aerobic zones, and with internal recirculation of sludge to provide sufficient biological removal of BOD, nitrogen, and phosphorus.

Slow-sand filtration with backwash filters is the recommended tertiary treatment removing solids, and pathogens like nematode eggs etc.

Issues of this plan are as follows:

- A decentralized system shall serve the target area. Especially for Ain Hour, as it is totally isolated and 6 kms away from the Zabadani town.
- The potential irrigation area is located upstream of the proposed STP site.
- For the reuse of treated water, a pumping station is needed.

6) Technical and Financial Assistance from Malaysian Government

Malaysian Government offered a loan to the State Planning Commission (SPC) of Syria for the construction of water treatment plant (WTP) and sewage treatment plant (STP) in Rural Damascus Governorate. The contract is on a turnkey basis and the proposed plants will be designed, built, installed, commissioned and handed over to Syrian government. The Malaysian Study Team is now preparing Master Plan for water supply and sewerage system.

15 WTP and 23 STP will be designed and constructed within 39 months. This contract includes O&M training to Syrian staff.

Their planned STPs list is shown below:

Table 5.2.17 List of STP to be constructed by Malaysian Government

No.	Name of STPs
1	Dhmeer STP
2	Al Qotifeh STP
3	Robaiheh STP
4	Hfeer Foka STP
5	Al Qastal STP
6	Ras Al Ma’arah STP
7	Nabek STP
8	Al Jarajeer STP
9	Al Hamerah STP
10	Al Jabah STP
11	Al Nasereah STP
12	Tofail STP
13	Housh Arab STP
14	Ain Al Teneh STP
15	Rankoos STP
16	Hafeer Al Tahta STP
17	Ma’araba STP

Out of total number of 23, locations of these 17 STPs were confirmed. Needless to mention, they all were situated within Damascus Rural Governorate.

5.2.8 Aleppo Governorate

(1) Existing Sewerage Facilities

The Allepo Governorate is located in the north of the Syria, facing the southern border of Turkey. Allepo City is a historic place of glory and prosperity since 3rd millennium B.C. Until now, Allepo dominates the trade routes connecting the East and West. Allepo is the second largest city in Syria and still plays a key economic role. A district map is shown in **Figure 5.2.10**.

Figure 5.2.10 District Map of Aleppo Governorate

Based on the regional plan, a sewer network has been installed by the MLAE, and the Governorate by each city council. The detailed sewerage coverage ratio is shown in **Table 5.2.18**.

Table 5.2.18 Breakdown of Sub-districts contained and Sewerage Service Ratio in Allepo Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Jabal Sama'an	1	Jabal Sama'an Center and Surrounding Communities	162	86%
	2	Atareb	24	85%
	3	Tal Dhamah	113	75%
	4	Haretan	21	75%
	5	Dar Ta'zeh	15	80%
	6	Zarba	44	90%
2. A'zaz	1	A'zaz Center and Surrounding Communities	20	80%
	2	Akhtareen	47	65%
	3	Tal Ref'at	13	75%
	4	Mare'a	19	95%
	5	Nabel	12	90%
	6	Sovran	23	65%
3. Al Bab	1	Al Bab Center and Surrounding Communities	28	80%
	2	Tadef	24	75%
	3	Deir Hafer	12	70%
	4	Al Ra'ie	31	80%
	5	Aremeh	33	55%
	6	Rasm Harmal Al Emam	24	60%
	7	Kwers Sharqi	21	70%
4. Jarablos	1	Jarablos Center and Surrounding Communities	35	90%
	2	Ghandorah	30	90%
5. Al Sfeerah	1	Al Sfeerah Center and Surrounding Communities	39	75%
	2	Khanaser	30	65%
	3	Banan	11	80%
	4	Al Hajeb	22	40%

Table 5.2.18 Breakdown of Sub-districts contained and Sewerage Service Ratio in Allepo Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
6. Afreen	1	Afreen Center and Surrounding Communities	44	93%
	2	Bol bol	33	85%
	3	Janderas	37	85%
	4	Rajo	46	90%
	5	Sharan	37	75%
	6	Sheikh Al Haded	14	55%
	7	Ma'dbatle	35	70%
7. Ain Al Arab	1	Ain Al Arab Center and Surrounding Communities	74	70%
	2	Sheiokh Tahtani	30	65%
	3	Saren	112	70%
8. Manbej	1	Manbej Center and Surrounding Communities	137	70%
	2	Abu KalKal	47	90%
	3	Khafseh	85	90%
	4	Maskaneh	44	65%

Note) Sd = Sub-district

The Aleppo City STP still exists and is operated utilizing the Aerated Lagoon Method since 2002 with a design capacity of 345,600 m^3/day for a present population of 1,800,000. The treatment performance is very poor, especially during winter as the temperature largely affects on the kind of method used.

As shown in **Table 5.2.19**, performance and inlet wastewater quality is different each season. All it means is that there has been insufficient study on fundamental conditions such as temperature, mechanical/biological treatment efficiency and industrial wastewater quality. It is suggested that a plant rehabilitation that considers the mechanical/biological efficiency during winter period and inlet wastewater quality be made as soon as possible.

Generally, the Lagoon Method is suitable for treatment of domestic wastewater targeted for irrigation re-use but this is not suitable for industrial wastewater. If industrial wastewater is contained in the sewer network, it must be accepted, but rather be treated by the company's own treatment plant.

Table 5.2.19 Treatment Performance in Aleppo STP

		Summer			Winter		
		Incoming	Effluent	Removal Rate(%)	Incoming	Effluent	Removal Rate(%)
BOD	Year 2002 (mg/L)	340	120	64.7	380	145	61.8
	Year 2003 (mg/L)	340	82.5	75.7	375	110	70.7
COD	Year 2002 (mg/L)	550	135	75.5	560	140	75.0
	Year 2003 (mg/L)	550	140	74.5	520	150	71.2
SS	Year 2002 (mg/L)	495	160	67.7	560	195	65.2
	Year 2003 (mg/L)	500	130	74.0	600	180	70.0

(2) Existing Sewerage Development Plans

There was a regional plan prepared by GCEC in 1997. Outline of sewerage facility design is shown in **Table 5.2.20**.

Table 5.2.20 Outline of the planned Sewerage Facilities in Aleppo Governorate

Name of STP	Beginning Diameter (mm)	End Diameter (mm)	Length (m)	Population in 2030	Capacity (L / sec)	Treatment Method
Nobbol-maaret Al-arteek	400	1,200	30,000	200,000	1,450	Extended Aeration
Al bab-Arran	400	1,400	16,000	500,000	3,230	Extended Aeration
Manbej	400	1,000	6,200	150,000	1,110	Extended Aeration
Batbo-Kafrnouran	400	1,000	15,000	120,000	910	Extended Aeration
Tal-hasel Al-sfeera	300	1,000	13,000	140,000	1,045	Extended Aeration
Ein-Alarab Al-hajeb	300	800	10,000	87,000	680	Extended Aeration
Ras-Alhomr Al-khafsa	300	600	12,000	35,000	305	Extended Aeration

There is no relevant study executed by foreign donor agencies.

5.2.9 Hama Governorate

(1) Existing Sewerage Facilities

The Hama Governorate is located in west central part of Syria. It is well-known for its old waterwheels, some as large as 27 m in diameter. These waterwheels bring water up from Orontes River for irrigation. The district map is shown in **Figure 5.2.11**.

Figure 5.2.11 District Map of Hama Governorate

Based on the regional plan, a sewer network has been installed with financial support from the MLAE, the Governorate or by each city council. The detailed sewerage coverage ratio is shown in **Table 5.2.21**.

Table 5.2.21 Breakdown of Sub-districts contained and Sewerage Service Ratio in Hama Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Hama	1	Hama Center and Surrounding Communities	99	93%
	2	Hrbnfseh	26	80%
	3	Hamra'a	39	96%
	4	Sovran	22	65%
2. Al Salameih	1	Salameih Center and Surrounding Communities	42	70%
	2	Bara Al Sharqi	14	98%
	3	Sa'en	17	90%
	4	Saborah	20	64%
	5	Akerbat	22	98%
3. Al Skelbeih	1	Skelbeih Center and Surrounding Communities	32	92%
	2	Tal Salhab	22	85%
	3	Ziara	18	60%
	4	Shatha	12	85%
	5	Al Madeek Citadel	30	79%
4. Mhardeh	1	Mhardeh Center and Surrounding Communities	21	80%
	2	Kafer Zaita	9	84%
5. Msiaf	1	Msiaf Center and Surrounding Communities	33	60%
	2	Jeb Ramleh	20	98%
	3	Aovej	13	75%
	4	Ain Hlakeem	18	95%
	5	Wadi Al Aioun	21	92%

Note) Sd = Sub-district

The Salameih STP is currently operating in the area. Its plant capacity is 7,000 m^3/day and it uses the Stabilization Pond Method. Due to the population increase, the STP shall be expanded and a study for its expansion is now ongoing.

Furthermore, the Hama City STP is now under construction. It has a design plant capacity of 70,000 m^3/day for the 1st stage and 140,000 m^3/day for 2nd stage and will use the Conventional Activated Sludge Method. Alongside the said construction, studies are currently in place for the Shaizar & Mhardeh Cities STPs. The design plant capacity is 6,600 m^3/day and the extended aeration method will be adopted.

(2) Existing Sewerage Development Plans

The GCEC prepared a regional plan in 1997. The outline of the sewerage facility design is shown in **Table 5.2.22**.

Table 5.2.22 Outline of the planned Sewerage Facilities in Hama Governorate

Name of STP	Beginning Diameter (mm)	End Diameter (mm)	Length (m)	Population in 2030	Capacity (L / sec)	Treatment Method
Al Morana	300	500	12,000	20,000	175	Extended Aeration
Balshona	300	400	3,000	15,000	140	Extended Aeration
Kfr-Takharem	300	600	18,500	30,000	244	Extended Aeration
Sheikh Yousif	300	400	6,000	12,000	115	Extended Aeration
Al Karina	300	300	8,000	4,000	45	Extended Aeration
Kfr Bouhm	300	600	13,000	45,000	350	Extended Aeration
Al Nahr Al Barid	300	400	8,000	15,000	140	Extended Aeration
Al Nasriya	300	400	3,000	15,000	140	Extended Aeration
Kafr Moud	300	400	5,000	10,000	95	Extended Aeration
Ma'ardes	300	600	8,000	28,000	230	Extended Aeration
Msiaf-Bkrana	300	600	6,000	35,000	280	Extended Aeration
Souran	300	1,000	5,500	134,000	930	Extended Aeration
Tal Al Tout	300	500	12,500	19,500	168	Extended Aeration
Al Mahrousa	300	500	15,000	20,000	175	Extended Aeration
Hialeen	300	600	20,000	35,000	280	Extended Aeration
Al Atmaneh	300	600	12,000	28,000	230	Extended Aeration
Kahef-habash	300	300	7,000	4,500	55	Extended Aeration
Um-Al Tyour	300	400	14,000	12,000	115	Extended Aeration
Al Zena-Slhab	300	600	24,000	35,000	280	Extended Aeration
Bdama	300	400	6,000	7,500	78	Extended Aeration
Fateera	300	400	17,000	12,000	115	Extended Aeration
Al Deer-Al Krbeh	300	900	24,000	60,000	450	Extended Aeration
Krnaz	300	600	14,000	30,000	244	Extended Aeration

There is no relevant study executed by foreign donor agencies.

5.2.10 Homs Governorate

(1) Existing Sewerage Facilities

The Homs Governorate is situated in the south of the Hama Governorate. Since the ancient times, its midway location has made it a principal crossroad. Today Homs still plays this vital role. It contains important oil refinery and many major factories, plants and mills. A district map is shown in **Figure 5.2.12**.

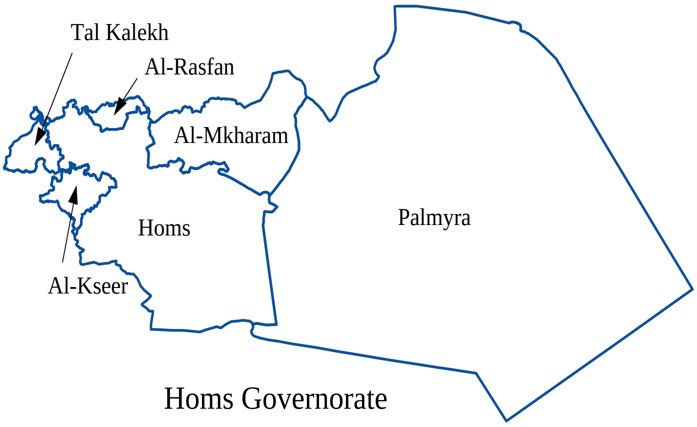


Figure 5.2.12 District Map of Homs Governorate

Based on the regional plan, sewer network has been installed by the MLAE, Governorate or by each city council. The detailed sewerage coverage ratio is shown in **Table 5.2.23**.

Table 5.2.23 Breakdown of Sub-districts contained and Sewerage Service Ratio in Homs Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Homs	1	Homs Center and Surrounding Communities	66	95%
	2	Taldo	22	50%
	3	Hasya	8	65%
	4	Khrbet Teen Nour	39	70%
	5	Rakama	20	25%
	6	Sadad	2	70%
	7	Ain Al Neser	16	90%
	8	Ferkelous	29	55%
	9	Kareten	2	70%
	10	Mheen	5	75%
	11	Khrbet Al Kabou	6	65%
2. Palmyra	1	Palmyra Center and Surrounding Communities	5	80%
	2	Sokhneh	6	35%
3. Tal Kalekh	1	Tal Kalekh Sha'ra Center and Surrounding Communities	41	90%
	2	Hadida	24	70%
	3	Sheen	27	50%
	4	Naserah	20	60%
	5	Hawash	17	40%
4. Al Rasfan	1	Al Rasfan Center and Surrounding Communities	13	80%
	2	Talbeseh	16	60%
5. Al Kseer	1	Al Kseer Center and Surrounding Communities	52	97%
6. Al Mkharam	1	Al Mkharam Center and Surrounding Communities	30	70%
	2	Jeb Al Jarah	31	65%

Note) Sd = Sub-district

The existing STP is the Homs STP which has been operating using the Activated Sludge Method since 1998. Its present plant capacity is 133,900 m^3/d, for a population of 550,000. Treatment performance is quite unfavorable due to the quality of industrial wastewater. Two separate lines collect wastewater: the Sugar Line for the industrial wastewater and the Regular line for domestic wastewater. Refer to **Figure 5.2.13** to **5.2.14**.

As shown in **Table 3.3.2,** “The maximum limit of industrial pollutants permitted to be discharged to the sewer network” stipulates the COD concentration limit as 1,600 mg/l. Incoming COD in sugar line apparently exceeds this limit. Being beyond public responsibility, a pre-treatment plant must be put up by sugar industries by legal arrangement. For the regular line, high concentration is also evident, which could greatly mean the possibility of industrial wastewater intrusion. Discharge of industrial wastewater must be monitored and controlled by the MLAE.

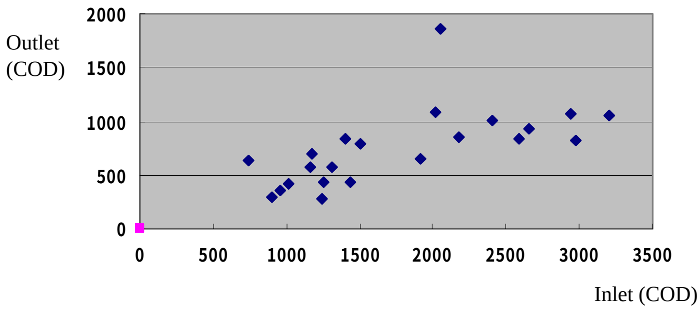


Figure 5.2.13 Incoming and Treated Wastewater Quality in Homs STP (Sugar Line-Nov/2006)

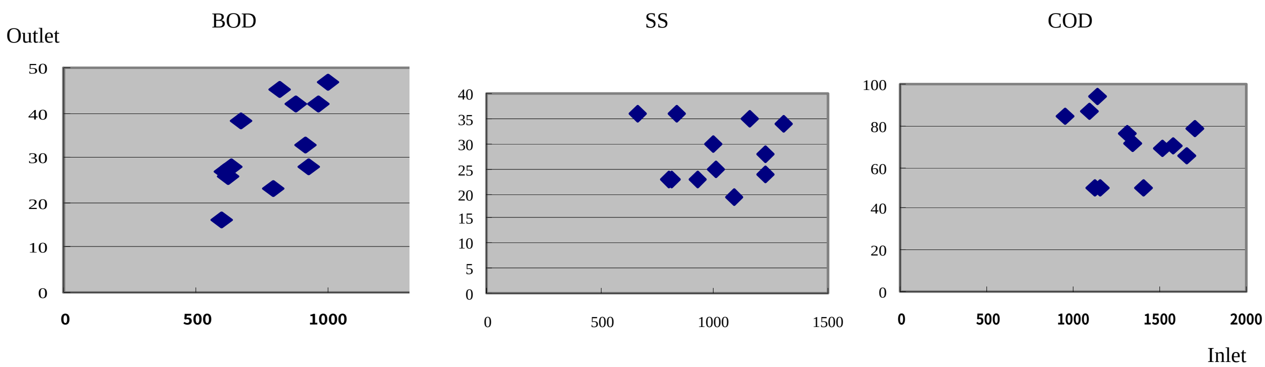


Figure 5.2.14 Incoming and Treated Wastewater Quality in Homs STP (Regular Line-2006)

(2) Existing Sewerage Development Plans

The regional plan was prepared by the GCEC in 1997. Outline of sewerage facility design is shown in **Table 5.2.24**.

Table 5.2.24 Outline of the planned Sewerage Facilities in Homs Governorate

Name of STP	Beginning Diameter (mm)	End Diameter (mm)	Length (m)	Population in 2030	Capacity (L / sec)	Treatment Method
Al Fadlieh	300	600	7,500	27,000	224	Extended Aeration
Rablah	300	400	3,500	12,000	115	Extended Aeration
Al Souaire	300	600	6,800	27,000	224	Extended Aeration
Al Isma'iliya	300	600	16,000	50,000	380	Extended Aeration
Tarin	300	900	22,000	60,000	450	Extended Aeration
Sheen	300	600	17,000	28,000	230	Extended Aeration
Al Moshrefeh	300	600	7,000	45,000	350	Extended Aeration
Ain Al Naser	300	400	12,000	20,000	175	Extended Aeration
Al Bouaida	300	400	8,500	10,500	102	Extended Aeration
A'abel	300	400	6,800	8,500	82	Extended Aeration
Balka	300	400	5,000	8,000	80	Extended Aeration
Al Riyat	300	400	10,000	8,500	82	Extended Aeration
Al Ghajar-Ameer	300	500	10,500	20,000	175	Extended Aeration
Al Kabou-Al Sharakliya	300	500	4,000	25,000	210	Extended Aeration
Al Kniseh	300	400	6,000	15,000	140	Extended Aeration

There is no relevant study executed by foreign donor agencies.

5.2.11 Idleb Governorate

(1) Existing Sewerage Facilities

Idleb Governorate is located in northwestern Syria, bordering Turkey. As it is located in broad olive woods, it has a temperate climate in the summer, and a cold rainy one in winter. The surrounding countryside is most attractive: gently rolling upland where the red soil contrasts with the green of plants and trees. A district map is shown in **Figure 5.2.15**.

Based on the regional plan, a sewer network has been installed by MLAE, the Governorate or by each city council. Detailed sewerage coverage ratio is indicated in **Table 5.2.25**.

Figure 5.2.15 District Map of Idleb Governorate

Table 5.2.25 Breakdown of Sub-districts contained and Sewerage Service Ratio in Idleb Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Idleb	1	Idleb Center and Surrounding Communities	18	95%
	2	Abu Al Dhour	25	81%
	3	Banesh	3	90%
	4	Taftanaz	5	77%
	5	Sarakeb	22	85%
	6	Ma'er Tamsreen	16	98%
2. Areeha	1	Areeha Center and Surrounding Communities	24	96%
	2	Ehsem	19	87%
	3	Mhambal	17	90%
3. Jisr Al Shoghur	1	Jisr Al Shoghur Center and Surrounding Communities	33	94%
	2	Bedama	13	95%
	3	Darkoush	14	95%
	4	Al Janodeih	13	98%
4. Harem	1	Harem Center and Surrounding Communities	5	100%
	2	Dana	11	85%
	3	Salkeen	21	97%
	4	Kafer Takhareem	22	95%
	5	Kour Kenia	15	96%
5. Ma'ret Al No'man	1	Ma'aret Al No'man Center and Surrounding Communities	29	81%
	2	Khan Sheikhoun	9	82%
	3	Senjar	68	66%
	4	Kafer Nabel	21	86%
	5	Heesh	14	75%

Note) Sd = Sub-district

The Idleb STP is presently under construction. It has a plant capacity of 29,900 m^3/day at phase one and shall be expanded in 2015 up to 51,000 m^3/day for phase two. The Stabilization Pond Method will be employed.

Another STP, the Areiha STP, is now being planned for implementation but detailed information is unavailable..

(2) Existing Sewerage Development Plans

The GCEC prepared a regional plan in 1997. Outline of sewerage facility design is shown in **Table 5.2.26**.

Table 5.2.26 Outline of the planned Sewerage Facilities in Idleb Governorate

Name of STP	Beginning Diameter (mm)	End Diameter (mm)	Length (m)	Population at 2030	Capacity (L / sec)	Treatment Method
Trmaneen-Aldand	300	600	7,100	71,000	570	Extended Aeration
Kafr-batteekh Maardebsi	300	500	2,750	31,900	305	Extended Aeration
Al-sheikh Idrees	300	400	2,600	9,400	96	Extended Aeration
Loof	300	500	6,300	23,000	215	Extended Aeration
Deir-sharki babeela	300	800	13,200	121,000	915	Extended Aeration
Taftanaz	300	600	8,500	71,000	570	Extended Aeration

There is no relevant study executed by foreign donor agencies.

5.2.12 Sweida Governorate

(1) Existing Sewerage Facilities

The Sweida Governorate is located in the eastern south of Damascus Governorate; the Rural Damascus Governorate on the north and the Dar'aa Governorate on the west. It has a temperate climate in the summer time, and cold one in winter. A district map is shown in **Figure 5.2.16**.

Figure 5.2.16 District Map of Sweida Governorate

Based on the regional plan, sewer network has been designed by GCEC or private company under the order of Governorate or by each city council. Upon completion of the network design, it was submitted to the MLAE for their technical review and finance computation. Thus, the sewerage network has been developed under the financial support of the MLAE. The detailed sewerage coverage ratio is shown in **Table 5.2.27**.

Table 5.2.27 Breakdown of Sub-districts contained and Sewerage Service Ratio in Sweida Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Al Sweida	1	Al Sweida Center and Surrounding Communities	34	65%
	2	Sejen	12	4%
	3	Mshanaf	14	0%
2. Shahba	1	Shahba Center and Surrounding Communities	12	62%
	2	Shakka	11	0%
	3	Sovra	13	0%
	4	Areeka	9	17%
3. Salkhad	1	Salkhad Center and Surrounding Communities	13	64%
	2	Karba	4	60%
	3	Meleh	11	88%
	4	Al Ghareia	4	47%
	5	Debeen	3	34%

Note) Sd = Sub-district

Although there is no existing STP as of the present time, the Sweida City STP is now being studied by a Spanish design company. With a design plant capacity of 18,750 m^3/day, it will be expanded to 34,500 m^3/day in the year of 2015.

(2) Existing Sewerage Development Plans

There was a regional plan prepared by GCEC in 1997. The outline of sewerage facility design is shown in **Table 5.2.28**.

Table 5.2.28 Outline of the planned Sewerage Facilities in Sweida Governorate

Name of STP	Beginning Diameter (mm)	End Diameter (mm)	Length (m)	Population in 2030	Capacity (L / sec)	Treatment Method
Kanawat Atel	400	800	6,000	6,000	62	Extended Aeration
Maf'aleh Atel	400	800	9,000	4,000	45	Extended Aeration
Rassas	500	800	9,000	6,000	62	Extended Aeration
Al Ghida	600	800	6,000	5,000	51	Extended Aeration
Rashidi	600	600	8,000	5,000	51	Extended Aeration

There is no relevant study executed by foreign donor agencies.

5.2.13 Qunetra Governorate

(1) Existing Sewerage Facilities

The Qunetra Governorate is located at the North eastern side of the Al-Yarmouk basin region. The land is characterized by volcanic origin fertile soil, a superabundance of springs, rainfalls and snow falls, and the diversity of its climate attracts a lot of tourists. The district map is shown in **Figure 5.2.17**.

A sewer network is continuously being developed and its detailed sewerage coverage ratio is shown in **Table 5.2.29**.

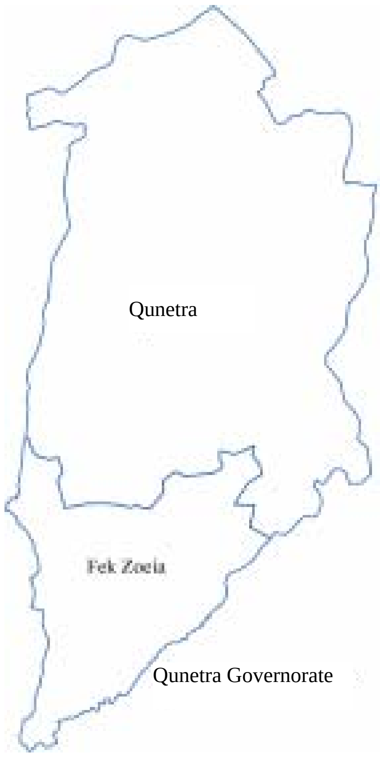


Figure 5.2.17 District Map of Qunetra Governorate

Table 5.2.29 Breakdown of Sub-districts contained and Sewerage Service Ratio in Qunetra Governorate

Name of District	Name of Sub-district belonging		No. of Communities belonging	Sewerage Service Ratio in Sd center
1. Quniera City Center	1	Qunitera City Center	39	90%
	2	Khan Arnebeh City	19	80%
	3	Khshneih	28	60%
	4	Mas'ada	32	0%
2. Fek Zoeia	1	Fek Zoeia	32	70%
	2	Bteiha	18	0%

Note) Sd = Sub-district

Due to the political restrictions, Mas'ada and Bteiha are not inhibited.

There is no existing STP and therefore, raw sewage is discharged into natural water courses nearby which contributes to water contamination in public water bodies and in the groundwater.

(2) Existing Sewerage Development Plans

A regional plan was prepared by GCEC in 1997. The outline of sewerage facility design is shown in **Table 5.2.30**.

Table 5.2.30 Outline of the planned Sewerage Facilities in Qunetra Governorate

Name of STP	Beginning Diameter (mm)	End Diameter (mm)	Length (m)	Population in 2030	Capacity (L / sec)	Treatment Method
Al Rakad Valley	400	1,200	15,500	30,000	240	Extended Aeration
Brika and B'er Ajam	400	600	4,300	3,000	37	Extended Aeration
Swisa and Korkos	500	800	8,500	10,000	96	Extended Aeration
Nabe'e Al Sukher	400	800	3,500	14,000	130	Extended Aeration
Momtaneh	600	800	2,500	3,500	45	Extended Aeration
Al Rafeed	400	800	3,500	19,000	165	Extended Aeration
Ghadeer Al Bostan	400	600	4,000	6,000	262	Extended Aeration
Jabaa	-	-	-	10,000	96	
Hadar	-	-	-	10,000	96	
Mashara	-	-	-	5,000	51	

There is no relevant study executed by foreign donor agencies.

5.2.14 Damascus Governorate

(1) Existing Sewerage Facilities

This Governorate is the national capital of Syrian Arab Republic.

Urban Infrastructure has been highly developed throughout the Governorate and water supply and sewerage system covers the whole area. The location map is shown in **Figure 5.2.18** and detailed sewerage coverage ratio is described in **Table 5.2.31**.

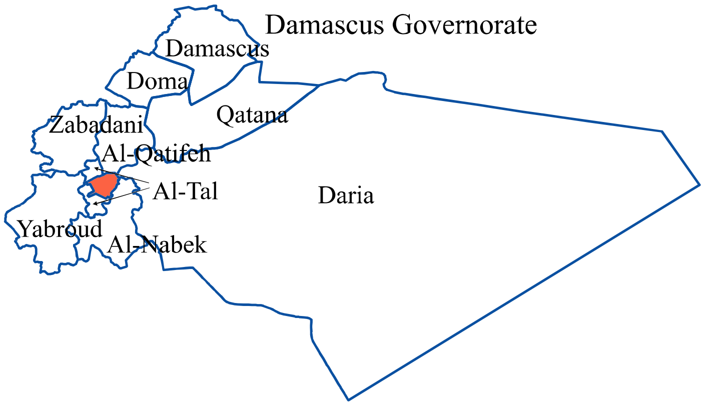


Figure 5.2.18 Location Map of Damascus Governorate

Table 5.2.31 Breakdown of Sub-districts contained and Sewerage Service Ratio in Damascus Governorate

Name of District	Name of Sub-district belonging		Sewerage Service Ratio in Sd center
1. Damascus	1	Asad Al Din	99%
	2	Nakshabandi	95%
	3	Ayobiya	95%
	4	Abu Jarash	92%
	5	Salhiya	95%
	6	Shoura	100%
	7	Mastabeh	100%
	8	Mrabet	100%
	9	Ghareb Al Malki	100%
	10	Kiwan	98%
	11	Rabweh	90%
	12	Mazzeh	95%
	13	Old Mazzeh	95%
	14	Dummar	90%
	15	Mazra'a	100%
	16	Rawda	100%
	17	Sarouja	98%
	18	Hijaz	100%
	19	Kanawat	98%
	20	Bab Sreijeh	98%
	21	Ansari	99%
	22	Baramkeh	100%
	23	Kafer Soseh	95%
	24	Iwan	90%
	25	Kadam	92%
	26	Zehira	97%
	27	Ka'aa	100%
	28	Jame' Dakak	99%
	29	Hakleh	99%
	30	Bab Maser	99%
	31	Midan Westani	98%

Table 5.2.31 Breakdown of Sub-districts contained and Sewerage Service Ratio in Damascus Governorate

Name of District	Name of Sub-district belonging		Sewerage Service Ratio in Sd center
	32	Bab Msala	100%
	33	Bilal	97%
	34	Dawamneh Karawneh	97%
1. Damascus	35	Al Ameen	99%
	36	Srouje	99%
	37	Shaghour	94%
	38	Bab Al Jabeih	100%
	39	Sweika	98%
	40	Tijari	100%
	41	Ma'dhanet Al Shahem	100%
	42	Kemareih	100%
	43	Akeibeh	95%
	44	Masjed Al Aksab	95%
	45	Amarah	95%
	46	Bab Toma	98%
	47	Bab Sharqi	98%
	48	Jobar	97%
	49	Diwanieh	100%
	50	Kosour	100%
	51	Ma'Monieh	95%
	52	Fares Al Khouri	100%
	53	Kasr Al labad	97%
	54	Zainabieh	97%
	55	Kaboun	98%
	56	Barzeh Al Balad	98%
	57	Tadamon	95%
	58	Wahdeh	97%
	59	Al Dwela'a	98%

Note) Sd = Sub-district

There is one existing Pump Station and one STP in this Governorate, the Yarmok PS and Adraa STP, respectively.

(1) Yarmok PS

As Damascus City is situated in hemi-cone-shaped alluvial fan, wastewater is conveyed through trunk sewers installed along the river. Therefore, there is no transmission pumping station in Damascus City.

The Yarmok PS has been in operation since 1998 to transport wastewater generated in areas where connected to this PS to the force main running through Damascus City with total length of four kms and diameter of 2,000 mm.

It is equipped with five units of vertical centrifugal pumps with diameter of 1,000 mm. Total nominal pump capacity of 240,000 m^3/day was planned for wet weather wastewater flow, of which 30,000 m^3/d was estimated as domestic wastewater flow. The Yarmok PS has vast site area and incoming wastewater is screened and pumped.

(2) Adraa STP

In the end of 1997, a biological treatment system was established in the northeast side of Al Ghouta in Adraa in order to treat the domestic wastewater of Damascus City and some surrounding villages. The wastewater treatment process being applied is the activated sludge method and currently the plant is approximately treating 300,000 m^3/d. Reportedly, the design plant capacity is 485,000 m^3/day. It seems as if it has surplus treatment capacity against the present incoming wastewater volume. However, as 42 units of aeration tanks are now in operation and the capacity of each tank is 1,700m^3, aeration time by current plant operation is:

Aeration Time = 1,700×42 【total capacity of aeration tank operated】
÷（300,000/24）【hourly incoming wastewater amount】= 5.7 hours

According to Japanese guidelines, required aeration time for conventional aerated sludge method is 6 to 8 hours. Apparently, aeration time attained by current operation is insufficient.

Total number of existing aeration tank is 56. Expected aeration time against the design plant capacity is:

Aeration Time = 1,700×56 【total capacity of aeration tank operated】
÷（485,000/24）【hourly incoming wastewater amount】= 4.7 hours

This means additional remedial measures are inevitable to ensure a stable and sound plant function through the future.

1) Present condition and suggestion

The present condition and suggestions on remedial measure were summarized in **Table 5.2.32**:

Table 5.2.32 Present Condition of Adraa STP and Applicable Remedial Measures (1/2)

<table>
<tr><th>Issues</th><th>Present Status</th><th>Applicable Remedial Measures</th></tr>
<tr><td>Re-use of treated wastewater</td><td>Treated wastewater contains high concentration of nutrients, farmers have not been utilized it affirmatively.</td><td>Introduction of additional treatment shall be examined to upgrade the quality of treated wastewater.</td></tr>
<tr><td>Insufficient aeration time</td><td>Compared with incoming wastewater flow, total capacity of currently operated aeration tank is not enough to attain proper treatment efficiency.

Total capacity of existing aeration tank is 95,200 m^3. Based on this total capacity of existing aeration tanks, actual plant capacity was calculated with standard BOD-SS loading of 0.3 kgBOD/kgSS day, incoming BOD concentration of 300 mg/l and MLSS of 2,500 mg/l.
Result was 238,000 m^3/day. Compared with design capacity of 485,000 m^3/day, actual plant capacity is too small.

Incoming BOD concentration of 300 mg/l was set based on incoming BOD data shown in Figure 5.2.19. It's higher than 90% of those of total samples.</td><td>There is a total of 56 existing aeration tank .
To secure necessary aeration time against incoming wastewater flow, number of aeration tank in operation shall be increased.

Additional construction of aeration tank or introduction of high-efficiency aeration device is needed to secure necessary aeration time.

Maintenance of necessary aeration time will lead to the improvement of treated wastewater quality.</td></tr>
<tr><td>Return Supernatant from Sludge Treatment Process</td><td>Return supernatant from sludge treatment process is currently discharged into the pit just upstream of inlet PS. It seems that this return supernatant has been aggravated sewage treatment efficiency.
According to the wastewater quality analysis on samples taken at a) Inlet(without supernatant) and b) discharge pit of inlet PS(with supernatant), results were as follows:
<table><tr><th>Indices</th><th>Inlet</th><th>Pump Discharge</th></tr><tr><td>SS</td><td>136</td><td>258</td></tr><tr><td>COD</td><td>275</td><td>435</td></tr></table>Date) 5th July 2006

This apparently shows the adverse effect by the said supernatant.</td><td rowspan="2">To terminate the discharge of supernatant generated in sludge treatment process, its operation must be terminated.

Operation of sludge thickening and anaerobic sludge digestion process shall be stopped.

Withdrawn sludge shall be directly discharged to sludge drying bed only as a temporally measure.

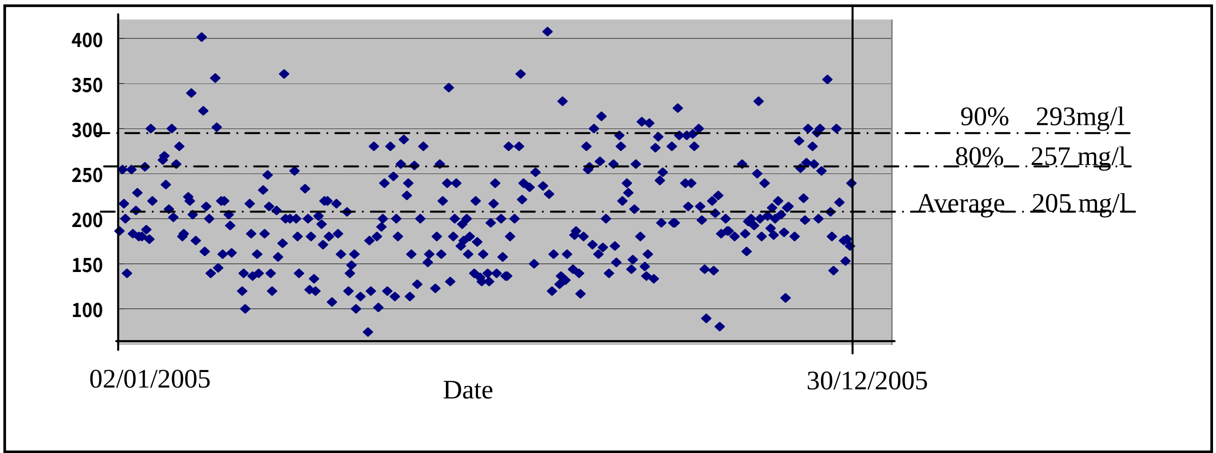
As sludge drying bed has odor issue, it cannot be long-term solution. As stated earlier, land for additional aeration tank might be needed in the future.
Since generated sludge amount increases through the future, drastic countermeasure shall be proposed to attain stable sludge treatment performance.

Employment of mechanical sludge dewatering unit is applicable. Existing vast land occupied by sludge drying bed can be utilized to construct additional aeration tanks.

Cleaning of existing digestion tank.
Introduction of mechanical sludge mixing device to digestion tank can be another option to optimize the existing tanks.

Sludge composting can be another option of sludge treatment but market research to farmers shall be conducted in advance. Upon planning of composting of generated sludge, introduction of fermentation process is indispensable to reduce the sludge volume and to stabilize the nature of the products. This process is also effective in extinction or inactivation of parasite eggs and germs.</td></tr>
<tr><td>Low efficiency in Sludge Treatment Process</td><td>The JICA Study Team observed that primary sludge was very thick. This might have been caused low efficiency in the Sludge Digestion process as sludge mixing with gas is supposed to be unsuccessful owing to the said sludge nature. This resulted in poor fermentation in digestion tank.

Low efficiency can be verified by analysis result on VSS:
<table><tr><th>Indices</th><th>Before Digestion</th><th>Digested Sludge</th></tr><tr><td>VSS (%)</td><td>58</td><td>47.9</td></tr></table>Date) 5th July 2006</td></tr>
</table>



Source) Adraa STP Laboratory Record

Figure 5.2.19 Annual BOD Data in Adraa STP

(2) Existing Sewerage Development Plans

Needless to say, this Governorate is the national capital and therefore, urban infrastructures are been highly developed throughout. Although there is no regional plan, water supply and sewerage system development in this Governorate has been prioritized and the network design has the highest precedence. As shown in **Table 5.2.31**, sewerage service ratio in areas comprising Damascus City is almost 100%. However, due to the pipe deterioration in some areas, namely Old Damascus, pipe renewal works were prepared and partially implemented.

As sewerage development in Damascus City is almost completed, no relevant study was executed by foreign donor agencies for any new sewerage system development. Damascus City is in undergoing rehabilitation of its urban infrastructures.

5.2.15 Major Issues and Countermeasures

Table 5.2.33 Major Issues and Countermeasures (Sewage Treatment Plant)

No.	Issues	Countermeasures
1	Compared with the progress of STP construction, that of sewer network development is relatively smooth. This is largely due to administrative delineation of responsibilities for sewerage works and capability of domestic design firms. In case of sewer network, each city, town or municipality can contract out their specific network design to any design firm and can ask budgetary support from the MLAE. In the case of the STP, designs for it have been contracted out as the GCEC cannot design the facility and do not have sufficient technical know-how. This led to the delay in STP construction. Due to the absence of a STP, raw wastewater is discharged into public water bodies causing severe water quality pollution.	It is common to all technologies. The most important idea is "introduction of Appropriate Technology" Construction of STP is not the end in itself. Proper O&M activities are indispensable to maintain sound STP function. Appropriate treatment method that can be operated and maintained by locally available O&M skill shall be chosen. In this regard, "Wet Land Method" seems to be applicable since two STPs employed this method have been functioning quite well in Harran Al Awameed in Rural Damascus Gov. and Thawra in Raqqa Gov. Further, Oxidation Ditch Method is also recommended, as this method needs no complicated O&M skill and is cost-efficient.
2	As aforementioned, operation of three existing STPs in Raqqa Gov. was terminated due to the lack of O&M capacity. Refer to page **5-18**.	To optimize the completed STPs, capable O&M staff shall be immediately dispatched to resume plant operation. However, training of qualified O&M staff will take long, contracting out of O&M activity to a private firm shall be examined as one applicable option.

Table 5.2.34 Major Issues and Countermeasures (Trunk Sewer and Sewer Network)

No.	Issues	Countermeasures
1	Inappropriate pipe laying and connection, especially in the case of concrete pipes were observed and reported in many places. Some concrete pipes were laid directly on the bottom of the ditch without pipe bedding. This may cause pipe destruction by external load. Pipe strength is inferior. Some pipes are not even reinforced by steel bars. Pipe connection structure is also not precisely manufactured. Wastewater is leaking from such connections that were improperly done causing groundwater contamination, and where wastewater may also infiltrate into water supply pipe network.	To protect pipes from destruction by external load, proper pipe bedding shall be installed. The MHC shall instruct contractors. Strict pipe specifications and pipe quality inspection test procedures shall be issued and be enforced. Quality of domestic concrete is inferior. Due to the poor manufacture of connections, pipe connections are not water-tight. Adoption of other pipe materials namely, Poly-Vinyl Chloride (PVC) Pipe and Poly-Ethylene (PE) Pipe shall be taken into account, since they are manufactured in Syria. Compared to concrete pipes, their unit cost is not so high and is negligible when future pipe replacement is considered
2	Some sewer network has been deteriorated and broken, causing roads to sink.	Deteriorated pipes are mainly concrete pipes. Some of them are not even reinforced and are structurally weak. Adoption of other pipe materials shall be examined.

Table 5.2.35 Major Issues and Countermeasures (Existing Sewerage Development Plan)

No.	Issues	Countermeasures
1	"Regional Plan" was prepared by the GCEC for nine governorate, namely: 1) Lattakia, 2) Tartous, 3) Dar'aa, 4) Aloppo, 5) Hama, 6) Homs, 7) Idleb, 8)Sweida and 9) Qunetra. Regional plan looks like a major plan for sewerage development. According to the general plan, numerous trunk sewers, PSs and STPs cover the whole governorate area. As sewerage system is only feasible in urbanized area, this plan is apparently not realistic, and not applicable since a big budget and much time are needed to construct the proposed long lengths of trunk sewers and large number of STPs. During longer construction period, contamination in public water bodies might be further accelerated. This plan might have been the main cause for project implementation to be put on hold.	The MHC must apply two sewerage system options properly based on the locality of target area. Two options are: 1) On-site System 2) Sewerage System As the MHC has not been adequately managing data on their existing sewerage facilities, they must start by formulating a "Sewerage Database" applying GIS Software. For details, refer to **Table 5.2.38**. After the completion of the database, they can easily divide the Governorate Area into three categories: a) Area served by On-site System b) Area served by Sewer Network but no STP c) Area served by Sewer Network and STP Aside from the information on the existing sewerage facilities, water contamination status in water sources and public water bodies receiving discharged raw wastewater shall also be indicated in GIS Map. Such GIS Map is quite useful to determine the priority order of areas to be served by the citedsewerage system options. Remember Sewerage System is only feasible in the urban area. Apply the optimum sewer treatment options according to the locality of target area, namely topography, size of population, expected wastewater quality, STP land availability, usage of treated wastewater, locally available O&M skill. As to planning procedure, refer to **Table 5.2.36**.

Table 5.2.36 Major Issues and Countermeasures (Planning Procedure) (1/3)

<table>
<tr><th>No.</th><th>Issues</th><th>Countermeasures</th></tr>
<tr><td rowspan="2">1</td><td>DESIGN FUNDAMENTALS

Due to the shortage in design know-how and experiences, the Syrian sewerage sector is not aware of the appropriate planning procedure.</td><td>There are design fundamentals, generally called as "FrameValues". They are:

<table>
<tr><th>Frame Value</th><th>Remarks</th></tr>
<tr><td>Target Year</td><td>Design target year, generally set by 20 years later/ 9-1</td></tr>
<tr><td>Design Service Population</td><td>Population to be served in target Year/ 7-1</td></tr>
<tr><td>Pollution Load</td><td>Pollutant loading contained in generated wastewater/ 7-15</td></tr>
<tr><td>Design Wastewater Flow</td><td>Estimated by per capita water consumption/ 7-8</td></tr>
<tr><td>Design Wastewater Quality</td><td>Calculated by dividing anticipated pollution load by per capita water consumption/ 7-14</td></tr>
</table>
Note) 9-1 is page to be referred on relevant information

For detailed calculations and estimates, refer to the page shown above.

These frame values vary depending on the locality of target area. Therefore, careful observation and data collection is indispensable to set appropriate ones. Refer to next column.</td></tr>
<tr><td>By reviewing the existing studies mainly done by the GCEC, the Study Team noticed that the baseline in setting of the design frame values such as pollution loading,
BOD/SS/NH_4 (g/capita/day) is quite scarce, considering that those are quite important factors to determine the optimum wastewater treatment method and facility size.</td><td>Specific pollution loading survey shall be conducted and data shall be collected in form of digital file.

Survey and data collection shall be executed by the MLAE. Survey shall cover major cities and typical rural areas in each Government.

Baseline survey and data llectionc is quite important, as it will bring proper and precise design output.</td></tr>
<tr><td>2</td><td>DELINEATION OF SEWERAGE SERVICE AREA

As aforementioned, "Regional Plan" was planned to cover the whole Governorate area by sewerage system but it not applicable due to the said reasons.

Refer to Table 5.2.35.</td><td>"Sewerage service area" means "area where service by sewerage system is feasible". Sewerage system is only feasible in urbanized areas.

Furthermore, water balance within the water basin shall be preserved to maintain the existing ecosystem and aquatic system. Wastewater collection crossing many water basins and discharge of treated wastewater where proposed STP is located might bring negative environmental impact.

Therefore, sewerage service area shall arefully consider the locality of target area and water balance within existing water basin.</td></tr>
</table>

Table 5.2.36 Major Issues and Countermeasures (Planning Procedure) (2/3)

No.	Issues	Countermeasures
3	SELECTION OF SEWERAGE OPTIONS the Syrian design would be appropriate to employ Centralized Sewerage System serving many cities, towns and municipalities. However, as sewerage system is only applicable to urban areas owing to the balance of project benefit and cost efficiency, small-scale municipalities located far from these urban areas must be served by other sewerage options.	Remember that "Sewerage System is ONLY feasible in urban area". For instance, providing that A City was chosen as prioritized area for sewerage system development, an appropriate sewerage system for the target city shall be selected.. Sewerage systems can be roughly classified into two categories, namely: a) Centralized Sewerage System serves several cities b) Decentralized Sewerage System serves only one city Refer to **Figure 9.4.2** in page **9-38**. This figure shows the comparison sample between the two systems. There is Community A next to large-scale City A. Whether the wastewater generated in Community A to be connected to City A for integrated treatment (Centralized) OR Both wastewater to be treated by their STPs (Decentralized) ⇒Must be determined by economical comparison work. Due to the topographic feature, where collection of sewage by gravity is difficult, a pumping station might be planned. Comparing economic and financial cost shall be done over the total project cost including construction cost and O&M cost.
	Which sewerage option is applicable to such isolated and small-scale municipalities?	An On-site Systems shall serve areas where a sewerage system is not applicable. It can be classified into two types, namely: a) Pit Latrine b) Septic Tank Refer to **Figure 9.4.1** in page **9-37**. It shows the proposed flow chart of On-site Sewerage System selection. Major factors when selecting from the two types of on-site systems are Village, Household Density Density of Households Permeability of Ground and Usage of Groundwater. Currently, a major on-site system in Syria is the Pit Latrine. However, as most are open holes dug into ground without watertight lining, there is great possibility of groundwater contamination where ground permeability is high. Conversion to Septic Tank with less effluent pollution load is desirable. Application of Governmental subsidy system shall be examined for smooth transition to the Septic Tank system. Refer to **Figure 9.7.1** in page **9-124**. This is a typical package treatment system generally adopted in Japan as on-site system. Itis called "Jokaso" in Japanese. This facility has many variations in treatment capacity. As such, if the package type pre-fabricated system is manufactured in Syria, this can be another future option.

Table 5.2.36 Major Issues and Countermeasures (Planning Procedure) (3/3)

No.	Issues	Countermeasures
4	STP PLAN When the Study Team visited a STP site, construction work was on-going. The problem of the STP is the location which was on top of the hill far away from city center. Generated wastewater in the city must be pumped to the STP and treated wastewater must be sent back to city as there is no demand for it near the STP site. The STP location is quite unsuitable since pumping consumes power. Furthermore, there is high risk of generation of Hydrogen Sulfide by pumping over a long distance to the STP. According to the engineer of the Establishment, this site was decided based on land availability and related environmental laws stipulating a buffer zone. Reportedly residents are opposed to build a STP in site near their residential areas.	Upon planning, engineers must mind the Cost and Power Efficiency of the plan. Cost and power saving plan is superior plan. Residents seem to have negative perception against sewerage facilities that emit intense foul odor, cause groundwater contamination, and so on. However, upon Q&A between residents and the Study Team in Stakeholder Meetings, Team found that none of them have ever visited a STP. An information, education and communication (IEC) campaign is needed to raise their awareness. If they recognize the importance of a sewerage facility, land acquisition will be much easier. Natural calamities such as flood shall be taken into account. The STP must be planned in the proper site, safe from these.
	Aside from Mediterranean Coastal Area, precipitation in Syria is generally scarce. Therefore, there is high demand toward re-use of treated wastewater.	According to the interview of officers of the Establishment and the farmers, demand for treated wastewater re-use differs by agriculture production. In short, it is not needed throughout a year. For example, some crops need treated wastewater in summer, etc. Thus, even if the treated wastewater is available throughout the year, this will be used as needed and thus there will be no real optimization of treated wastewater. Preparation of an “Irrigation Map” showing product, farm area, and demand for treated wastewater (needed amount and months) is desirable. It shall be added to the Sewerage Database Map. Based on this irrigation map, the engineers from the Establishment can prepare a treated wastewater distribution schedule showing the distribution amount to specified irrigation areas. If there are no demands in farm lands, treated wastewater shall be discharged into the nearest public water body used to receive raw wastewater.
	As stated earlier, residents’ negative perception on sewerage system is mainly due to odor issues.	The most intensely foul odor is emitted from the sludge treatment facilities. However, as far as sludge is fully oxidized, odor should not be a problem. This means that prompt sludge treatment is effective to lessen odor emission. For instance, sludge generated in wastewater treatment process can be directly installed in Mechanical Sludge Dewatering Unit.
5	SEWER PLAN In some plans, many PSs were proposed.	As a premise, sewer flow is dictated by gravity. In case of flat topography, pipe installation depth is essential. In case of a Manhole PS, a small capacity submersible installed in the manhole is applicable. If many PS is needed due to topographic feature of target area (plan A), area shall be divided into several zones where wastewater can be collected by gravity. Each zone can be served by decentralized STP or on-site facilities (plan B). Select the optimum alternative by economic and cost comparison.
6	As GCEC is expected to be a leading consultant firm in Syria, they must carefully examine the locality of study areas to prepare the optimum plan and facility design. The optimum plan will bring: ➢ Facilities in proper location and appropriate size ➢ Easy, economical and sustainable O&M activities ➢ Cost and time saving implementation schedule	

Table 5.2.37 Major Issues and Countermeasures (Project Priority)

No.	Issues	Countermeasures
1	Currently, all governmental agencies are executing their projects proposed in the Five Year Plan (FYP) prepared by the State Planning Committee (SPC). The FYP is prepared Ministry-wide. However, project prioritization criteria are not transparent. Prioritization of project must be in terms of water pollution control or EIA study results.	Sewerage development project prioritization must be determined by the degree of urgency in system development and project benefit. As no Ministry has materials for precise decision-making, project prioritization has been made without much basis. GIS sewerage database will be a useful tool for project prioritization. Furthermore, the national goal of water quality preservation of public water bodies shall be established by MLAE as long-term project target of the sewerage sector.

Table 5.2.38 Major Issues and Countermeasures (Data Management)

<table>
<tr><th>No.</th><th>Issues</th><th>Countermeasures</th></tr>
<tr><td>1</td><td>All Regional Plans” were prepared by the GCEC and the design outputs were to be submitted to the MHC and then distributed to each Establishment. However, hard or digital copies could not be found by the Study Team in the GCEC, the MHC or the Establishment.

Along with administrative restructuring of the MHC, urgent data management strengthening must be included.</td><td>Data management shall be computer-aided in a manner that has accounting data processing ability. A GIS system is applicable for “Sewerage Database” formation.

The MHC must establish “GIS Section” in their office and in each Establishment. This section will exclusively conduct database-processing work.

The following are the proposed input data:
<table>
<tr><th>Facilities</th><th>Input Data</th></tr>
<tr><td>Sewer Pipe</td><td>Pipe diameter, material, invert level, installation year</td></tr>
<tr><td>Manhole</td><td>Elevation of manhole cover, depth and diameter</td></tr>
<tr><td>PS</td><td>Pump and equipment specification, completion year</td></tr>
<tr><td>STP</td><td>Plant capacity, treatment method, completion year, treatment facilities</td></tr>
<tr><td>Water Sources</td><td>Intake method, present water quality
If polluted, name the pollution source</td></tr>
<tr><td>Public Water Bodies</td><td>Present water quality
If polluted, name the pollution source</td></tr>
<tr><td>Factories</td><td>Name of product, contents of pre-treatment facility, effluent volume and quality</td></tr>
<tr><td>Livestock</td><td>Kind of livestock, number of heads, location of wastewater discharge</td></tr>
</table>
As to sewerage facilities, O&M records shall also be done. Every end of the month, each Establishment shall prepare a “Monthly O&M Report” in form of a digital file and submit this to the MHC office.

A complete database system shall be shared with the MLAE for their water quality monitoring. The MLAE shall also share their monitoring results by inputting them into a GIS map. The MHC can also monitor the water quality control effect brought by sewerage system.

It is essential that here shall be a coordinated and continuous updating of the database.</td></tr>
</table>

Table 5.2.39 Major Issues and Countermeasures (Design Standard)

No.	Issues	Countermeasures
1	Currently, no unified design standard is available in Syria. Domestic design firms including the GCEC are adopting foreign design standards of USA, GB, German, Russia, Turkey and so on. Therefore, design outputs differ depending on design standard referred to.	To maintain the design level standards, the establishment of a unified design standard is essential. As foreign design standards were established based on the physical characteristics of their country, namely topography, climate, wastewater quality and available technology level, these may not be applicable to local Syrian conditions. Modification based on the nature of target area is needed. Therefore, a unified Syrian design standard is needed for the facilities. The standard should incorporate suitability to the Syrian environment yet maintain the quality of design output. The results of specific pollution loading surveys stated in **Table5.2.36** and foreign design standard list is shown in **Chapter 9, 9.2.4** will be useful references when establishing the National unified design standard.

Table 5.2.40 Major Issues and Countermeasures (Topographic Data)

No.	Issues	Countermeasures
1	According to the pervious (9th) FYP for the MLAE, preparation of computerized topographic plans (at scale of 1/1,000) for all Syrian residential areas was proposed. However, progress is slow.	For all development plans, the latest topographic map is essential, however the only available topographic map is old and its scale is 1/50,000, which is too small-scaled to use in sewerage development planning. In the 10th FYP, the setting up of "the information system" was proposed and according to the director of survey section of the MLAE, they have planned to establish "Web-GIS Data Center" which shall manage spatial data all over Syria in accordance with the said project. The data is accessible through a website. To facilitate the establishment of "Web-GIS Data Center" the MHC shall cooperate with the MLAE. Free access to spatial data shall always be secured for engineers and officers engaged in development projects.

Table 5.2.41 Major Issues and Countermeasures (Human Resource Development)

No.	Issues	Countermeasures
1	FYP for MHC stated seven "Objectives". Objective 6 is "professional development for all workers". The MHC training section sent their staff abroad to participate in training programs in Egypt, Germany, Jordan and Tunisia. The trained staff members are supposed to pass on or transfer their technical knowledge which they had gained upon their return. This however did not happen	There is one existing" Training Center" in Adraa STP in Damascus Governorate. The MHC planned another one near the Hama STP, now under construction. Based on the case that happened in Raqqa Governorate, current motivation of the MHC staff can be judged as low. Refer to **Table 5.2.9** and page **5-18**. Training of the MHC staff as qualified O&M staff will take time. Contracting out the O&M activity to a private firm shall be examined as one applicable option.

Table 5.2.42 Major Issues and Countermeasures (Relevant Laws)

No.	Issues	Countermeasures
1	Existing environmental laws are too stringent for the sewerage system. Effluent standard is shown in **Table 3.3.1** to **3.3.3**. However, the water quality criteria required in these standards seems too stringent for the present Syrian situation. It would be quite difficult for all the enterprises, especially small and medium scale firms to comply with these standards.	In Japan, the criteria for the effluent standards is stipulated by the central government, but national uniform standards are more lax than that of Syria and these standards are applied only to the specified factories by the law with the effluent discharge amount exceeding 50 m^3/day. As the environmental problems tend to vary according to the locality, the law in Japan allows the prefectural government to enforce the local effluent standards that are more stringent than the national uniform standards. Likewise, Syrian national standards shall be modified to allow less stringent limits and give the Governorate the authority to enforce the local effluent standards. Local effluent standards shall be established based on the local water pollution status. For reference, NH_3 effluent standard in Syria and other countries was listed in **Table 5.2.43**. Oxidation Ditch Method is applicable in Syria as it is stable in incoming load fluctuation and it needs no complicated O&M skills. De-nitrification is also available.

Table 5.2.43 Effluent Standard of NH_3 in Syria and other Countries

Countries	Effluent Standard of NH_3	Receiving Water Bodies
Syria	NH_3 5 mg/l 0.5 mg/l	Discharge to river Discharge to agriculture drain net
World Bank	NH_3 10 mg/l	Discharge to water body.
German	NH_4-N 10 mg/l	Discharge to water body. Applied from May to October when the wastewater temperature is more than 12 ℃, condition to be easy of accomplishment of nitrification and de-nitrification.
Japan	NH_4-N Not to be detected T-N 20 mg/l	Discharge to closed water body applied in Chiba Prefecture *

*) This is the example applied in Chiba Prefecture. As to detailed national effluent standard, refer to p**3-17**.

Table 5.2.44 Major Issues and Countermeasures (Administrative Demarcation)

No.	Issues	Countermeasures
1	As to sewerage system development, two Ministries are involved according to the scale of target municipality, design/construction/O&M phases and type of sewerage facilities, as shown in **Table 5.2.45**. Such fragmented and overlapping administrative jurisdiction has resulted in current inefficient execution of sewerage development projects. It resulted in huge wastage in time and budget.	The "10th Five Years Plan" for the MHC declared that the water and sewerage services administration would be unified under the MHC. The organization of MHC will be restructured to separate its function into the Regulator (central Ministry) and Executor (Establishment). A transition period would be imperative at this moment. According to the FYP, the role of MLAE and municipality written in **Table 5.2.45** is scheduled to be shifted to the MHC and Establishment but so far, progress is slow. Positive effort is needed to facilitate this organization reform. Inter-Ministry cooperation and data sharing are also quite important. GTZ has been supporting and will continue to MHC in this field.support.

Table 5.2.45 Demarcation on Responsibilities for Sewerage Works

Type of Municipality	Planning	Construction			Operation and Maintenance	
		STP	Trunk Sewer	Sewer Network	Before set-up of Company	After set-up of Company
Regional Areas and Cities	MHC	MHC	MHC	Mun. + MLAE	Mun. + MLAE	Company
Small Towns and Villages	Mun. + MLAE	Mun. + MLAE	MHC	Mun. + MLAE	Mun. + MLAE	Company

Note) "Company" means Sewerage Company to be established in cities upon completion of STP
Company is under the auspices of Establishment, MHC
"Mun." = Municipality

CHAPTER 6 INVESTMENT PROGRAM AND FINANCIAL STATUS OF SEWERAGE SECTOR

6.1 Investment for the Sewerage Sector in the Tenth (10th) Five-Year Plan

6.1.1 Investment for the Sewerage Sector by Type of Project and by Governorate

The Plan intends to make a fivefold investment from 2006 to 2010 amounting to 37 billion Syrian Pounds (SP). The investment plan includes three types of projects: (1) Started Projects, (2) New Decided Projects and (3) New Proposed Projects. As shown in **Table 6.1.1**, the number of projects totals 529 (Started Projects 195, New Decided Projects 77, and New Proposed Projects 257), excluding Damascus. The Started Projects are currently being implemented; New Decided Projects, meanwhile, are those projects that shall be implemented in a couple of years and been put in the annual investment budget; and the New Proposed Projects are still at the proposal stage awaiting decision for implementation.

The planned investment for the New Proposed Projects, amounting to SP 21.9 billion, is the largest among the three types of projects, , and takes up more than half (59.2%) of the total investment during the Planning period. The Started Projects follows with SP 9.1 billion investment, taking up 24.6% of the total. While the remaining 16.2% is invested for the New Decided Projects which amounts to SP 6 billion. (see **Figure 6.1.1**).

Eighty-five percent (85%) of the Started Projects (about SP 7.7 billion) is targeted to be done by 2007. Investment for the New Decided Projects reached its peak in 2007, when 74% (about SP 4.4 billion) of the total (SP 6 billion) was spent during that year. Majority of the New Proposed Projects will be implemented after 2008 although some commenced during 2007 As a result, the planned investment reached SP 10.9 billion in 2007, the highest of the annual investment amount. (See **Figure 6.1.2**).

Governorate-wise distribution of the planned investment shows that SP 4.2 billion, or 11% of the total, is allocated to Deir-Ez-zor followed by Tartous, Aleppo, Hama and Rural Damascus. The smallest is SP 0.9 billion (2.5%) which goes to Damascus. New Decided Projects amounting to SP 1.15 billion, alongside with SP2.8 billion of New Proposed Projects are planned for Deir-Ez-zor. In Tartous and Aleppo, New Proposed Projects of SP 2.9 billion and SP 3.1 billion are planned, respectively. For Hama and Rural Damascus, Started Projects of SP 1.7 billion are being implemented. While the invested amounts of Started and New Decided Projects are considerable for the Damascus location, it is noteworthy that no New Proposed Projects are allocated for the said area. (See **Figures 6.1.3** and **6.1.4**).

Table 6.1.1 Investment for Sewerage in the Tenth Five-Year Plan

(in thousand Syrian Pounds)

Governorate	Project Type	Number of Projects	Approximate Cost	Investment by Year during the Plan Period					
				2006	2007	2008	2009	2010	Total
Lattakia	Started Projects	23	704,066	339,000	156,000				495,000
	New Decided Projects	11	523,000	211,000	312,000				523,000
	New Proposed Projects	47	1,463,000		385,750	385,750	370,750	320,750	1,463,000
	Total	81	2,690,066	550,000	853,750	385,750	370,750	320,750	2,481,000
Tartous	Started Projects	11	492,291	160,000	320,000				480,000
	New Decided Projects	7	642,000	40,000	602,000				642,000
	New Proposed Projects	26	2,871,855			1,141,242	888,500	842,113	2,871,855
	Total	44	4,006,776	200,000	922,000	1,141,242	888,500	842,113	3,993,885
Deir-Ez-zor	Started Projects	5	338,089	93,600	121,000				214,600
	New Decided Projects	10	1,153,000	90,000	1,063,000				1,153,000
	New Proposed Projects	35	2,857,821		94,762	940,370	926,692	865,997	2,827,821
	Total	50	4,348,910	183,600	1,278,762	940,370	926,692	865,997	4,195,421
Hassakeh	Started Projects	4	230,200	100,000	59,000				159,000
	New Decided Projects	1	160,000	25,000	135,000				160,000
	New Proposed Projects	2	1,260,148			246,000	490,000	524,148	1,260,148
	Total	7	1,650,348	125,000	194,000	246,000	490,000	524,148	1,579,148
Raqqa	Started Projects	2	462,000	130,000	290,000				420,000
	New Decided Projects	1	1,000,000	20,000	20,000	20,000	20,000	20,000	100,000
	New Proposed Projects	1	980,000		200,000	200,000	280,000	300,000	980,000
	Total	4	2,442,000	150,000	510,000	220,000	300,000	320,000	1,500,000
Dar'aa	Started Projects	27	1,216,409	406,100	662,400				1,068,500
	New Decided Projects	8	295,832	110,000	185,832				295,832
	New Proposed Projects	39	1,220,000		353,000	289,000	289,000	289,000	1,220,000
	Total	74	2,732,241	516,100	1,201,232	289,000	289,000	289,000	2,584,332
Rural Damascus	Started Projects	7	1,695,000	227,000	367,000	366,750	366,750	366,750	1,694,250
	New Decided Projects	8	511,000	47,000	464,000				511,000
	New Proposed Projects	5	1,047,110			352,410	351,200	343,500	1,047,110
	Total	20	3,253,110	274,000	831,000	719,160	717,950	710,250	3,252,360
Aleppo	Started Projects	13	919,000	156,000	180,000				336,000
	New Decided Projects	7	30,200	157,540	15,000				172,540
	New Proposed Projects	6	3,096,752		795,857	761,725	757,525	781,645	3,096,752
	Total	26	4,045,952	313,540	990,857	761,725	757,525	781,645	3,605,292
Hama	Started Projects	27	2,046,800	823,000	753,000	100,000			1,676,000
	New Decided Projects	5	359,000	125,000	115,000	115,000			355,000
	New Proposed Projects	22	1,420,000		62,500	466,500	456,500	434,500	1,420,000
	Total	54	3,825,800	948,000	930,500	681,500	456,500	434,500	3,451,000
Homs	Started Projects	24	1,490,050	143,000	612,000				755,000
	New Decided Projects	7	270,000	96,000	174,000				270,000
	New Proposed Projects	32	1,218,913			560,971	560,971	552,540	1,674,482
	Total	63	2,978,963	239,000	786,000	560,971	560,971	552,540	2,699,482
Idleb	Started Projects	40	1,514,230	720,000	206,258				926,258
	New Decided Projects	3	70,000	15,000	55,000				70,000
	New Proposed Projects	4	2,233,400		450,000	550,000	550,000	683,400	2,233,400
	Total	47	3,817,630	735,000	711,258	550,000	550,000	683,400	3,229,658
Sweida	Started Projects	7	309,032	89,000	220,032				309,032
	New Decided Projects	4	961,000	21,000	940,000				961,000
	New Proposed Projects	36	1,276,000			416,000	416,000	444,000	1,276,000
	Total	47	2,546,032	110,000	1,160,032	416,000	416,000	444,000	2,546,032
Qunetra	Started Projects	5	311,000	90,000	160,000				250,000
	New Decided Projects	5	183,000	60,000	123,000				183,000
	New Proposed Projects	2	520,000			160,000	170,000	190,000	520,000
	Total	12	1,014,000	150,000	283,000	160,000	170,000	190,000	953,000
Damascus	Started Projects			91,700	60,000	60,000	60,000	60,000	331,700
	New Decided Projects			151,900	228,400	201,720	3,100	12,600	597,720
	New Proposed Projects								
	Total	0	0	234,600	288,400	261,720	63,100	72,600	929,420
Syria Total	**Started Projects**	**195**	**11,728,797**	**3,568,400**	**4,166,690**	**526,750**	**426,750**	**426,750**	**9,115,340**
	New Decided Projects	**77**	**6,158,032**	**1,169,440**	**4,432,232**	**336,720**	**23,100**	**32,600**	**5,994,092**
	New Proposed Projects	**257**	**21,464,999**	**0**	**2,341,869**	**6,469,966**	**6,507,138**	**6,571,593**	**21,890,568**
	Total	**529**	**39,351,828**	**4,737,840**	**10,940,791**	**7,333,438**	**6,956,988**	**7,030,943**	**37,000,000**

Source) MHC

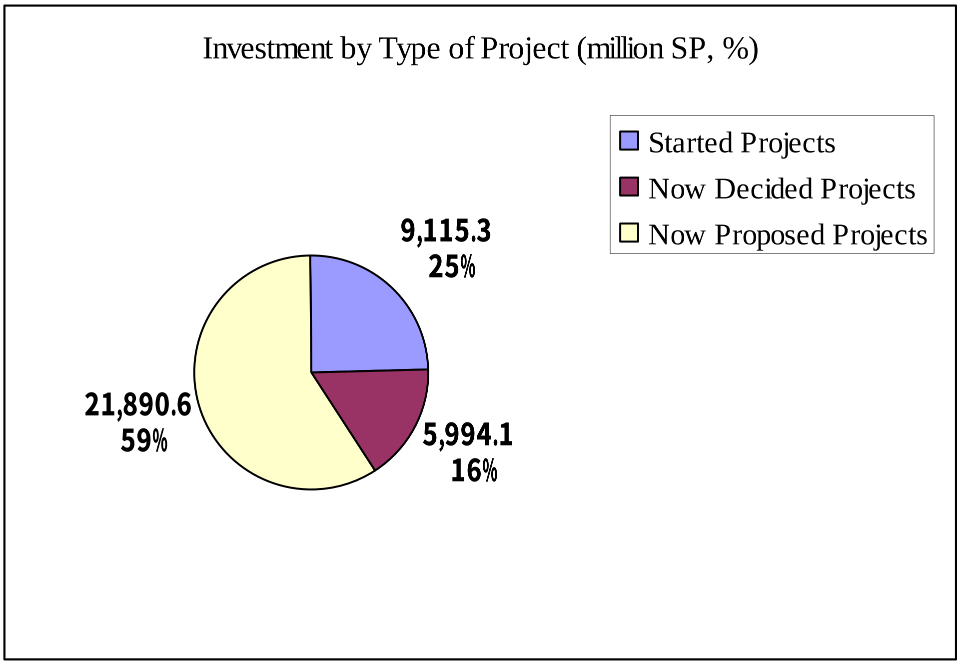


Figure 6.1.1 Total Investment Amount and Composition by Type of Project, 2006-2010

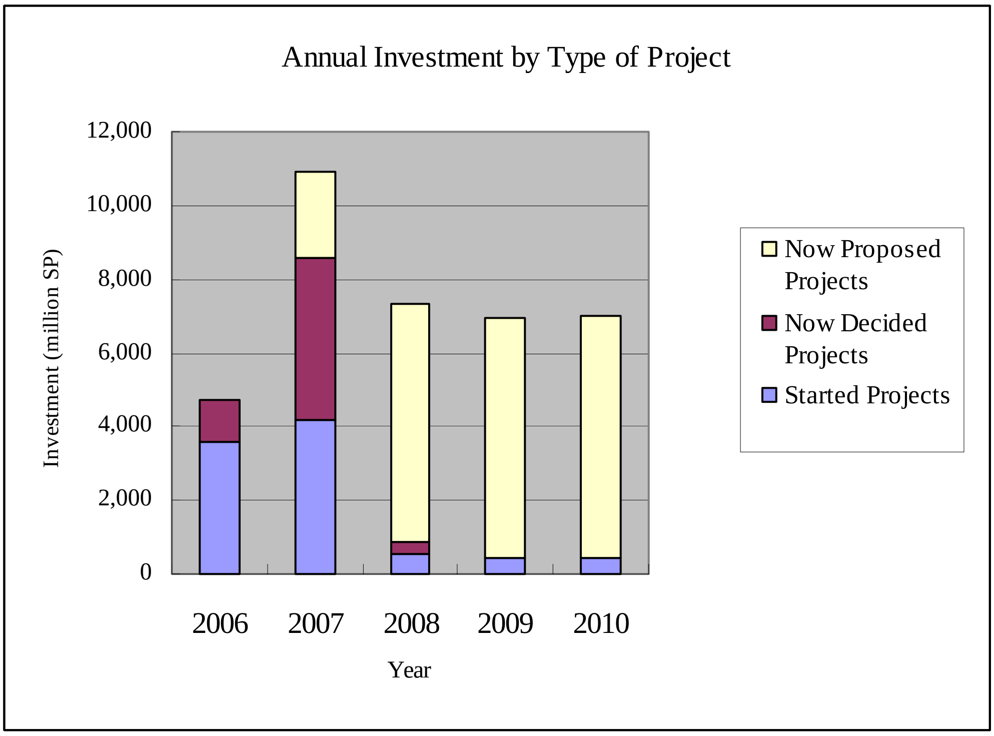


Figure 6.1.2 Annual Investment Amount by Type of Project

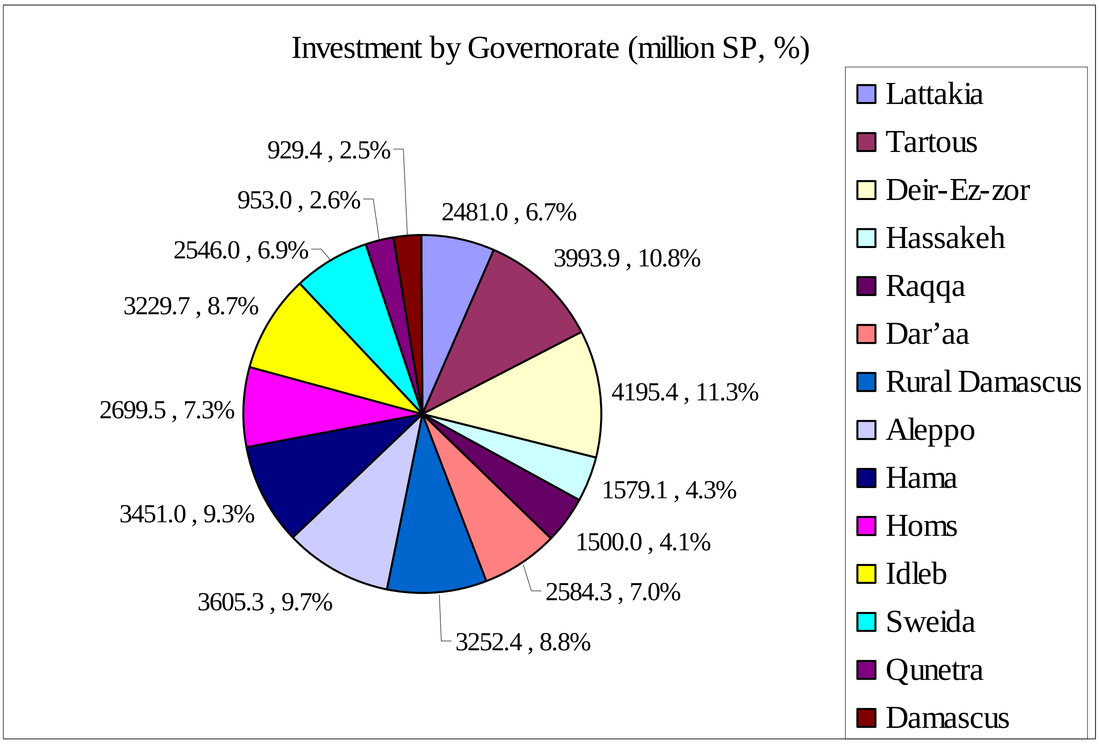


Figure 6.1.3 Investment Amount and Composition by Governorate, 2006-2010

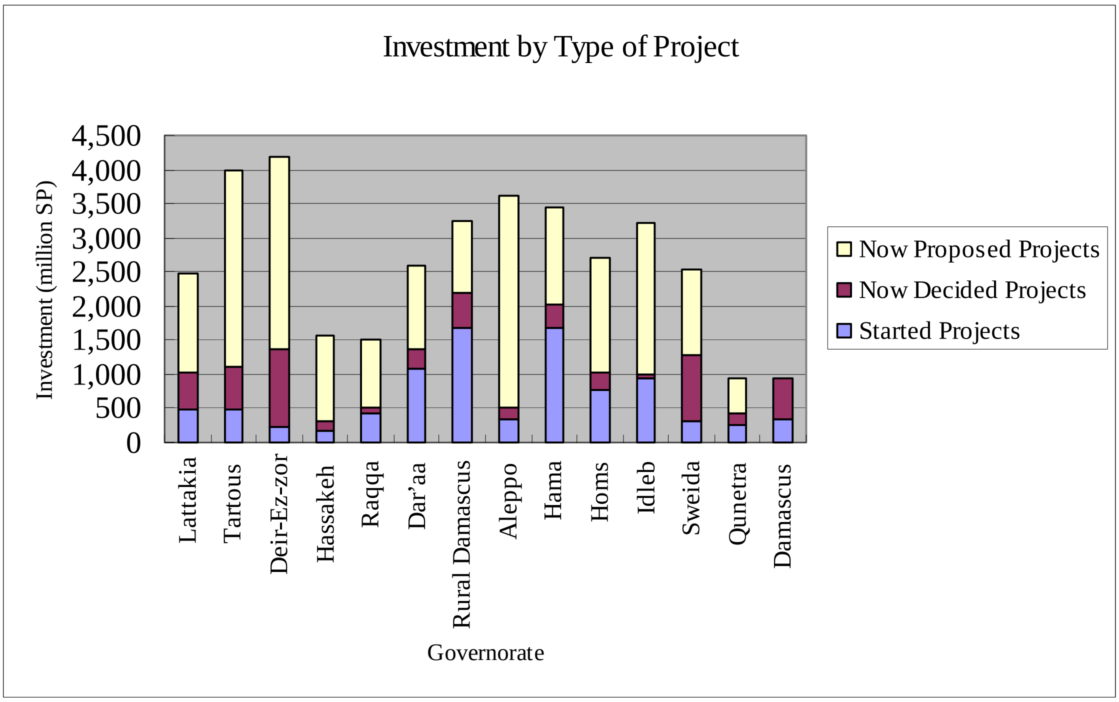


Figure 6.1.4 Investment Amount by Governorate and Type of Project

In comparison to the present population distribution, the amounts of planned investment per capita vary greatly by Governorate. The average for Syria is pegged at SP 2,000 per person during the Five-Year Plan period. For Qunetra, however, nearly SP 13,000 per person is proposed, and for Damascus and Aleppo less than SP 1,000 per person. The reasons for such a disparity can be attributed to the city size and its existing sewerage system.

Table 6.1.2 Investment for Sewerage per Capita

Governorate	Population at Living Place	Investment Plan for Sewerage	Investment per Person	Investment by Period		Investment per Person	
				2006-07	2008-10	2006-07	2008-10
Lattakia	906	2,481,000	2.74	1,403,750	1,077,250	1.55	1.19
Tartous	721	3,993,855	5.54	1,122,000	2,871,855	1.56	3.98
Deir-Ez-zor	1,036	4,195,421	4.05	1,462,362	2,733,059	1.41	2.64
Hassakeh	1,314	1,579,148	1.20	319,000	1,260,148	0.24	0.96
Raqqa	814	1,500,000	1.84	660,000	840,000	0.81	1.03
Dar'aa	869	2,584,332	2.97	1,717,332	867,000	1.98	1.00
Rural Damascus	2,328	3,252,360	1.40	1,105,000	2,147,360	0.47	0.92
Allepo	4,178	3,605,292	0.86	1,304,497	2,300,895	0.31	0.55
Hama	1,442	3,451,000	2.39	1,878,500	1,572,500	1.30	1.09
Homs	1,571	2,699,482	1.72	1,025,000	1,674,482	0.65	1.07
Idleb	1,294	3,229,658	2.50	1,446,258	1,783,400	1.12	1.38
Sweida	333	2,546,032	7.65	1,270,032	1,276,000	3.81	3.83
Qunetra	74	953,000	12.88	433,000	520,000	5.85	7.03
Damascus	1,606	929,420	0.58	532,000	397,420	0.33	0.25
Total	**18,488**	**37,000,000**	**2.00**	**15,678,631**	**21,321,369**	**0.85**	**1.15**

Source) MHC Note) Unit of population is 1,000 persons and unit of investment is 1,000 SP

6.1.2 Achievement of the Investment Plan during 2006 and Prospect after 2007

According to a document on investment for sewerage obtained from DAWSSA, there are considerable discrepancies between the DAWSSA and the 10th Five-Year plans. So, it is difficult to discuss about the achievement of the Five-Year Plan in 2006. Thus, it is necessary to collect and analyze data of other Establishments for a more detailed evaluation.

Table 6.1.3 Actual Investment by Item for Sewerage (until 2006) and Plan after 2007 of Damascus Water and Sewerage System Authority (DAWSSA)

(in thousand S.P.)

Governorate	Code No.	Project Name	Estimated Total Cost	Actual Expenditure			Budget for 2007	Expected Expenditure after 2007		
				Before 2005	2005	2006		2008	2009	2010
Damascus	335	Sewerage Project								
	3352	Building		98,294	95,745	73,505	69,000			
	3353	Machines		33,749	49,400	55,000	55,000			
	3354	Transport Facilities			85					
	3355	Tools		1,188	2,131					
	3356	Furnitures		772						
	3357						25,000			
		Total	**1,211,120**	**134,000**	**147,361**	**128,505**	**150,000**	**175,720**	**182,000**	**188,000**

Source) DAWSSA

In **Table 6.1.4**, some financial data are shown for the projects at the planning stage.

Table 6.1.4 Sewerage Projects at the Planning Stage

Governorate	No.	Name of Facilities	Status	Planned Population	Reference
Lattakia	1	Banias	Pre-F/S Stage		
Tartous	2	Al-Seismieh	Planning Stage	14,000	
Deir-Ez-zor	3	Deir-ez-zor	Planning Stage	320,000	Sewer under Construction
Hassakeh	4	Hassakeh	Planning Stage	157,000	Extension required
Raqqa	5	Raqqa	Tender Procedure		
Dar'aa	6	Mzerib	Designing Stage	47,545	
	7	Al-Sheik-Hasekeen	Designing Stage	96,463	
	8	Om-Al-Myaden	Planning Stage	55,905	
Rural Damascus	9	Sigaya	Planning Completed	13,700	
	10	Al Nabak	Planning Stage	48,000	
	11	Al Zabadani	F/S Stage	261,000	Pop=50,000, Others are Tourists
	12	Daraya	Planning Stage		Started in 2006
	13	Khan Al Shei/ Khan Daneah	F/S Stage		
	14	Barada/ Ghouta Gharbiyah	F/S Completed	616,000	Three Treatment Plants

Source) MHC

Table 6.1.5 shows the actual investment amount by the Establishment, which includes investment for water supply.

Table 6.1.5 Investment of Establishments, Including MHC and Related Companies, 2004-2006

(in thousand SP)

MHC, GEPWS by Governorate and Other Establishment	2004		2005		2006	
	Local & Foreign	Foreign Loan	Local & Foreign	Foreign Loan	Local & Foreign	Foreign Loan
Ministry (MHC)	**3,297,702**	**299,006**	**3,745,932**	**78,352**	**4,081,853**	**127,000**
(GEPWS)						
Lattakia	868,652		634,344		449,674	
Tartous	527,106		740,693		405,325	
Deir-Ez-zor	719,911		1,006,246		970,700	
Hassakeh	1,046,768		913,393		1,049,805	
Raqqa	548,057		805,776		750,000	
Dar'aa	656,770		533,000		706,910	
Rural Damascus	754,646		1,004,567		1,167,547	
Aleppo	1,342,255		1,370,796		1,604,984	
Hama	819,706		703,530		800,348	
Homs	519,435		634,187		519,416	
Idleb	570,187		703,366		700,000	
Sweida	470,000		601,000		607,264	
Qunetra	125,280		124,051		129,000	
Damascus	826,741	167,988	780,066	62,200	1,135,438	475,000
GEPWS Total	**9,795,514**	**167,988**	**10,555,615**	**62,200**	**10,996,441**	**475,000**
Other Establishments Total	**1,097,795**	**0**	**972,523**	**0**	**1,507,067**	**0**
Total	**14,131,011**	**466,994**	**15,274,070**	**140,552**	**16,585,331**	**602,000**

Source) MHC Note) GEPWS = General Establishment of Potable Water and Sewerage

It is important to organize the financial data of the Establishment for water and sewerage both separately and as a whole. Some Establishments have separated their sewerage departments, but other Establishments still keep their sewerage functions. It is understood that water supply can be a profitable business under proper tariff policies but the sewerage function is more difficult to run profitably - and transform it into a viable business. Accordingly, there are discussions and examples of Public Private Partnership (PPP) for water supply and cross subsidies between the departments of water and sewerage within an Establishment.

6.2 Budgetary Arrangement for Sewerage Projects

6.2.1 Budget Preparation and Approval System

The annual investment budget is prepared by the MHC and the Establishments and it includes the cost of the annual investments in water and wastewater projects carried out by both parties and the estimated funds needed to cover these investments.

As shown in **Figure 6.2.1**, there is a preparation cycle both from the MHC and Establishments' budgets, which in theory, should be treated as one budget and not separate from each other. The cycle usually starts by estimating the needs for projects, then drawing initial plans, consolidating them at the MHC (Directorate of Planning) and then sending them to SPC and to the MOF for approval before commencing the implementation. In practice however, the MHC and Establishment budgets are treated and evaluated separately by SPC and MOF. They are allocated directly by the MHC and the Establishments.

Thus, MHC and the Establishments play a major role in preparing and implementing the financial plans. If budgets are approved centrally, this does not mean that the MHC and Establishments cannot control the quality of the plans and the project implementation.

Several problems are seen however, in the budget plans and the project implementation, which are as follows:

- The lack of cost estimate standardization often leads to miscalculation in the estimated budget, which are done by the technical engineers based on their personal experience. These miscalculations increase the margin of error significantly.
- There is no unified budgeting system or method in place, which the MHC and the Establishment can use as a reference, in conjunction with the Establishments in preparing plans. As a countermeasure, an integration of the recurring and investment budgets under the Ministry of Finance is recommended. The MHC should fully assess the requested budgets from all Establishments before delivering them to SPC and MOF.
- No qualitative assessment of previous projects' performance is carried out. The monitoring of the implementation is purely on the financial aspect. It reflects the performance of budget spent in a defined period of time with no reference to qualitative implementation. The preparation of an Annual Investment Report is recommended using a set of performance indicators covering not only the financial side, but also the qualitative aspect to improve monitoring of the project's performance.
- Any delay in the implementation means that the MHC and the Establishment will lose

the funds as they will be returned to the central budget at the end of the fiscal year.

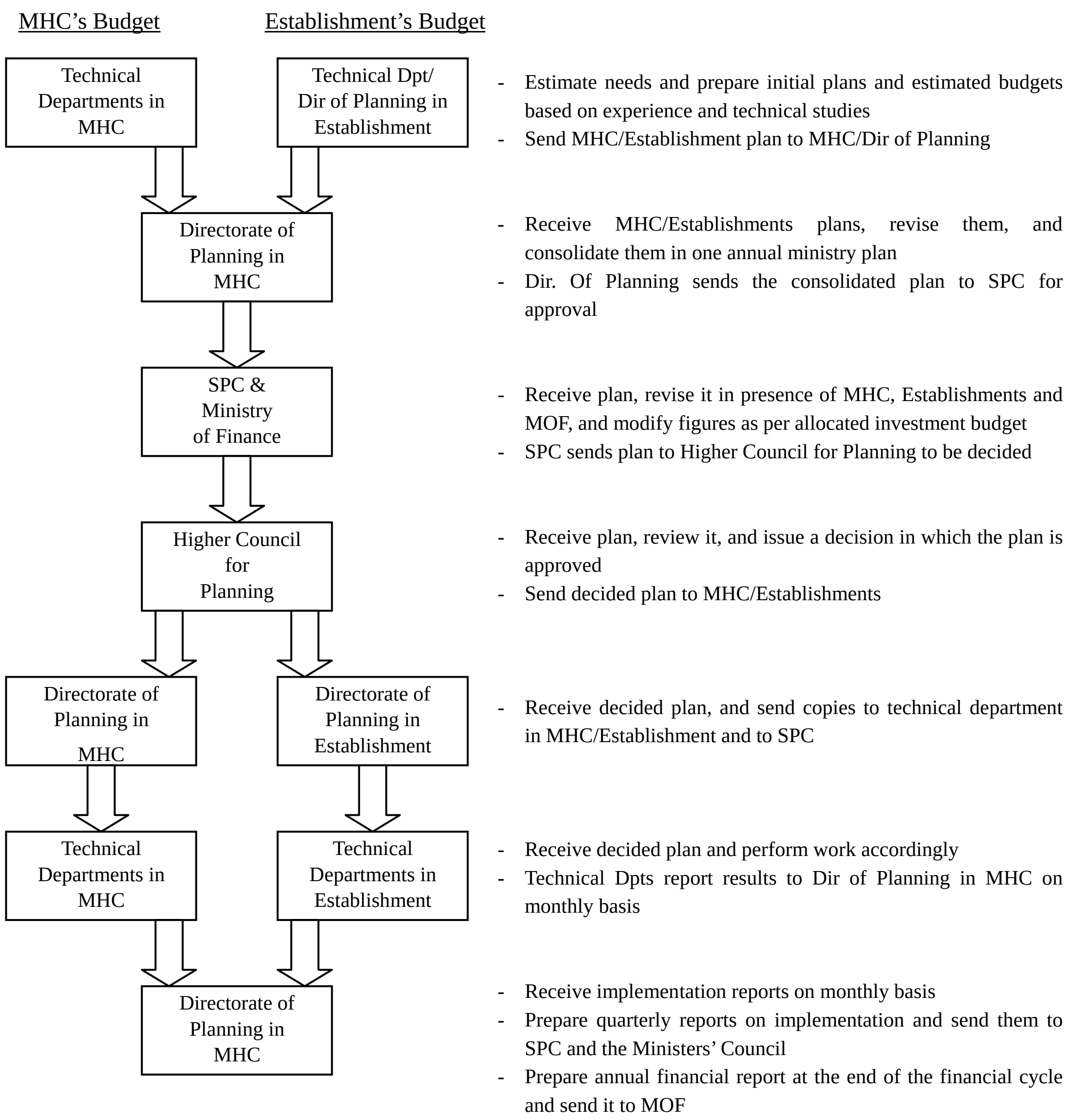


Figure 6.2.1 MHC and Establishment Budget Preparation and Approval Cycle

6.2.2 Investment Budget for Water and Sewerage

The investment budget for water and sewerage is composed of the National Budget and the budgets of 14 Public Establishments of Drinking Water and Sewerage (Establishments), each of which has a responsibility to develop, operate and maintain the water and sewerage system under its jurisdiction. The National Budget for the development of water and sewerage is under the Ministry of Housing and Construction (MHC). The Ministry of Local Administration and Environment (MLAE) and the 14 Governorates under the MLAE are responsible in carrying out the works related to administration of the Central and local governments.

The budget of the municipalities is allocated by the MLAE annually, at the beginning of the year, as schematically shown in **Figure 6.2.2** below. The allocation of the total budget is carried out by the MLAE based on the population of each municipality, its territory and other possible considerations (i.e. Special requests of municipalities may be taken into consideration).

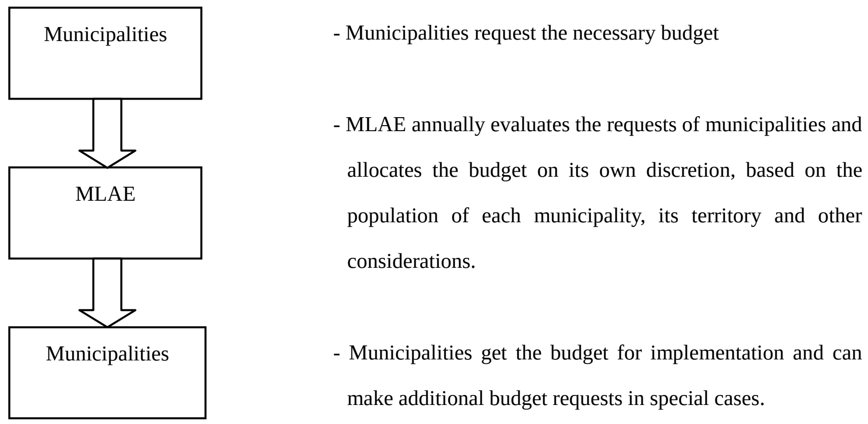


Figure 6.2.2 MLAE Budget Allocation

The governorates and municipalities under them have their own budgets for sewerage and waste disposal; however, the sewerage issues are gradually being transferred to the Establishment (including the Sewerage Company) .

For 2005, investment budgets of the Establishments accounted for SP 10,615 million and those of governorates SP 18,751 million. The budgets of governorates include the investments for sewerage and waste disposal.

Table 6.2.1 Investment Budget for Water and Sewerage by Governorate, 2005

(in thousand SP)

Section	Mahafazat	Local Resources	External Resources	Total
52102	Damascus	705,000	167,000	872,000
52103	Lattakia	635,000	0	635,000
52104	Aleppo	1,400,000	0	1,400,000
52105	Homs	639,000	0	639,000
52106	Hama	704,000	0	704,000
52107	Idleb	654,000	0	654,000
52108	Sweida	601,000	0	601,000
52109	Raqqa	776,000	0	776,000
52110	Dar'aa	703,000	0	703,000
52111	Deir-Ez-zor	912,000	0	912,000
52112	Tartous	758,000	0	758,000
52113	Hassakeh	914,000	0	914,000
52115	Rural Damascus	919,000	0	919,000
52117	Qunetra	128,000	0	128,000
	Total	**10,448,000**	**167,000**	**10,615,000**

Table 6.2.2 Investment Budget by Governorate Including Sewerage & Waste Disposal, 2005

Section	Mahafazat	Local Resources	External Resources	Total
12203	Damascus	775,000	0	775,000
12204	Lattakia	1,433,000	0	1,433,000
12205	Aleppo	2,041,000	0	2,041,000
12206	Homs	1,152,000	0	1,152,000
12207	Hama	1,270,000	0	1,270,000
12208	Idleb	994,000	0	994,000
12209	Sweida	1,697,000	0	1,697,000
12210	Raqqa	1,257,000	0	1,257,000
12211	Dar'aa	1,057,000	0	1,057,000
12212	Deir-Ez-zor	1,219,000	0	1,219,000
12213	Tartous	965,000	0	965,000
12214	Hassakeh	1,013,000	0	1,013,000
12215	Rural Damascus	711,000	0	711,000
12216	Qunetra	679,000	0	679,000
12217	Damascus (Municipal Sector) (Self-financing & loan from the Public Debt Fund)	2,347,000	51,000	2,488,000
	Total	**18,700,000**	**51,000**	**18,751,000**

6.2.3 Investment Budget for Sewerage

The investment amount for sewerage projects during 2007 included in the Five-Year Plan was 10,940 million Syrian Pounds counting in SP 6,774 million for the new decided and new proposed projects. On the other hand, the Establishment-wise 2007 budget plan indicated SP 4,694 million for sewerage projects as shown in **Table 6.2.3**, presenting a large discrepancy in the Five-Year Plan. It would seem that the budget does not include the new decided and new proposed projects as defined in the Five-Year Plan.

Table 6.2.3 Investment Budget for Sewerage by Governorate, 2007

(in thousand SP)

Section	Mahafazat	Local Resources	External Resources	Total
52102	Damascus	500,000	0	500,000
52103	Lattakia	400,000	0	400,000
52104	Aleppo	200,000	0	200,000
52105	Homs	350,000	0	350,000
52106	Hama	624,000	0	624,000
52107	Idleb	-	-	-
52108	Sweida	200,000	0	200,000
52109	Raqqa	200,000	100,000	300,000
52110	Dar'aa	600,000	0	600,000
52111	Deir-Ez-zor	300,000	0	300,000
52112	Tartous	400,000	0	400,000
52113	Hassakeh	220,000	0	220,000
52115	Rural Damascus	180,000	220,000	400,000
52117	Qunetra	200,000	0	200,000
	Total	**4,374,000**	**320,000**	**4,694,000**

Source) MHC

6.3 Financial Condition in Public Establishments

6.3.1 Present Tariff System and Tariff Level

In Syria, a nation-wide unified water and sewerage tariff is applied. The existing tariff system represents a kind of a volume-based progressive system with additional fixed charges.

Parts of the tariff system are defined by numerous documents and revised from time to time. The volume-based water tariff was last revised by the MHC effective from 1 November 2007, whereas the sewerage tariff was left unchanged (as of November 2007).

With the recent change of the water tariff table, a new structure of blocks (tiers) and new prices were introduced. Apart from the prices increasing from one block to another, which is common for any progressive-type of tariff system, excessive water consumption in Syria (>41 m^3 per quarter) is penalized higher by applying the price of the highest block to the total volume of the water consumed. It is too premature, however, to assess results of the application of the new water tariff table.

The latest water and sewerage tariffs are shown below in **Tables 6.3.1** and **6.3.2** respectively.

Table 6.3.1 Water Tariff Table

Category	Tariff	Notes
Volume-based charges	SP/m^3	
Domestic 1 to 15 m^3	2.5	
Domestic 16 to 25 m^3	7	
Domestic 26 to 40m^3	15	
Domestic 41 to 60m^3	22	applied for the total volume consumed
Domestic 61 $m^3$and over	30	applied for the total volume consumed
Governmental institutions	14	
Industrial, commercial and tourism	30	
Fixed charges (per year)	SP	
Meters maintenance	240	
Network fee	250	

Note: Other fixed fees may apply. For instance the water meters' installment fee; a special surcharge of SP20 for the bills exceeding SP100 and so on.

Source) MHC

Table 6.3.2 Sewerage Tariff Table

Category	Tariff
Volume-based charges	Percentage *
Domestic 1 to 20m^3	5%
Domestic 21 to 30m^3	10%
Domestic 31 to 60m^3	15%
Domestic 61 $m^3$and over	20%
Governmental institutions	55%
Industrial, commercial and tourism	40%
Fixed charges (per year)	SP
Domestic	120 SP
Commercial	150 SP
Industrial and tourism	200 SP
Governmental institutions	250 SP

*As percentage to the water charges; not applicable in Governorates where sewage treatment is not available.

Source) MHC

It is worth noting that due to the recent change of the water tariff, irregularities occurred between the block structures used in the water and sewerage tariff tables. It is unclear (as of November 2007) how the Establishments will apply the sewerage tariff table in the future. Possible changes of the sewerage tariff table are still under consideration.

Whereas no reliable statistics were found regarding the household income and expenditure details in Syria, even with the accomplishment of a,Public Survey, during the F/S stage, the figures provided in the “Basic Design Study Report (I) on the Project for Development of New Water Sources for Damascus City in the Syrian Arab Republic” issued by JICA in March 2005 (see Table-6 on page A6-12) were used. According to this Report, water expenses account for from 0% to 3% of the total household expenditure, depending on the household category. Since it is less than the 4%-5% threshold usually adopted by international donors, the existing tariffs are believed to be affordable for the average household. Further details on the affordability of the water and sewerage tariffs are provided in Chapter 11 and will be further analyzed at the F/S stage, subject to the fact that the tariff table was revised as of 1 November 2007 and the analysis of the past statistics has limited value.

The present water tariff in Syria (the lowest block price of SP 2.5/m^3, which is equivalent to approximately USD 0.05) is lower than that in similar countries such as Jordan and Tunisia, as shown below.

Table 6.3.3 Water and Sewerage Tariff in Jordan

Consumption	Water		Sewerage		Total
Category	JD/m^3	US$ /m^3	JD/m^3	US$ /m^3	US$ /m^3
20 and below	A lump sum of 2.9 JD (4.1 US$)				
40	0.120	0.16	0.035	0.05	0.21
70	0.337	0.47	0.127	0.18	0.65
100	0.533	0.75	0.213	0.30	1.05
120	0.664	0.94	0.271	0.38	1.32
131 and above	0.850	1.20	0.350	0.49	1.69

Note) JD means Jordan Dinar (Jordanian currency).

Table 6.3.4 Water and Sewerage Tariff in Tunisia

Consumption	Water		Sewerage		Total
Category	TD/m^3	US$ /m^3	TD/m^3	US$ /m^3	US$ /m^3
0-20	0.135	0.09	0.017	0.012	0.10
21-40	0.215	0.15	0.155	0.11	0.26
41-70	0.430	0.30	0.219	0.15	0.45
71-150	0.650	0.45	0.424	0.29	0.74
151 and above	0.700	0.48	0.468	0.32	0.80

Note) TD means Tunisia Dinar (Tunisian currency).
Source) World Bank Report in 2003

6.3.2 Financial Conditions of Public Establishments

The following table shows a summary of profit-loss statements of 14 Establishments.

Table 6.3.5 Profit and Loss of Establishments, 2004

(in thousand SP)

Name of GEPWS	Total Gross Revenue	Operating Expenses	Operating Profit (Loss)	Financial Expenses (Interest of GDF)	Current Profit (Loss)
Lattakia	272,300	265,400	6,900	65,618	-58,718
Tartous	190,000	477,525	-287,525	0	-287,525
Deir-Ez-zor	187,010	249,447	-62,437	0	-62,437
Hassakeh	267,650	434,171	-166,521	336,579	-503,100
Raqqa	258,000	338,000	-80,000	16,000	-96,000
Dar'aa	155,220	435,078	-279,858	48,000	-327,858
Rural Damascus	297,000	296,600	400	0	400
Aleppo	1,532,379	1,523,552	8,827	700,000	-691,173
Hama	457,450	467,290	-9,840	0	-9,840
Homs	430,500	514,000	-83,500	0	-83,500
Idleb	276,763	453,442	-176,679	2,665,000	-2,841,679
Sweida	70,546	107,934	-37,388	27,706	-65,094
Qunetra	35,685	138,210	-102,525	8,451	-110,976
Damascus	610,096	485,295	124,801	0	124,801
Total GEDWS	**5,040,599**	**6,185,944**	**-1,145,345**	**3,867,354**	**-5,012,699**

Source) MHC Note) GDF = Government Debt Fund

According to **Table 6.3.5**, only four Establishments gained operating profit in 2004, which are Damascus, Aleppo, Lattakia and Rural Damascus. Except for these four Establishments, revenues of the other Establishments are very generally low due to the imposition of low tariff structure and high percentage of the unaccounted for water. Their operational deficits are also usually covered by the Ministry of Finance (MOF). Only a few Establishments that have a large number of connections or a large volume of commercial consumption gain operational profits. However, current profit after deducting financial expenses is not reliable. Syria does not adopt the international standard for financial statements.

6.4 Tentative Recommendations for Financial Reform Plan

6.4.1 The Ongoing Fiscal Reform Process

As described in Chapter 4, the Syrian Government at present is making efforts towards the fiscal reform supported by GTZ of Germany. The perspective of the Financial Management Strategy proposed within this Reform Plan is summarized as follows:

(1) Investment Policy

- MHC will assess the level of investment subsidy for each Establishment as well as overall budget volume for government subsidies, and in parallel, the Syrian Government will prepare for a change from total investment budget financing to needs based co-financing of projects (SPC, MOF) and MHC will develop appropriate co-financing levels for the water sector based on cost-benefit analysis.

(2) Tariff Setting Policy

- Tariffs should cover at least full operation and maintenance cost and the replacement of electrical and mechanical equipment, and be regionalized to achieve this, however, a social safety net for low income households would compensate for the regional differences in tariffs.

- Elected governorate councils as representatives of water service clients should get involved in the tariff decisions, e.g. through a strong representation of the establishments' boards.

(3) Reform of Establishments

- The Establishments manage their operations through their water units that have submit themselves to accrual accounting/cost center accounting, according to international standards. They acquire revenues through regional tariffs suggested by the tariff setting policy.
- Internalization of market based management for better interaction with private and civil communities should be promoted.

(4) Role of Central Ministry

- MHC as a regulator will identify a small set of performance indicators to assess the Establishments' performance, and monitor the performance of water establishments and approve tariffs at the governorate level.
- MHC plans to develop guidelines for feasibility studies and project appraisal according to international standards (i.e. appraisal from technical, socio-economic, financial and environmental aspects) and provide training to Establishments. This work however is still at its early stage.

6.4.2 Recommendations towards Financial and Economic Analysis

Through the support for the Reform Plan mentioned above, the GTZ proposed a new tariff structure, and such a revision of the current tariff table was approved by the Minister in August 2007. In about two months, the new tariff table will be officially announced to public. However, it is perceived that the new tariff table is primarily based on the cost recovery of recurrent expenditures in the Establishments, many of which operate only the water supply system. However, the new tariff is believed to include the revise of the sewerage tariff as well.

This Study focuses on sewerage projects and their operations, and therefore, it should examine and propose various sewerage tariff structures including the recovery of investment costs based on detailed surveys and estimates for capital and O&M for the M/P priority projects in the target seven Governorates. These results will be able to serve as a baseline for setting the appropriate levels of sewerage tariff alongside government subsidies, through the development of a long-term government subsidy system for sewerage projects. Thus, the outcome obtained from such examinations shall be provided to MHC as recommendations from the JICA Study, for a basis of the cost recovery policy of sewerage sector.

It is equally important to show the benefits of sewerage development by using social and economic indicators. Although a sewerage project is prone to having difficulties in its financial cost recovery, it compensates by bringing about various social and economic benefits to society. Every existing sewerage study in Syria lacks this viewpoint, and this Study will provide such benefits by using the Economic Internal Rate of Return (EIRR).

Details are discussed in Chapter 11.

CHAPTER 7 PLANNING FUNDAMENTALS

7.1 Basic Policy on establishment of Sewerage Development Plan

A sewerage system development plan will be prepared in two stages, namely 1) Macro Plan and 2) Master Plan. "Macro Plan" refers to the macroscopic picture for sewerage development covering priority areas of the target seven Governorates. For details, refer to Chapter 8.4.2. In the implementation of the Macro Plan, the fundamental framework behind the long-term objective of the sewerage system development will be examined. These are: served population, number of STP, sewage and sludge treatment, basic policy for O&M activities and priority order of projects. Further, one core city or area will be selected for each of the seven designated Governorates and a Master Plan will be respectively formulated for them.

The scale of the sewerage system is determined by the design sewage flow at target year. Design sewage flow is calculated by multiplying the design service population by per capita sewage rate. Further, sewage quality will be determined in the design of the sewage treatment facilities. Such design criteria are estimated herein.

7.2 Population Projection

7.2.1 General

Designng for the served population is the most fundamental criteria in the determination of the scale of the sewerage development plan. Served population refers to the future population in the target year. The future population is projected by means of the past population data.

7.2.2 Population Data

Two kind of population data are available, namely National Census Data and Residential Registration Data. Their general comparison is shown in **Table 7.2.1**:

Table 7.2.1 Comparison of National Census Data and Residential Registration Data

Items	National Census	Residential Registration
1. Frequency of data collection	Three times during the last 25 years (1981,1994,2004)	Periodically totaled every year.
2. Accuracy of data	Number of residents actually living there.	Counted the number of registered person containing who isn't actually living there. On the contrary, people who are actually living there are not counted. Therefore, less reliable.
3. Data contents	No population data is available as to small communities in cities and towns. Census data conducted in 1981 does not include population data by cities.	Population data are available as to cities, towns, villages and small communities contained in them.

Source) National Census and Residential Registration

Residential Registration Data often has large discrepancies in terms of the number of persons actually living there. Even though the number of data is small, the Study Team adopted the National Census Data to estimate the future population accounting for the accuracy of data.

7.2.3 Population Estimation Method

Annual average population growth rate was calculated based on the past population transition and future population was projected according to the said rate. National population growth rate from 1981 to 1994 was approximately 3.3%, considered very high. Rates from 1994 to 2004 decreased to 2.66%. Population growth rate seems to display a decreasing trend from then on. Population growth rates every five years were stabilized, accounting for the reduction in rate based on the population transition in two periods, 1981 to 1994 and 1994 to 2004. Refer to **Table 7.2.2** and **Table 7.2.3**:

Table 7.2.2 Population in Each Governorate

	Population in Syria (Person)			Increasing Ratio (%)			Reduction Rate in Population Growth Ratio
Governorates	1981	1994	2004	1981 -1994	1994 -2004	Ratio (%)	(%/every 5 years)
Lattakia	551,508	746,441	879,551	2.36	1.65	69.9	80.0
Tartous	443,167	587,514	701,395	2.19	1.79	81.7	90.0
Deir-Ez-zor	408,357	711,375	1,004,747	4.36	3.51	80.5	90.0
Hassakeh	669,614	1,022,940	1,275,118	3.31	2.23	67.4	80.0
Raqqa	349,848	553,395	793,514	3.59	3.67	102.2	100.0
Dar'aa	362,798	606,620	843,478	4.03	3.35	83.1	90.0
Rural Damascus	918,551	1,646,744	2,273,074	4.59	3.28	71.5	80.0
Aleppo	1,877,339	2,975,063	4,045,166	3.61	3.12	86.4	90.0
Hama	736,822	1,097,769	1,384,953	3.11	2.35	75.6	80.0
Homs	812,419	1,217,342	1,529,402	3.16	2.31	73.1	80.0
Idleb	580,440	905,483	1,258,427	3.48	3.35	96.3	100.0
Sweida	199,584	268,337	313,231	2.30	1.56	67.8	80.0
Qunetra	26,266	48,774	66,627	4.88	3.17	65.0	80.0
Damascus	1,109,431	1,394,322	1,552,161	1.77	1.08	61.0	70.0
Total	9,046,144	13,782,119	17,920,844	3.29	2.66	80.9	

Source) National Census

Table 7.2.3 Population Increasing Ratio in the Future

Governorates	Increasing Ratio (%)			
	2004-2010	2010-2015	2015-2020	2020-2025
Lattakia	1.65	1.32	1.06	0.85
Tartous	1.79	1.61	1.45	1.31
Deir-Ez-zor	3.51	3.16	2.84	2.56
Hassakeh	2.23	1.78	1.42	1.14
Raqqa	3.67	3.67	3.67	3.67
Dar'aa	3.35	3.02	2.72	2.45
Rural Damascus	3.28	2.62	2.10	1.68
Aleppo	3.12	2.81	2.53	2.28
Hama	2.35	1.88	1.50	1.20
Homs	2.31	1.85	1.48	1.18
Idleb	3.35	3.35	3.35	3.35
Sweida	1.56	1.25	1.00	0.80
Qunetra	3.17	2.54	2.03	1.62
Damascus	1.08	0.76	0.53	0.37
Total	2.66			

7.2.4 Population Projection

Based on the 2004 population, the future population was calculated by adopting each of the population growth rates. As for the seven Governorate prioritized under the Master Plan preparation, the future population was estimated by the units of District and Sub-district. As to other Governorates, future population was projected by unit of Governorate. Further, the reduction rate of 70% was applied to the Sub-district with a population growth rate exceeding 4% to prevent exaggerated population projections.

Since the JICA Urban Planning Team has already estimated the future population of Damascus and the Rural Damascus Governorate, their results were adopted. However, the Yabroud District and Nabek District were excluded in their study since they are out of their scope of work. So the estimated population of these districts was added to the results. Further, as the JICA Urban Planning Team didn't estimate the population sub-district-wise, future population in sub-districts in the Zabadani District, Rural Damascus Governorate was projected according to the foregoing method. (Refer to **Table 7.2.4** as to the population projection in the targeted seven Governorates. As to population estimates in cities contained in the M/P target areas, refer to **Table 7.2.5)**:

Table 7.2.4 Population Projection in each Governorate

Governorates	Population in Syria				
	2004	2010	2015	2020	2025
Lattakia	879,551	983,300	1,060,700	1,127,800	1,185,300
Tartous	701,395	784,300	853,900	922,700	990,100
Deir-Ez-zor	1,004,747	1,239,800	1,433,400	1,618,200	1,793,700
Hassakeh	1,275,118	1,443,300	1,569,300	1,679,100	1,773,100
Raqqa	793,514	968,500	1,130,000	1,303,800	1,492,500
Dar'aa	843,478	1,020,500	1,171,700	1,321,100	1,468,500
Rural Damascus	2,273,074	2,855,400	3,358,900	3,909,000	4,500,700
Aleppo	4,045,166	4,864,000	5,586,900	6,330,300	7,085,600
Hama	1,384,953	1,592,100	1,747,500	1,882,600	1,998,300
Homs	1,529,402	1,754,000	1,922,400	2,068,900	2,193,900
Idleb	1,258,427	1,533,500	1,808,200	2,132,100	2,514,000
Sweida	313,231	313,231	343,700	365,700	384,400
Qunetra	66,627	80,300	91,000	100,600	109,000
Damascus	1,552,161	1,625,800	1,691,800	1,749,100	1,800,000
Total	17,920,844	21,058,031	23,769,400	26,511,000	29,289,100

Note)
a) Population projection was estimated based on population in 2004 and population growth rate
b) Population growth rate to year 2010 was calculated by population in 1994 and 2004
c) Growth rate 2010 to 2025 was calculated applying reduction ratio ranging from 0.7 to 1.0 based on the population growth characteristics in each Governorate

Table 7.2.5 Population Projection of M/P Target Cities (1/2)

Governo-rate	District	Sub -district	City & Town	1994	2004	2010	2015	2020	2025	Annual Growth Rate (%)
Lattakia	Total				2,534	2,600	2,700	2,800	2,800	
	Al-Haffeh	Slunfeh	Slunfeh		1,847	1,900	2,000	2,100	2,100	0.78
			Biereen		687	700	700	700	700	0.78
Tartous	Total				43,647	54,300	64,200	74,700	85,600	
	Banias	Banias	Banias	28,623	41,632	52,100	61,700	71,900	82,500	3.82
			Tero	726	838	900	1,000	1,100	1,200	1.45
			Khabet Snasel		645	700	800	900	1,000	2.03
			Boston Al-Najor	266	532	600	700	800	900	2.03
Deir -Ez-zor	Total			39,121	60,175	80,400	95,400	107,600	117,100	
	Mayadin	Mayadin	Mayadin	26,151	44,028	60,200	72,400	82,400	90,300	5.35
			Taiba	7,432	6,061	7,600	8,700	9,500	10,100	3.76
			Makhan	5,538	10,086	12,600	14,300	15,700	16,700	3.76

Table 7.2.5 Population Projection of M/P Target Cities (2/2)

Governorate	District	Sub -district	City & Town	1994	2004	2010	2015	2020	2025	Annual Growth Rate (%)
Hassakeh	Malkieh	Malkieh	Malkieh	22,182	26,311	29,100	31,200	33,000	34,500	1.72
Raqqa	Thawra	Thawra	Thawra	54,473	69,425	80,300	90,700	102,400	115,600	2.46
Dar'aa	Total			23,844	30,536	35,600	39,600	43,100	46,200	
	Dar'aa	Dar'aa	Atman	5,942	8,929	11,400	13,200	14,600	15,700	4.16
	Muzerib	Muzerib	Muzerib	10,476	12,640	14,200	15,500	16,700	17,900	1.90
			Yaduda	7,426	8,967	10,000	10,900	11,800	12,600	1.90
Rural Damascus	Total			40,966	47,737	54,000	58,700	62,700	66,100	
	Zabadani	Zabadani	Zabadani	21,049	26,285	30,000	32,800	35,200	37,300	2.25
			Bloudan	4,685	3,101	3,300	3,400	3,500	3,600	1.00
			Rawdah	2,825	4,536	6,000	7,100	8,000	8,700	4.85
			Hosh Bujet	429	604	700	800	900	1,000	3.48
		Madaya	Madaya	8,649	9,371	9,800	10,100	10,400	10,600	0.80
			Bukein	1,746	1,866	1,900	2,000	2,000	2,000	0.67
		Serghaya	Ain Hour	1,583	1,974	2,300	2,500	2,700	2,900	2.23

7.2.5 Verification by Regression Analysis

According to the National Census Data in 1981, 1994 and 2004, future population was estimated by adopting the following regression formula to verify the results of population projection by growth rate. Because of the nature of the formula, large populations were calculated by using the Exponential formula, while small populations were acquired by using the Logarithm formula. As the results of population projection by growth rate range between the results of the following four regression formula, the population projection adopted by the Study Team seems appropriate.

Regression Formula:

Linear **y=aX+b**
Geometric **y=a*X^b**
Logarithm **y=a+bLnX**
Exponent **y=a*e^bX**

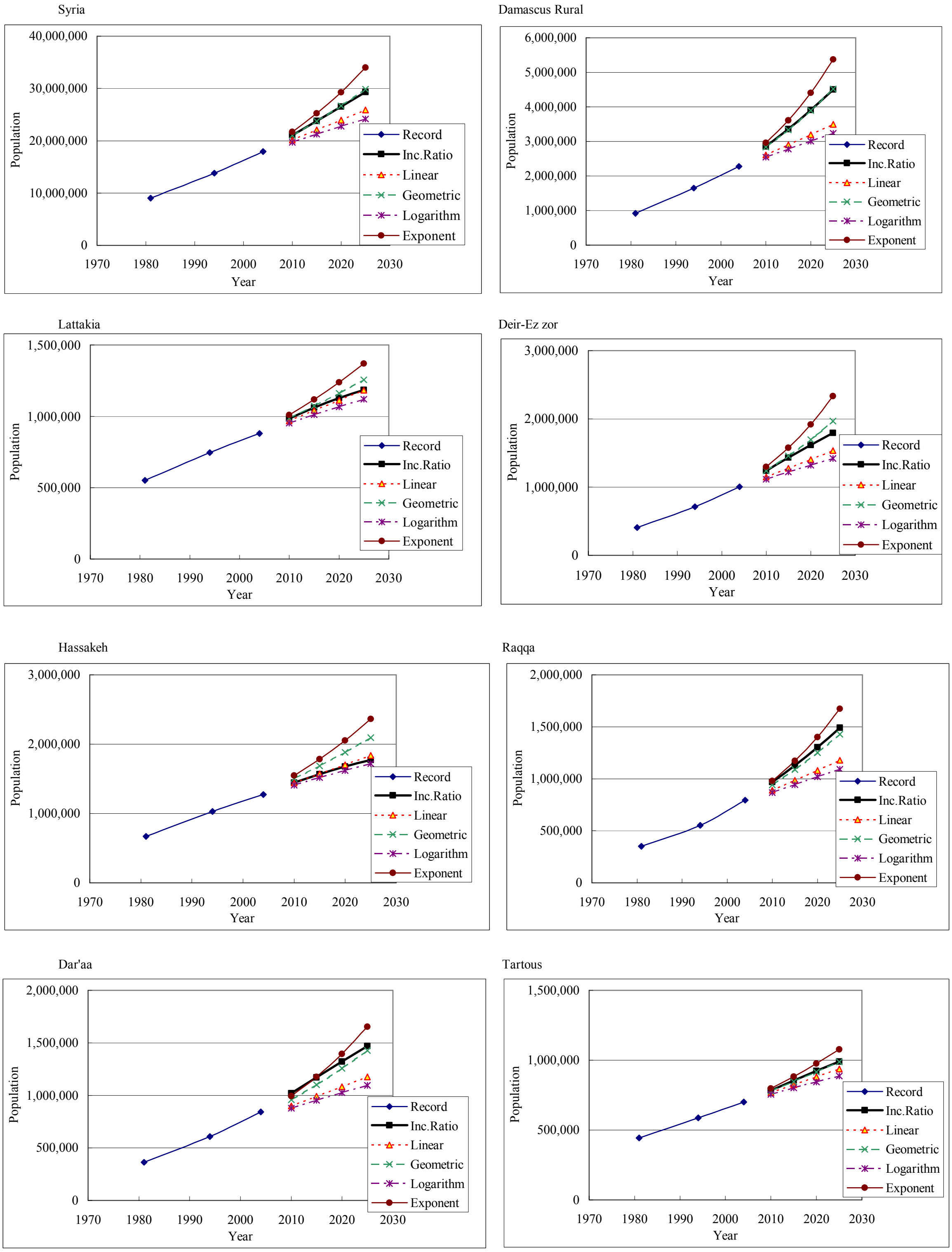


Figure 7.2.1 Results of Population Projection

7.3 Land Use Plan

Existing and future land use in the MP target year of 2025 by Governorates are shown in **Table 7.3.1 to 7.3.2**:

Table 7.3.1 Existing Land Use of Governorates

(Unit: km^2)

2006	Forests	Steppe and Pastures	Rocky and Sandy Land	Rivers and Lake	Building and Public Roads	Cultivated Land	Irrigated Land	Non-Irrigated Land	Fallow and others	Total
Lattakia	884	19	113	46	236	935	306	629	63	2,297
Tartous	324	29	52	24	235	1,232	273	960	0	1,896
Deir-Ez-zor	82	18,829	11,657	117	269	1,845	1,475	370	262	33,060
Hassakeh	1,221	5,890	698	258	651	12,949	4,851	8,098	1,668	23,334
Raqqa	165	9,462	330	688	656	5,554	1,998	3,557	2,761	19,616
Dar'aa	98	298	330	18	754	1,588	330	1,257	645	3,730
Rural Damascus	572	13,180	1,434	32	738	1,294	746	548	767	18,018
Aleppo	518	2,269	2,428	309	709	9,949	1,922	8,027	2,319	18,500
Qunetra	33	131	55	10	68	248	45	203	1,316	1,861
Damascus	11	0	0	0	93	14	14	0	0	118
Total	3,908	50,107	17,097	1,502	4,409	35,608	11,960	23,649	9,801	122,430

Source) Statistical Abstract 2006

Table 7.3.2 Future Land Use of Governorates

(Unit: km^2)

2025	Forests	Steppe and Pastures	Rocky and Sandy Land	Rivers and Lake	Building and Public Roads	Cultivated Land	Irrigated Land	Non-Irrigated Land	Fallow and others	Total
Lattakia	884	19	106	46	261	980	377	603	0	2,297
Tartous	324	29	19	31	260	1,232	273	960	0	1,896
Deir-Ez-zor	110	18,829	10,916	152	297	2,376	2,142	235	380	33,060
Hassakeh	1,635	5,890	653	334	720	12,172	7,030	5,142	1,928	23,334
Raqqa	221	9,462	309	892	726	5,161	2,902	2,260	2,845	19,616
Dar'aa	131	298	309	24	834	1,443	484	959	691	3,730
Rural Damascus	767	13,180	1,343	42	817	1,716	1,105	611	154	18,018
Aleppo	695	2,269	2,274	400	785	9,272	2,792	6,480	2,807	18,500
Qunetra	44	131	51	13	75	231	66	165	1,315	1,861
Damascus	11	0	0	0	100	7	7	0	0	118
Total	4,822	50,107	15,980	1,934	4,875	34,590	17,178	17,415	10,120	122,430
Ratio to 2006	123%	100%	93%	129%	111%	97%	144%	74%	103%	100%

Source) Statistical Abstract 2006

By comparison of existing and future land use, the followings were observed:

- “Rocky and sandy area” and “non-irrigated land” will be reduced, while
- “Forests”, “rivers and lake” and especially “irrigated land” will be expanded.

7.4 Wastewater Quantity and Quality

7.4.1 Wastewater Quantity

(1) Per Capita Sewage Rate

1) General

Since the documentation of relevant data on water supply is quite poor in Syria, the accurate estimation of per capita sewage rate is also extremely difficult. As a remedial measure, reference will be made to the existing study reports and actual life situations in residential areas.. However, as water supply data is fundamental to the preparation of the water supply plan and sewerage system development plan, appropriate information will be gathered and documented properly for the greater accuracy and reliability of required references.

The distribution of water supply is limited in Damascus, and water runs only from 6 AM to 3 PM. Therefore, every household is equipped with storage tank to secure water during water supply suspension hours. This is revelatory of the nationwide chronic water shortage in Syria. Owing to such circumstances, the hourly water consumption curve shows only one peak in the morning. As residents are fully aware of the current water supply status, per capita water consumption is not expected to grow drastically in future.

2) Existing Studies

According to the Feasibility Study on Zabadani executed by EIB and the Feasibility Study on Barada & Ghouta implemented by WB, the per capita sewage rate was created as shown in **Table 7.4.1**. However, detailed bases for per capita sewage rate were not clarified in each of these studies.

Table 7.4.1 Per Capita Sewage Rate in Existing Studies

	Unit		Zabadani by EIB	Brada & Ghouta by WB
Domestic Water demand	L/capita/day	2005 2025	80 175	110 110
Non-domestic demand				10 % of domestic demand
Unaccounted for water				20 % of domestic demand
Wastewater Production	%		80	80
Max. day factor			$5/P^{1/6}$ P: (Population in 1000)	1.2
Peak hour factor				1.8

Source) Feasibility Study on Muzebib Sewerage System/GCEC
Pre-Feasibility Study Zabadani Water and Wastewater Project/EIB
Wastewater Strategic Plan and Priority Investment Study in Barada & Ghouta Gharbiyah/WB

DAWSSA established the per capita water consumption as shown in **Table 7.4.2** and reflected them in facility designing.

Table7.4.2 Per Capita Water Consumption by DAWSSA

Community Population			LCD
1	to	5,000	75
5,000	to	10,000	100
10,000	to	25,000	125
25,000	to	50,000	150
50,000	or	More	175

Note) LCD = liter/capita/day

3) Per Capita Sewage Rate

a) Domestic Water Consumption

Total sewage rate is computed as follows:

Total sewage rate

=（Domestic Water Consumption + Commercial Water Consumption）× Conversion Ratio

+ Groundwater Infiltration

As domestic water consumption is essential to human life, the local difference is considered to be less. In Japan, domestic water consumption is about 200 LCD. Considering the current water supply conditions in Syria, domestic water consumption can be assumed to be 100 LCD approximately. Provided that per capita domestic water consumption will increase to 5 LCP every 5 years, it is expected to increase to 120 LCD in the year 2025.

b) Non-domestic Water Consumption

Non-domestic water consumption refers to water consumption in stores, offices and schools, except residential consumption. This can be calculated by ratio against domestic water consumption. This ratio is higher in urbanized areas and lower in residential areas. Per capita water consumption established by DAWSSA appears to include non-domestic water consumption.

According to the WB Study, the ratio of 30% was proposed that covers non-domestic water consumption and unaccounted for water. Correspondingly, the ratio assumed was as follows: 10% for residential areas and 30% for urbanized areas. For greater accuracy, relevant data will be corrected and arranged. The ratio of non-domestic water consumption for purposes of the cities prioritized under the Master Plan were settled as shown in **Table 7.4.3**:

Table 7.4.3 Ratio of Non-domestic Sewage

Governorate	District	Sub -district	City & Town	Ratio of Non-domestic Water Consumption	Remarks
Lattakia	Al-Haffa	Slunfeh	Slunfe	0.1	Residential
			Beireen	0.1	Residential
Tartous	Banias	Banias	Banyas	0.3	Big City
			Tero, Snasel,Najer	0.1	Residential
Deir-Ez-zor	Mayadin	Mayadin	Mayadin	0.3	Big City
Hassakeh	Malkieh	Malkieh	Malkieh	0.1	Residential
Raqqa	Al-Thawra	Al-Thawra	Al-Thawra	0.3	Big City
Dar'aa	Dar'aa	Dar'aa	Atman	0.1	Residential
	Muzerb	Muzerib	Muzerieb	0.1	Residential
			Al-Yaduda	0.1	Residential
Rural Damascus	Zabadani	Zabadani	Zabadani	0.3	Big City
			Bloudan	0.1	Residential
			Raudah Batruna	0.1	Residential
			Hosh Bajet	0.1	Residential
		Madaya	Madaia	0.1	Residential
			Bukein	0.1	Residential
		Surghya	Ain Hour	0.1	Residential

c) Conversion Ratio

Car washing water and gardening water do not flow into sewer pipes. The sewage conversion ratio refers to the water volume ratio calculated by dividing the water volume flows into the sewer pipe by the total water volume consumed. Existing studies assumed this ratio to be 80%. Correspondingly, the sewage conversion ratio of 0.8 was adopted.

d) Unaccounted Flow

If sewer pipes are installed below the groundwater level, groundwater infiltration into sewer pipes is duly anticipated. This infiltration volume must be added as groundwater infiltration. In Japan, this infiltration volume is assumed to be 10 to 20% of domestic sewage rate.

Owing to the scarce precipitation and shallow sewer pipe installation depth, groundwater infiltration volume may be regarded as negligible in Barada & Awaj and Yarmouk River basins. On the other hand, groundwater level is seemed to be high in Euphraties River basin and Mediterranean sea basin. In the WB Study, additional 30% flow is considered as non-domestic and unaccounted flows. An unaccounted flow includes groundwater. Considering abovementioned cases, unaccounted flow should be added to sewage volume. Therefore, unaccounted flow is assumed as 20% of Daily Maximum Unit Flow.

e) Hourly Fluctuation Ratio

The sewage rate has hourly and seasonal fluctuations. The daily maximum sewage rate refers to the maximum sewage rate generated throughout the year. This sewage rate is calculated by multiplying the ratio to the annual average sewage rate. This ratio is called the Max Day Factor and calculated by "annual maximum sewage rate/annual average sewage rate". According to Japanese data, the max day factor is 1.2. The World Bank also applied this 1.2 factor in their study. In accordance with these, the Max Day Factor of 1.2 was adopted for purposes of this study.

The pipeline and pumping station is designed based on the Hourly Maximum Sewage Rate. This sewage rate refers to the hourly maximum sewage rate within one day and is calculated by multiplying the ratio by the Daily Maximum Sewage Rate. This ratio is called the "Peak Hour Factor". In the WB Study, this ratio was set by 1.8. In the EIB Study, this ratio was calculated based on the population scale:

Peak Hour Factor (EIB) $=5/P^{1/6}$

P: Population (1,000)

The relationship between peak hourly factor and population size is shown in **Table 7.4.4**:

Table 7.4.4 The Relationship between Peak Hourly Factor and Population Size (EIB Study)

Population	Peak hour Factor
5,000	3.82
10,000	3.41
20,000	3.03
50,000	2.61

In Japan, the Peak Hour Factor ranges from 1.5 to 2.0. Compared to this, the factor indicated in the EIB Study appears to be excessive. The typical hourly fluctuation of the sewage rate in Syria is shown in **Figure 7.4.1**. The data of Adraa STP was measured by the Syrian Engineer on November 15, 2006. The data of Mayadin and Banias was measured by the Study Team on June 26, 2007.

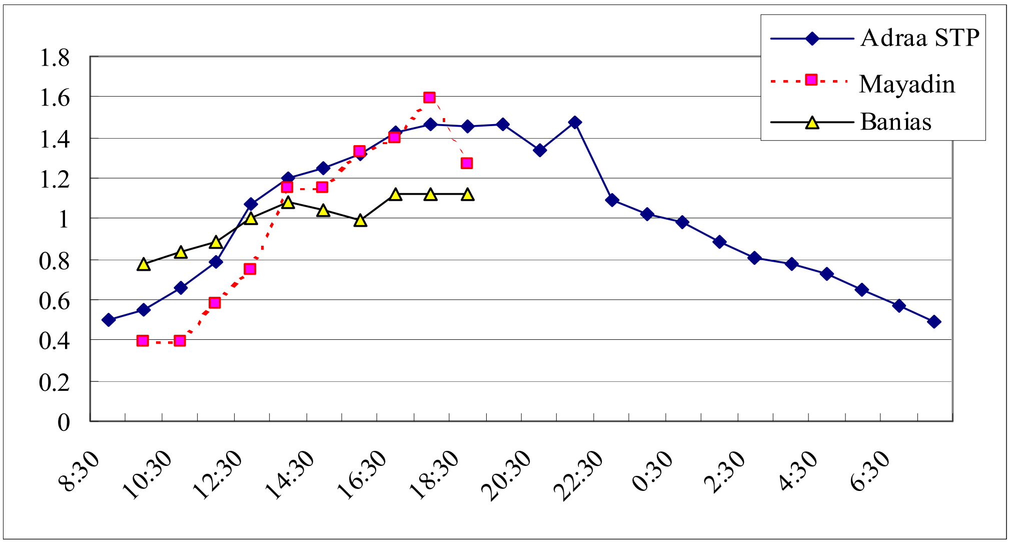


Figure 7.4.1 Hourly Fluctuation of Sewage Rate

f) Tourism Sewage Rate

Zabadani, Bluden, Bukein, Slunfeh, Banias are tourism spots and many tourists gather in these places during the summer season. Therefore, the sewage rate in the summer season is much larger than that during the winter season. In facility planning, the sewage rate during the summer season must be estimated. The tourism sewage volume ratio was defined as the ratio of summer tourism sewage volume measured against domestic sewage volume. This served as the basis of establishing the tourism sewage volume ratio. The ratio for Zabadani was set based on the EIB Study. Those for Slunfeh and Banias were set based on the information taken from the Governorate officers.

Sewage generated by tourists is shown in **Table 7.4.5**:

Table 7.4.5 Sewage Generated by Tourists

Municipality	Sewage by Tourists	Sewage by Residence	Total
Slunfeh	400 %	100 %	500 %
Banias	50 %	100 %	150 %
Zabadani	200 %	100 %	300 %
Bloudan	300 %	100 %	400 %
Madaya	50 %	100 %	150 %
Bukein	250 %	100%	350%

Source) EIB Report and interview to Governorate Officers

g) Summary

Based on the above-mentioned conditions, per capita domestic sewage rate was calculated as shown in **Table 7.4.6** and **7.4.7**:

Table 7.4.6 Per Capita Domestic Sewage Rate (Non-domestic Ratio= 0.3)

(Unit : LCD)

Items	2004	2010	2015	2020	2025
Daily Average Flow (DAF)					
Domestic	100	105	110	115	120
Non-Domestic	30	32	33	35	36
Total	130	137	143	150	156
Conversion ratio			0.8		
Wastewater	104	109	114	120	125
Daily Maximum Flow (DMF) (DMF=1.2×DAF)					
	125	131	137	144	150
Peak Hour Flow (PHF) (PHF=1.8×DMF)					
	225	236	247	258	270
Unaccounted Flow (=DMF×20%)					
	25	26	27	29	30
Design Sewage Unit Flow					
Daily Average	129	135	142	148	155
Daily Maximum	150	157	165	172	180
Peak Hour	250	262	275	287	300

Table 7.4.7 Per Capita Domestic Sewage Rate (Non-domestic Ratio= 0.1)

(Unit : LCD)

	2004	2010	2015	2020	2025
Daily Average Flow					
Domestic	100	105	110	115	120
Non-Domestic	10	11	11	12	12
Total	110	116	121	127	132
Conversion ratio			0.8		
Wastewater	88	92	97	101	106
Daily Maximum Flow (DMF) (DMF=1.2×DAF)					
	106	111	116	121	127
Peak Hour Flow (PHF) (PHF=1.8×DMF)					
	190	200	209	219	228
Unaccounted Flow (=DMF×20%)					
	21	22	23	24	25
Design Sewage Unit Flow					
Daily Average	109	115	120	125	131
Daily Maximum	127	133	139	146	152
Peak Hour	211	222	232	243	253

Note) Assumption:

- Daily Domestic Average Flow (Water Consumption) increases 1 LCD/Year owing to future living level upgrading
- Non-domestic ratio of 0.3 was adopted to Urbanized Area, while 0.1 was employed to Residential Area
- 80% of consumed water converts into wastewater
- Daily Maximum Flow is 1.2 times of Daily Average Flow
- Hourly Maximum Flow is 1.8 times of Daily Maximum Flow

h) Current Sewage Rate

As the development of the sewer network has almost been completed especially for the urban areas, a large percentage of the generated sewage centers on the discharge points. Thus, the current generated sewage rate can be estimated to some extent by measuring the discharged sewage volume. In the preparation of future FS, the verification of the current sewage rate done by measuring the sewage rate at discharge points can prove useful. Flow measurement can be conducted every one hour for a possible duration of two weeks. By this method, , the daily sewage rate and hourly sewage rate fluctuation can be acquired. Especially, the seasonal sewage rate data is quite useful for tourist spots with large seasonal sewage rate fluctuations. Further, this will lead to the collection and documentation of data related to sewage quality.

In the course of the study, simplified flow measurement was carried out in Zabadani and Makhan. The result shows larger values compared to the sewage volume calculated by multiplying the estimated per capita sewage rate by the served population. This is attributed to the following:

- Abovementioned flow measurement was conducted to observe hourly flow fluctuation and to estimate per capita daily sewage rate. Two cities were selected since there is no influence of industrial wastewater generated by large-scaled factories. 10 times of flow measurement was carried out per day by one hour intervals.
- Per capita daily sewage rate calculated based on the flow measurement results became much larger than per capita sewage rate estimated based on per capita daily water consumption. This discrepancy owes to the groundwater infiltration and sewage generated by statistically uncounted population.

As the examination of such unidentified water samples was not fully conducted, sewage volume calculated by measuring per capita sewage rate and served population was adopted for purposes of planning.
The comparison of discharged sewage volume and calculated sewage volume is shown in **Table 7.4.8**:

Table 7.4.8 Comparison of Discharged Sewage Volume and Calculated Sewage Volume

Day	City	Pipe	Water depth (m)	Area (m^2)	Velocity (m/s)	Quantity (m^3/day)	Population (person)	Average in 2004 (m^3/day)
26/7/2007 3:00 PM	Zabadani	D 0.8m x 2	0.3	0.172	0.8	23,800	40,623	8,671
15/8/2007 1:00 PM	Makhan	W 1.5m	0.08	0.120	0.8	8,300	10,086	888

7.4.2 Wastewater Quality

(1) Sewage Quality

1） Pollution Load

According to the studies conducted by other donor agencies, a constant pollution load was adopted regardless of the design sewage volume. Based on this design policy, thin sewage is generated in large sewage volume and thick sewage is generated in small sewage volume. This is totally discrepant to the current situation.

In some studies, a BOD of 600 mg/L was applied in small-scale sewerage systems and 54 hours in aeration time was adopted for extended aeration methods. If the design sewage volume differs to a great extent, such discrepancy will be outstanding. To remove this contradiction, the basic domestic pollution load should be appropriately established and the commercial pollution load should also be counted. If the sewage volume increases, the pollution load will increase proportionately.

Per DAWSSA findings, the standard per capita water consumption varies depending on the population scale, ranging from 75ℓ to 175ℓ. (Refer to **Table 7.4.2**.) In large-scale urbanized cities, per capita water consumption is expected to be higher due to improved lifestyles and large commercial water use. As aforementioned, groundwater infiltration is negligible and thus per capita sewage rate is likely similar to per capita water consumption. Per capita water consumption by population scale is shown in **Table 7.4.9**:

Table 7.4.9 Per Capita Water Consumption by Population Scale

Population Scale	Per Capita Water Consumption （LCD）
1-5,000	75
5,000-10,000	100
10,000-25,000	125
25,000-50,000	150
50,000 or more	175

Source）DAWSSA Data

Assuming that the minimum per capita water consumption of 75 ℓ in small-scale communities is considered as the basic water volume needed in daily life, this value was adopted as the basic per capita sewage rate. Sewage rate in such small-scale communities is supposed to be equivalent to water consumption volume.

Referring to the available pollution load data on **Table 7.4.10**, 23 g/d/c was adopted as the minimum pollution load. This was due to the assumption that lifestyles in French rural areas are similar to that in the rural parts of Syria. Inasmuch as there is no data available for other pollution loads except basic domestic pollution load, basic domestic sewage quality was identified as the standard sewage quality.

Table 7.4.10 Available Pollution Load Data

Location				Items	Pollution Load (g/d/c)					Source
Regional	Nation	City	Area		BOD_5	SS	COD	T-N	T-P	
Asia	Thai	Chaopia river downstream basin		Excreta	11.4	8.7				
				Sullage	41.9	16.6				
				Total	53.4	25.3				
	Indonesia	Jakarta		Excreta	10.5					
				Sullage	30.4～14.2					
				Total	40.9～24.7					
		Tempasar		Excreta	11.2					
				Sullage	32.7～15.6					
				Total	43.9～26.8					
	India				30～45					Duncan Mara
	India				35	67				D.A.Okun & G.Ponghis
	Japan			Excreta	18	20	10	9	0.9	The Japan Sewage Works Association
				Sullage	40	25	17	2	0.4	
				Total	58	45	27	11	1.3	
Southeast Asia					43					Duncan Mara
Africa	Zambia				36					Duncan Mara
	Kenya				23					Duncan Mara
	Uganda	Kam-pala	inhabited		63	43				D.A.Okun & G.Ponghis
South America	Brazil	Guan-abara				75				D.A.Okun & G.Ponghis
		San Pauro			44					WHO
Develop-ing country					45					WHO
			industrial		54	90				D.A.Okun & G.Ponghis
Western Europe	France		rural		23～34					Duncan Mara
	U.K.				50～59					Duncan Mara
					59	62				D.A.Okun & G.Ponghis
U.S.	U.S.				45～78					Duncan Mara
				Excreta	16.7	27		8.7	1.2	"Design Manual - Onsite wastewater Treatment and Disposal System"1980.10
				Sullage	28.5	17.2		1.9	2.8	
				Total	45.2	42.2		10.6	4	

Based on the above provisions, the BOD pollution load was estimated to be 23 to 54 g/d/c. (Refer to **Table 7.4.11)**. Comparing these values with those in other foreign countries, the lower values correspond to the pollution load generated in developing countries while the higher values correspond to those generated in advanced countries. This wide range is indicative of the local situation in Syria. Furthermore, the design pollution loads adopted by other donor agencies and GCEC are also estimated to be within this range.

Table 7.4.11 BOD Pollution Load

Design Sewage Volume (ℓ/d/c)	BOD Pollution Load (g/d/c)	Calculation
75	23	
175	53.7#	=23 g x175ℓ/75ℓ

Based on the above-mentioned BOD pollution load, the BOD concentration of sewage was calculated as 307 mg/ ℓ. This value is applicable compared to the current sewage quality in Syria. Upon water pollution analysis, the average value of 38 g/d/c is applied.

Referring to the data culled from the sewage quality analysis in Adraa STP, an area that had the largest number of samples, the average pollution load of SS, T-N, T-P was established as shown in **Table 7.4.12**. Although the T-P is a little bit high, it is still lower than the largest value of 4 g/d/c adopted in the USA and in this case, will not adversely affect planning.

Table 7.4.12 Average Pollution Load for Water Pollution Analysis

Parameter	Pollution Load (g/d/c)	Calculation (g/d/c)
BOD	38	23+53.7/2=38.4
SS	45	#1 38.4*242/205=45.3
T-N	9	#2 38.4*62/255=9.3
T-P	3	#3 38.4*20/255=3.0

#1 When BOD is 205mg/ ℓ , SS is 242mg/ ℓ

2005 year Annual average	BOD 205 mg/l	SS 242 mg/l

#2 When BOD is 255mg/ ℓ, T-N is 62mg/ ℓ

#3 When BOD is 255mg/ ℓ , T-P is 20mg/ ℓ

	PO_4 (mg/l)	T-N(mg/l)	BOD(mg/l)
2006/12/5	19.1	68.63	220
2006/12/18	21.7	58.60	244
2006/1/15	20.2	59.35	302
Average	20.3	62.20	255

2) Design Sewage Quality

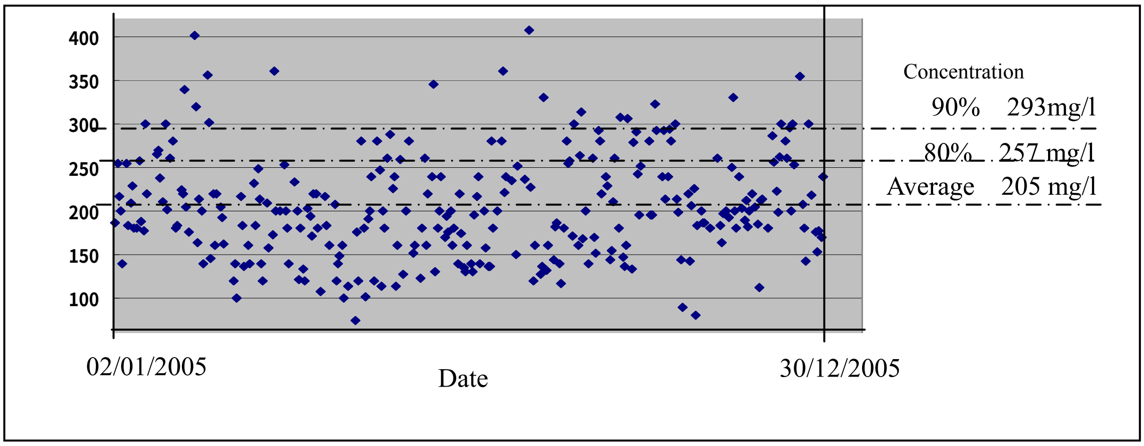
Based on the average pollution load, design sewage quality was established as shown in **Table 7.4.13** with allowance considering the unforeseen circumstances.

Table 7.4.13 Average Pollution Load and Design Sewage Quality

Parameter	Pollution load when average sewage unit flow is 155 LCD (g/d/c)	Calculated Sewage Quality (mg/ℓ)	Design Sewage Quality (mg/ℓ)
BOD	38.4	248	310
SS	45.3	292	360
T-N	9.3	60	74
T-P	3.0	19	24

The distribution of BOD concentration of incoming sewage to Adraa STP is shown in **Figure 7.4.2**. The laboratory of the Adraa STP has abundant sewage quality data. A BOD concentration of 307 mg/ ℓ was calculated at the upper portion of **Figure 7.4.2** and this provides ample room to planning.

Figure 7.4.2 BOD Concentration of Incoming Sewage(Adraa STP, 2005)



Source: Adraa STP Laboratory Record

Compared to the results of sewage quality analysis conducted by the Study Team at Mayadin where domestic sewage is predominant, 307 mg/ ℓ is exceeds the average BOD concentration. This also indicates that designed facilities should have an appropriate allowance if 307 mg/ ℓ that can be applied in facility designing. (Refer to **Table 7.4.14)**.

Table 7.4.14 Discharged Sewage Quality in Mayadin City (27 June 2007)

Sampling Time			9:30	12:30	15:30	18:30	Average
Quality	SS	mg/l	585	562	530	455	533
	BOD	mg/l	297	285	234	333	287
	COD	mg/l	433	315	255	374	344
	T-N	mg/l	60	44	40	44	47
	T-P	mg/l	3.0	3.8	3.5	3.0	3.3
	Coliform	Bacteria /100ml	3×10^6	15×10^6	18×10^6	120×10^6	
Flow rate			0.39	0.75	1.32	1.27	Max 1.6 At 17:30

CHAPTER 8 RECOMMENDATION ON DEVELOPMENT STRATEGY

8.1 Background and Framework of Development Strategy

The paramount goal of the Sewerage System Development is to protect water resources from pollution. In Syria, however, a large scale of investments in the sewerage projects has already stared in the absence of national goals on water quality preservation of public waters. To rationalize and optimize the scale of investments in the sewerage projects, a development strategy for the water quality control as well as for the sewerage management needs to be established.

In the target study areas, however, there are a variety of pollution sources including domestic, industrial, livestock wastewater, and non-point sources such as runoff from agricultural land, urban areas, forests, etc. Each of the pollution loads contributes significantly to contamination of surface water, groundwater and seawater. For example, although domestic wastewater is the largest BOD pollution source common to all the target seven governorates, significant contribution of industrial wastewater to the public water pollution is observed in Tartous, Lattakia, Deir-Ez-zor and Rural Damascus Governorate, while pollution loads from non-point sources have a considerable level in Raqqa and Hassakeh Governorate. In particular, inadequate treatment of domestic and industrial wastewater is a serious problem to water resources preservation. Although a numerous number of public sewer networks are in place in the study areas, most of them are not equipped with sewage treatment plants, and management of industrial wastewater discharge is also poor, with uncontrolled discharges of untreated effluent to water bodies (through often drainage or storm water channels) or to the public sewer system.

In such circumstances, only providing countermeasures that can be taken by the sewerage sector (i.e., sewerage system development) is not enough for water resources pollution control, and comprehensive pollution control measures need to be implemented involving other relevant sectors.

Firstly, as a strategy for the water quality control, a framework recommended here is an approach that quantifies the issues possible in Syria. The key steps are to:

- Establish a lead organization and involve stakeholders
- Set water quality objectives
- Develop strategies
- Conduct monitoring and feedback

Lead Organization

The lead organization, the Ministry of Housing and Construction (MHC), must keep on good cooperation with the environmental/water quality monitoring ministries, the Ministry of Local Administration and Environment (MLAE) and the Ministry of Irrigation (MOI), and have access to all other relevant ministries and agencies and must have enough influence to ensure the involvement of key private sector stakeholders. It must be sufficiently persuasive to promote discussion and consensus among the many parties involved. It does not have to have all powers and functions necessary for implementation, but to be given only technical and coordination functions. However, it must have sufficient support at all government levels and with other stakeholders so that all the relevant bodies cooperate in the planning process and are held to the agreements reached.

Water Quality Objectives of the Receiving Water Bodies

From the environmental point of view, a wastewater strategy must be based on a water quality plan for the receiving water bodies, and therefore, it is necessary to have explicit medium- to long-term objectives for the quality of water in the water bodies in the catchment under consideration. Although these objectives are not yet established in Syria, they are generally based on defined beneficial uses for the water bodies, typically including uses such as source of water supply, agricultural use, fisheries protection, and so on. A set of key numerical parameters can be defined for each use, and the water quality objectives can be developed in terms of uses for different sections of the water bodies and a strategy for achieving those standards. The objectives then provide clearly defined goals for protection or improvement of each section of the system.

Developing the Strategy

Load Estimation

The first step in developing a wastewater strategy is to estimate the overall loads in the catchment over the time scale being considered, which is about 20 years in case of this study. This will require, in addition to information on population growth and densities, estimates of industrial and agricultural activities and information of land use conditions. Overall planning requires estimates of domestic, industrial, livestock, agricultural land and natural loads on a geographic basis and over the time period under consideration. The estimates need to be developed for key parameters such as BOD, COD, nutrients, fecal coliform, depending on the particular characteristics of the catchment and receiving waters.

Determination of the Reductions Necessary

Once load estimates are available, it is possible to determine the reductions in present and future loads needed to achieve the water quality objectives. For this purpose, it is necessary to carry out water quality modeling. The objective of the modeling is to estimate the impacts of the increasing loads on water quality and to identify where load reductions are required in order to achieve the water quality objectives.

Development of Options for Load Reduction

After the desired degree of reduction in pollutant loads has been estimated, the next step is to develop options for achieving that reduction. If the most significant pollutants are those associated with effluent form sewer networks, for example, the control effort will clearly be concentrated on the municipal wastewater treatment. Often, however, oxygen depletion and nutrients are the critical issues, and the causes are typically a mixture of municipal and industrial sources. Then it is necessary to control both type of sources.

The major components of the options for load reduction are:

- Expansion/Upgrading of sewer systems
- Development/Upgrading of sewage treatment
- Introducing a system to regulate discharges of industrial wastewater
- Reducing industrial loads
- Control of non-point pollution source of pollution

Monitoring and Feedback

The most critical management issue is to monitor the desired outcome (the ambient water quality) and to compare it with the projections used in the design. Any major variations from the design predictions will then be identified, and appropriate adjustments can be made.

Secondly, the other important issue is the establishment of a development strategy for the sewerage sector itself, in order for the Syrian sewerage sector to be able to sustain the sewerage operation by themselves throughout the life cycle of sewerage management. This will include overall aspects such as technical, institutional, organizational, and financial improvements. These issues will be discussed in Chapter 8.4.2**.**

8.2 Basic Conditions for Developing Strategy for Water Pollution Control

8.2.1 Establishment of River Basin Units for Analysis

In formulation of the Sewerage System Master Plan for prevention of water pollution in the river basin and improvement of public health, it is appropriate to arrange various types of collected data by river basin unit and make the water pollution analysis. However, necessary types of geographic information and statistic data are not fully provided in Syria and it is very difficult to arrange these types of data by river basin unit. Thus, various types of data available from the governorates belonging to the river basin will be arranged by basin unit to make the water pollution analyses.

The governorates under the water pollution analyses in each river basin unit are as follows:

Barada / Awaj River Basin	Rural Damascus and Damascus City
Coastal area (Mediterranean Sea Basin)	Tartous and Lattakia
Khabour River Basin	Hassakeh
Euphrates River Basin	Deir-Ez-zor, Raqqa and Aleppo
Yarmouk River Basin	Dar'aa and Qunetra

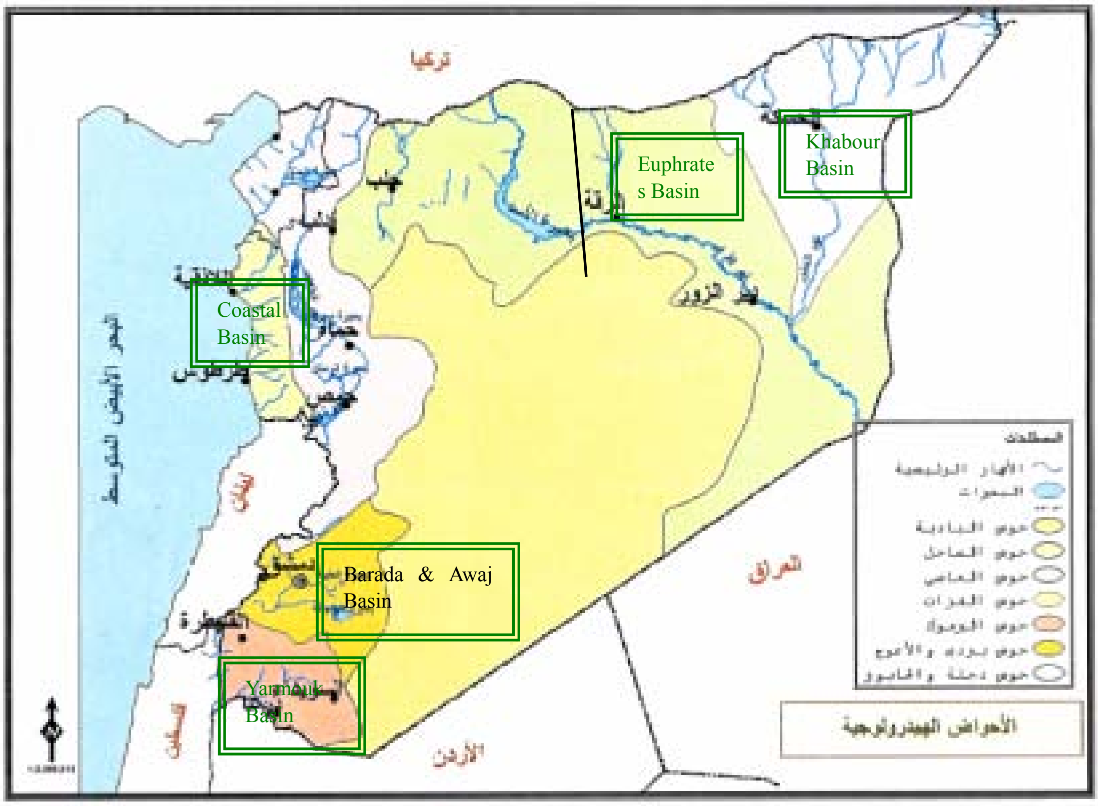


Figure 8.2.1 Target River Basin for Water Pollution Analysis

8.2.2 Water Quality Objectives of Target Water Bodies

In order to develop a wastewater strategy, it is necessary to have explicit medium- to long-term objectives for the quality of water in the water bodies (in other words, environmental standards for public waters).

Although these objectives are not yet established in Syria, many other developed or developing countries already set up such objectives in the form of the "Classification System", and they are generally based on defined beneficial uses for the water bodies.[1]

When considered water utilization situations of public waters in Syria, to apply the following water quality objectives is proposed at this moment for each public water body.

- Euphrates River: Drinking water supply with ordinary treatment
- Khabour River: Agricultural uses
- Barada & Awaj River: Agricultural uses
- Mediterranean Sea: Marine recreation uses such as bathing
- Yarmouk River: Drinking water supply with advanced treatment
- Groundwater Sources: Drinking water supply with simple treatment

As to pollution parameters applied for the analysis, BOD or COD is widely used in many cases, however, it is a prerequisite that existing monitoring data on such parameters are accessible. In case of the target water bodies, the monitoring parameters by each public water body are shown in **Table 8.2.1**.

Table 8.2.1 Monitoring Pollution Parameters

Public Waters	Monitoring Pollution Parameters
Euphrates	BOD, COD
Khabour (Al Basel Lake)	COD
Barada	BOD
Mediterranean Sea	Fecal Coliform
Yarmouk	BOD
Groundwater Source	NO_3

---

[1] Examples of Classification Systems

Malaysia

Ⅰ. Conservation of natural environment, water supply Ⅰ- practically no treatment necessary, Fishery Ⅰ- very sensitive aquatic species,

ⅡA. Water supply Ⅱ-conventional treatment required, Fishery Ⅱ- sensitive aquatic species,

ⅡB. Recreational use with body contact

Ⅲ. Water supply Ⅲ- extensive treatment required, Fishery Ⅲ- common, of economic value, and tolerant species livestock drinking

Ⅳ. Irrigation

Ⅴ. None of the above

Vietnam

ⅠA. Domestic water supply with appropriate treatment

ⅠB. The purposed other than domestic water supply

Ⅱ. Protection of aquatic life

Japan

AA. Drinking water supply with simple treatment; protection of natural environment and any other uses under A

A. Drinking water supply with ordinary treatment; support of troutoid fishes; bathing and any other uses under B

B. Drinking water supply with advanced treatment; support of salmonoid fishes and any other uses under C

C. Support of crucianoid fishes; industrial water supply with ordinary treatment and any other uses under D

D. Industrial water supply with advanced treatment using chemical dosing; agriculture and any other uses under E

E. Industrial water supply with special treatment; preservation of the river sight beauty

In consideration of availability for such existing monitoring data, this Study proposes to employ the following pollution parameters for each target water body based on the reasons herewith.

- Rivers: BOD (BOD is used worldwide as a parameter to assess organic pollution for rivers. The BOD data is available for the target rivers in Syria.)
- Mediterranean Sea: Fecal Coliform (COD is often used to assess organic pollution of sea waters, and fecal coliform is usually used as a parameter of microbiological contamination. However, only fecal coliform data is accumulated and no COD data is available for the Mediterranean Sea. Fecal coliform is an important indicator to assess whether the seawater quality is suitable for marine recreational activities such as bathing.)
- Groundwater: Total Nitrogen (T-N) (NO_3 contamination of groundwater is a critical problem for drinking water sources in Rural Damascus. Abundant NO_3 data are accumulated.)

In summary, the temporally water quality objectives can be proposed as shown in **Table 8.2.2**.

Table 8.2.2 Proposed Water Quality Objectives for Target Water Body

Public Waters	Water Quality Objectives	Proposed Water Quality Standards		
		BOD (mg/l)	T-N (mg/l)	Fecal Coli (MPN/100ml)
Euphrates river	Drinking water supply with ordinary treatment	2*1	-	-
Khabour river	Agricultural uses	8*1	-	-
Barada river	Agricultural uses	8*1	-	-
Mediterranean	Marine recreation uses such as bathing	-	-	1,000*1
Yarmouk river	Drinking water supply with advanced treatment	3*1	-	-
Groundwater	Drinking water supply with simple treatment	-	12*2	-

Note 1): *1; Japan's water quality standards are applied.
*2; The WHO guideline for drinking water regulates NO_3 concentration to less than 50mg/l, this comes to 11.3 mg/l as NO_3-N.

Note 2): As shown in the right table, no large difference is found in the BOD standards for the same objective of the beneficiary uses between the countries. Therefore, it is relevant to apply the Japanese standards.

BOD standards for water quality objectives in rivers (mg/l)

Objectives	Vietnam	Malaysia	Japan
Water Supply Ⅰ	Less than 4	1-3	2
Water Supply Ⅱ		3-6	3
Agricultural Use	-	6-12	8

For the drinking water quality standard of groundwater, the WHO standard is applied because it is widely used in many developing countries.

8.3 Proposed Development Strategy for Water Pollution Control

8.3.1 Methodology for Developing Strategy

There is a diversity of pollution sources including unspecified pollution sources in the river basin units. To develop the water pollution prevention strategy, it is necessary first to estimate the future pollution loads that are predicted based on the current status and various countermeasures.

Various future pollution loads (in 2025) can be inferred from the trend of various pollution sources which can be grasped by collecting the statistic materials and data on various pollution sources (point source pollution loads and non-point source pollution loads). In addition, it is necessary to predict the reductions of various pollution loads by various countermeasures, and forecast and evaluate the water quality improvement effects in each water body in the target river units in taking these countermeasures.

In this study, the pollution loads (discharge loads) from pollution sources in each governorate belonging to the target river basin unit, the pollution loads (runoff loads) which run off to rivers and sea areas, and the pollution loads (infiltration loads) infiltrated into groundwater will be estimated. The river water quality data, flow data and water quality data of sea areas and groundwater will also be collected to analyze the correlation between these pollution loads and the water quality in the water bodies into which those pollution loads are discharged. The definition of each pollution load for the purpose of this study is shown in **Figure 8.3.1**.

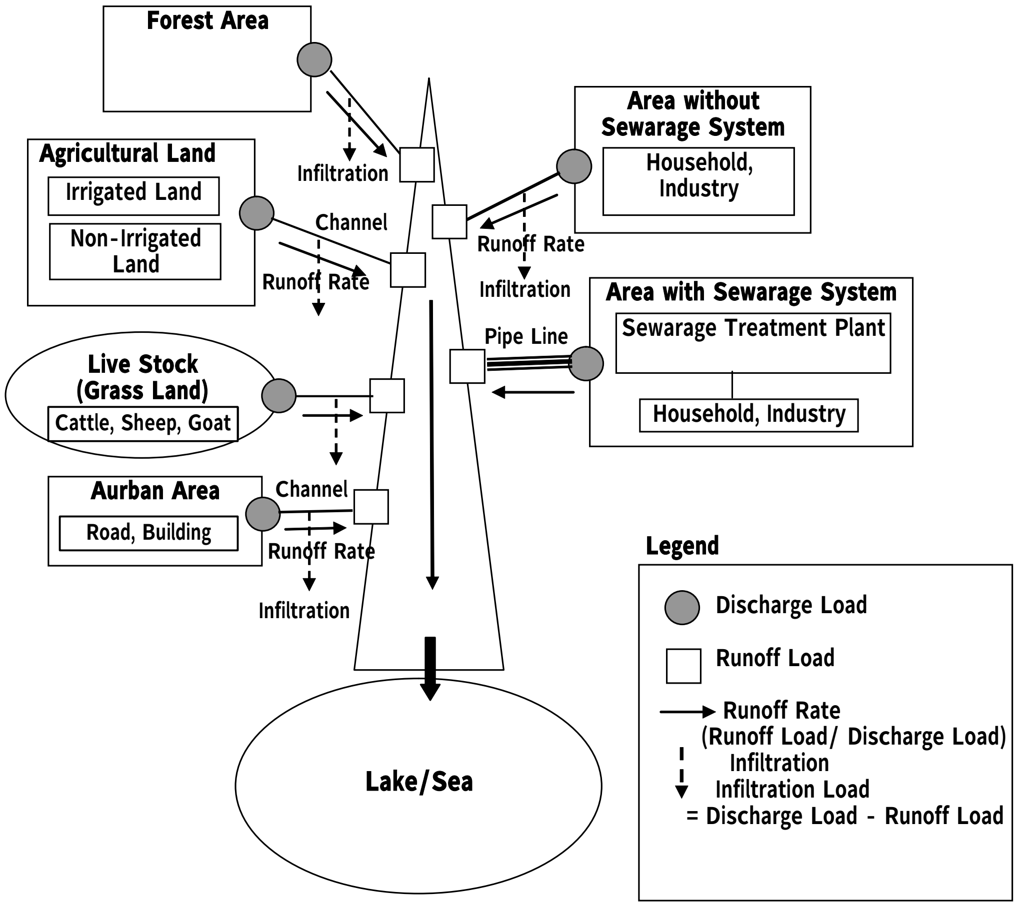


Figure. 8.3.1 Definitions of pollution loads in this study

(1) Divisions of Pollution Loads

In this study, the pollution sources in the target river basin units are divided into point-source type and non-point source type (unspecified pollution source type). For estimation of pollution loads, the point sources are further divided into domestic sewage, sewage system and industry, and the non-point sources include agricultural lands, urban areas and forests/grasslands. The pollution load from livestock is handled as a point source load in general, but the loads from grasslands and pastures are deemed as the loads from livestock and handled as the non-point source loads because most of livestock are raised in grasslands and pastures in Syria.

The categories of pollution sources are shown in **Figure 8.3.2** below.

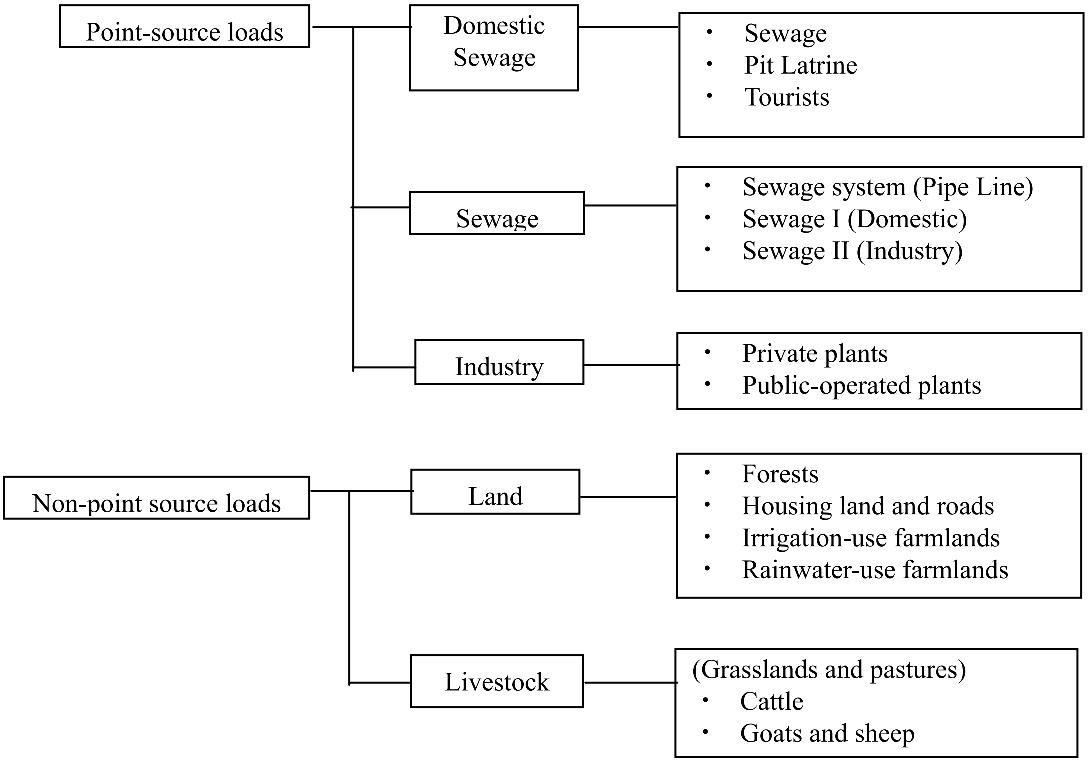


Figure 8.3.2 Categories of pollution sources in this study

(2) Target Water Quality Items

For estimation of pollution loads (discharge loads, runoff loads and infiltration loads), four water quality items of BOD, COD, T-N, and T-P are adopted.

In the water pollution analyses made in the coast of the Mediterranean Sea, fecal coliforms were used as water quality index. In the estimation of the runoff load due to fecal coliforms, the relations between BOD, COD, T-N, T-P, and fecal coliforms were grasped to define the runoff loads due to fecal coliforms from the results of water quality analyses of untreated sewer (raw sewer) that was made by a local subcontractor.

(3) Target Years

Current status: 2006 (commencement year of the Study)

Future status: 2025 (Master Plan Target Year)

As to detailed policy of Master Plan Target Year setting, refer to **Chapter 9**, **9.1.1**.

(4) Framing for Pollution Loads

In estimation of various discharge loads, the current and future frames of each pollution source were defined based on the existing materials and data. The pollution source frames and used materials are shown in **Table 8.3.1**.

Table 8.3.1 Pollution Load Frames

Pollution Source Categories			Frame	Materials
Point source loads	Domestic Sewage type	Sewerage / Pit Latrine / Tourists	Population	Population Statistics, Sewage Plan
	Sewage system	Sewage (Pipe Line) / Sewage I (Livelihood type)	Population	Sewage Plan
		Sewage II (Industrial type)	Reception volume in sewage plants	Sewage Plan
	Industrial type	Private plants / Public-operated plants	Number of plants by industrial field	Industrial Statistics, and Results of drain survey in main plants made by local subcontractors
Non-point source loads	Land type	Forests/farmlands (Irrigated lands, Non-irrigated lands) / Urban areas (roads and buildings)	Area	Agricultural Statistics
	Livestock type	Cattle/goats/sheep	Number of heads	Agricultural Statistics

(5) Method of Estimating Point-source Discharge Loads

In the estimation of discharge loads from various point-source pollution loads, the unit load method (pollutant load per unit activity of source) which is a general approach was used.

a) Domestic Sewage-type Discharge Loads

The discharge loads from pit latrines in the areas with no sewage system was estimated as follows:

Number of pit latrine population (users) × Basic unit of pit latrine system (g/person/day)
= Discharge loads from pit latrines (g/day)

As the basic unit of untreated sewage, the result obtained from the discharge water quality in the sewage plant in Adraa was adopted. This basic unit contains the human waste and the household effluent.
BOD: 38 g/person/d, COD: 66 g/person/d, T-N: 9 g/person/ day, T-P: 3 g/person/d

The basic unit of the pit latrine system was estimated only for household effluent. The ratio used to calculate urine which compromises untreated sewage of household effluent follows the report by Kunimatsu and Muraoka (1989). Kunimatsu at el (1989)investigated household

pollutants in a number of Japanese municipalities and reported that the general ratio of household effluent is 85%, of which urine accounts for 15% of that. Accordingly, the basic unit for the pit latrine system is 85% of pollutant load from the household effluent mentioned above.
BOD: 32 g/person/d, COD: 56 g/person/d, T-N: 7.7 g/person/ day, T-P: 2.6 g/person/d

The discharge load from tourists (hotel guests) was determined to be 85% of the residents and estimated referring to the "Guidelines and Explanations of the Study of the Master Plan for Sewage Systems by River Basin Unit" issued in Japan (Japan Sewage Works Association, 1993) as follows:

Hotel guests × 0.85 × Basic unit of untreated sewage (g/person/day)
= Discharge load from tourists (g/day)

b) Discharge Loads from Sewage Systems

① Households with only sewerage system (pipeline) with no treatment
The discharge load from households was estimated in the same way as those from pit latrines.

② Households in sewage treatment areas
The discharge load from households to a sewage treatment plant was estimated as follows:

Sewage population (number of persons) × Basic unit of sewage (g/person/day)
= Discharge load from households (g/day)

The basic unit of sewage was determined in referring to the removal rate in the Adraa sewage treatment plant (BOD: 90%, COD: 85%, T-N: 40%, T-P: 0%).
BOD: 3.8 g/person/d, COD: 9.9 g/person/d, T-N: 5.4 g/person/ day, T-P: 3 g/person/d
For the proposed OD system (including de-nitrification and phosphorous removal), removal rates are BOD 95% (1.9g/person/d), COD 85% (9.9g/person/d), T-N 70% 2.7g/person/d), T-P 80% (0.6g/person/d)

③ Plants treated by sewage treated plants
The discharge load from industry to a sewage treatment plant was estimated as follows:

Plant discharge load of sewage system type (g/day)
= Discharge load received from plants (g/day)×Removal rate in sewage treatment plant

c) Industry-type Discharge Loads

The method of estimating industrial type discharge loads and the detailed results of estimation are indicated in Appendix attached hereto.

(6) Method of Estimation of Non-point Source Discharge Loads

For the estimation of non-point source discharge loads, the unit value method was adopted same as the estimation of point source discharge loads. The non-point source pollution loads derive from concentrated runoff of rainfalls and the runoff loads are largely varied with precipitation characteristics and locality. Especially in Syria where rainfall quantity is very different from area to area, it is problematic to apply the basic unit (kg/ha/day) of the non-point source load that had been obtained in another country. In this study, therefore, the existing basic unit has been reviewed and applied to Syria so that the precipitation characteristics and locality in Syria can be taken into consideration.

a) Discharge Load from Farmland

The precipitation quantities and fertilizer application rates were compared based on the existing basic unit as shown in **Table 8.3.2**. As the result, the basic unit as shown in **Table 8.3.3** was adopted.
The discharge load from farmland is estimated as follows:

Discharge load from irrigated farmland (kg/year) = Farmland area (ha) × Basic unit (kg/ha/mm) × (Annual irrigation volume: mm ＋Annual precipitation : mm)

Discharge load from rainfed farmland (kg/year) =
Farmland area (ha) × Basic unit (kg/ha/mm) × (Annual precipitation: mm)

Table 8.3.2 Basic Units for Discharge Loads from Farmlands Based on Existing Materials

Compartmentation of Pollution Load		Basic Unit of Load (kg/ha/year)				Fertilizer Application Rate (kg/ha/year)		Precipi-tation	Source
		BOD	COD	T-N	T-P	N	P	mm/year	
Cultivated Land	Iran		107	14.3	0.98	75	4	1200	JICA(2005)
Cultivated Land	Japan			28-132 (76)	0-6.9 (1.1)	300-400	100-150	1600	Kunimatsu, Muraoka(1989)

( ):Average

Table 8.3.3 Basic Units for Discharge Loads from Farmlands in Syria

Compartmentation of Pollution Load		Basic Unit of Load				Fertilizer Application Rate		Source
		BOD	COD	T-N	T-P	N	P	
		kg/ha/mm	kg/ha/mm	kg/ha/mm	kg/ha/mm	kg/ha/year	kg/ha/year	
Cultivated Land	Iran		0.0892	0.0119	0.00082	75	4	JICA(2005)
Cultivated Land	Japan			0.0475	0.00069	350	125	Kunimatsu, Muraoka(1989)
Cultivated Land	Syria	0.0446	0.0892	0.0083	0.00082	47	24	

* In this study, the basic units of COD and T-P were adopted from the survey results obtained in Iran. T-N was a value proportioned to the fertilizer application rate. The fertilizer volume was estimated based on the Syrian Agricultural Statistics (2005).

b) Discharge Load from Forests

The basic units were adopted by precipitation comparison based on the existing basic units as shown in **Table 8.3.4**.

The discharge load from forests is estimated as follows:

Discharge load from forests (kg/year) =

Forest area (ha) × Basic unit (kg/ha/mm) × (Annual precipitation: mm)

Table 8.3.4 Basic Units for Discharge Loads from Forests Based on Existing Materials

Compartmentation of Pollution Load		Basic Unit of Load				Precipitat-ion	Source
		BOD	COD	T-N	T-P		
		kg/ha/year	kg/ha/year	kg/ha/year	kg/ha/year	mm/year	
Forest and Grass	Iran		47	7.6	0.3	1200	JICA(2005)
Forest	Japan			4.45	0.095	1527	Kunimatsu, Muraoka (1989)
Forest	Japan			3.58	0.113	2074	
Forest	USA			3.03	0.077	1400	

Table 8.3.5 Basic Units for Discharge Loads from Forests in Syria

Compartmentation of Pollution Load		Basic Unit of Load			
		BOD	COD	T-N	T-P
		Kg/ha/mm	Kg/ha/mm	Kg/ha/mm	Kg/ha/mm
Forest and Grass	Iran		0.0392	0.00633	0.00025
Forest	Japan			0.00291	0.00006
Forest	Japan			0.00173	0.00005
Forest	USA			0.00216	0.00006
Forest	Syria	0.00575	0.0115	0.00227	0.00006

Note) In this study, the average values of T-N and T-P of the existing survey results were adopted. COD was presumed from T-N and T-P based on the ratios of COD/N and COD/P in the survey in Iran. BOD was determined to be 1/2 of COD.

c) Discharge Load from Urban Areas (roads and buildings)

The basic units as shown in **Table 8.3.7** were adopted by comparison of precipitation and population density based on the existing basic units as shown in **Table 8.3.6**.

The discharge load from urban areas was estimated as follows:

Discharge load from urban area (kg/year) =

Urban area's size (ha) × Basic unit (kg/ha/mm) × (Annual precipitation: mm)

Table 8.3.6 Basic Units for Discharge Loads from Urban Areas based on Existing Materials

Compartmentation of Pollution Load		BOD	COD	T-N	T-P	Precipitation	Population Density	Source
		kg/ha/year	kg/ha/year	kg/ha/year	kg/ha/year	mm/year	person/ha	
Building and Roads	Japan	191	34	4.5	1.6	1,200	71.2	Kunimatsu, Muraoka (1989)
	Japan	166	102	14.1	1.3	1,367	152.2	
	Japan	605	378	33.5	6.5	1,690	138	
	Japan	168	208	34.2	5.8	1,385	162	
	Japan	102	90	17.6	3.0	1,163	70.6	
	Japan	167	159	23.1	1.9	1,317	157	
	Medium Urban	147	62	11.1	2.3	1,182	70.9	
	Large Urban	277	212	26.2	3.9	1,440	152.3	

Table 8.3.7 Basic Units for Discharge Loads from Urban Areas in Syria

Compartmentation of Pollution Load		Basic Unit of Load				Population density
		BOD	COD	T-N	T-P	
		Kg/ha/mm	Kg/ha/mm	Kg/ha/mm	Kg/ha/mm	Person/ha
Building & Roads	Medium Urban	0.124		0.00935	0.00195	71
Building & Roads	Big Urban	0.192		0.01821	0.00269	152
Building & Roads	Syria	0.077	0.155	0.00327	0.00144	6-22 (15)

Note) In this study, the basic units of BOD, T-N and T-P were determined to be the values proportioned to population density.

d) Discharge Load from Livestock

In this study, the discharge loads from livestock were deemed to be the loads from pastures and grasslands in which livestock was pastured, and regarded those as the non-point source pollution loads. The basic units for livestock discharge loads were thought to be similar to other non-point source pollution loads which depend upon precipitation. Thus, the basic units were reviewed to be proportional with precipitation (**Table 8.3.9**) in referring to the livestock basic units surveyed in Iran (by JICA in 2005) as shown in **Table 8.3.8**.

Discharge load from livestock was estimated as follows:

Discharge load from livestock (kg/day) =

Livestock (number of heads)×Basic unit ([kg/head/day]/mm)×(Precipitation: mm)

Table 8.3.8 Basic Units for Discharge Loads from Livestock based on Existing Materials

Compartmentation of Pollution Load		Basic Unit of Load				Precipitation	Source
		BOD	COD	T-N	T-P		
		g/head/day	g/head/day	g/head/day	g/head/day	Mm/year	
Cattle	Iran	5.3	26	2.9	0.5	1,200	JICA(2005)
Sheep, Goat	Iran	1.3	6.5	0.73	0.13	1,200	JICA(2005)

Table 8.3.9 Basic Units for Discharge Loads from Livestock in Syria

Compartmentation of Pollution Load		Basic Unit of Load			
		BOD	COD	T-N	T-P
		(g/head/day)/mm	(g/head/day)/mm	(g/head/day)/mm	(g/head/day)/mm
Cattle	Syria	0.00442	0.0217	0.00242	0.00042
Sheep, Goat	Syria	0.00108	0.0054	0.00061	0.00010

(7) Method of Estimating Runoff Loads

As shown in **Figure 8.3.2**, the pollution load discharged from each source flows through a small canal or branch river, or through a sewage under drain pipeline into a main river. On the other hand, it is thought that part of the pollution load infiltrates into the underground to contaminate the groundwater. The discharge load that flows from each source into a main river or the underground is called 'runoff load', and the runoff rate is defined as a runoff load/discharge load.

In general, the runoff rate is low when the water quantity in a small canal or branch river is low and it is high when the water flow is high. The runoff rate for the annual average runoff load is determined depending upon the development level of such small canals and branch rivers. The runoff rate values as shown in **Table 8.3.10** have been reported.

Table 8.3.10 Standard Runoff Rate Values

District		Runoff Rate
Agricultural Area		0.0 ～ 0.2
Urban Area	Peripheral district	0.1 ～ 0.6
	Central district	0.6 ～ 1.0
Sewerage		1.0

Source) "Guidelines and Explanation of the Study of the Master Plan for Sewage Systems by River Basin Unit" issued by Japan Sewage Works Association in 1993

Therefore, the runoff rates from pollution sources was determined as shown in **Table 8.3.11** in reference to the rates in **Table 8.3.10** in order to estimate the runoff loads flowing into main rivers (or sea areas) in the target river units.

Table 8.3.11 Runoff Rates in this Study

Division			Runoff Rate
Point-source type	Domestic Sewage type	Areas with no sewage system (Pit Latrines)	0.1
	Sewage treatment system		1.0
	Industry		0.8
Non-point source type	Forests, farmlands (irrigated lands and non-irrigated lands) and livestock		0.1
	Urban areas (roads and buildings)		0.3

8.3.2 Modeling of Water Pollution Mechanism

(1) Water Quality Simulation Models

In making the water pollution analysis in the target river basin units, it is impossible to adopt complicated models because the existing data necessary for the analysis is limited in Syria. Especially, as for the rivers and groundwater, the water balance and inflow conditions of pollution loads in each sub-basin units are not clear. Therefore, the water quality analysis was made using simple models from the viewpoint of the balance between the water capacity and pollution load in each river basin unit. On the other hand, numeral simulation models were adopted for the coast of the Mediterranean Sea because some information on the coastal topology, water depths, tide levels, winds and pollution load inflow conditions had been made available. The numeral simulation models for the water quality prediction was examined based on a simple non-conservative model to ensure the prediction and evaluation of the effects of fecal coliforms in sewage drains. **Table 8.3.12** shows the simulation model types adopted in this study.

Table 8.3.12 Simple types of water quality simulation model

Target Water Area	Name of Model	Parameters used in Model
Rivers	Box Model	(BOD water quality change in river) = ((BOD runoff load) / (Average flow))×Purification rate
Mediterranean Sea	Simple Non-conservative Model	(Fecal coliform density change) = (Drifting) ＋ (Diffusion) － (Decomposition)
Groundwater	Box Model	(Water quality change in T-N density) = (T-N infiltration load) / (Groundwater capacity in target basin unit)

<u>Numeral Simulation Model for the Mediterranean Sea</u>

The numeral simulation model used in this study was composed of a hydrodynamic model and a water quality model. The calculation coverage is a 129km × 31km area from Tartous to Lattakia on the Syrian coast and its terrains (coastal terrain and water depths) are represented in 1000m meshes as shown in **Figure 8.3.3.**

- Hydrodynamic Model

The 2-dimensional one-layer model was adopted as the hydrodynamic model. The calculation results of the flow simulation using the hydrodynamic model can be used as the input data for the water quality model.

- Water Quality Model

The results of fecal coliforms survey in this sea area conducted by the Ministry of Irrigation were prepared as verification material for the water quality model (simple non-conservative model) which was used to predict fecal coliform density in the sea area. The main parameters (such as diffusion coefficient and decomposition rate) in this model were set to meet the actual measured density distribution for future prediction.

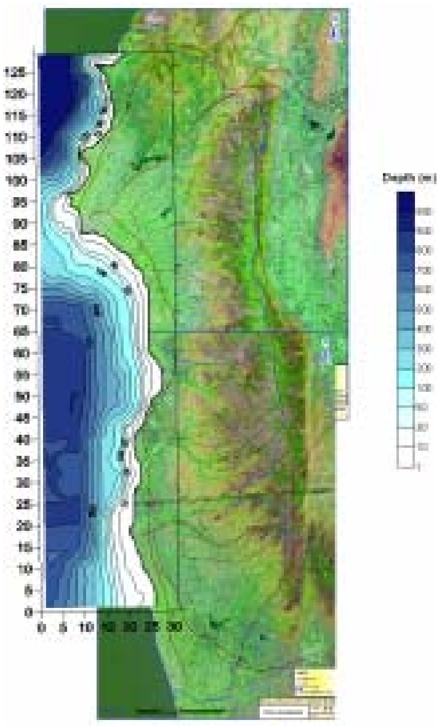


Figure 8.3.3
Calculation Scope According to Numerical Simulation in Mediterranean Region

(2) Study Cases

The study cases are listed in **Table 8.3.13**.

Table 8.3.13 Study Cases

	Year	With or Without Measure	Sewerage System Improvement
Current	2006		
Case 1	2025	No Measure	Sewerage propagation rate equal to current condition
Case 2	2025	Measure	Sewer propagation with current removal system such as Adraa STP (secondary treatment level)
Case 3	2025	Measure	Sewer propagation with more efficient removal system such as OD system with nitrogen removal

8.3.3 Present Water Pollution Analysis for Surface and Sea Water

(1) Calculation Results of Discharge Load, Runoff Load by Governorate

The results of calculation of discharge load, runoff load by governorate which were obtained by the method as described in Chapter 8.3.1 above are included in **Appendix. 8.1**. The pollution load characteristics by governorate will be described below.

Euphrates River Basin

Of the pollution loads (runoff loads) that flows in the River Euphrates, the point-source pollution load of BOD accounted for 76 to 91% and T-N for 76 to 91%. In particular, the pollution load from households that is discharged with no treatment into the sewer network connected to the sewage system was the highest of the point-source pollution loads, and followed by that from industrial facilities.

Khabour River Basin

Of the runoff loads flowing into the River Khabour, the BOD point-source pollution load accounted for 66% and T-N for 70%, which were higher than the non-point source pollution load rates in other river basin units. Of the point-source pollution loads, the pollution load from households connected with no treatment to the sewer network of the sewage system was the highest, while the pollution load from farmlands using the non-point source irrigation water had a high rate of infiltration load. The infiltration load of T-N was 2.8 times higher than the runoff load.

Barada / Awaj River Basin

The runoff load flowing into the River Barada/Awaj had a higher rate of point-source pollution load than in the other river basin units. The BOD point-source pollution load accounted for 97 to 98% and T-N for 98 to 100%. This means that the spread rate of sewer network is high.

Coastal Area (Mediterranean Sea Basin)

Of the runoff loads flowing into the Mediterranean Sea, the BOD point-source pollution load accounted for 88 to 92% and T-N for 93 to 96%. The pollution load from households connected with no treatment to the sewer network in the sewage system was the highest of the point-source pollution loads similarly to that in the other basin units.

Yarmouk River Basin

Of the runoff loads flowing into the River Yarmouk, the BOD point-source pollution load accounted for 90 to 92% and T-N for 94 to 96%. Similarly to those in other river basin units, the pollution load from households connected with no treatment to the sewer network in the sewage system was the highest among those point source pollution loads.

(2) Current Water Quality Analysis for the River Basins and Sea Area in the Project

a) Euphrates River Basin

As mentioned in Chapter 3 above, the current state in the Euphrates River is that, while no sign of water pollution has been detected at the Al-Asad Dam on the upper reaches, possibility of low-level pollution has been indicated at Deir-Ez-zor on the lower reaches. The only material obtained from the Ministry of Local Administration and Environment (MLAE) (see **Table 3.4.3**) was used to summarize the BOD influent load and the condition of water quality at each measurement point along the Euphrates River as shown below.

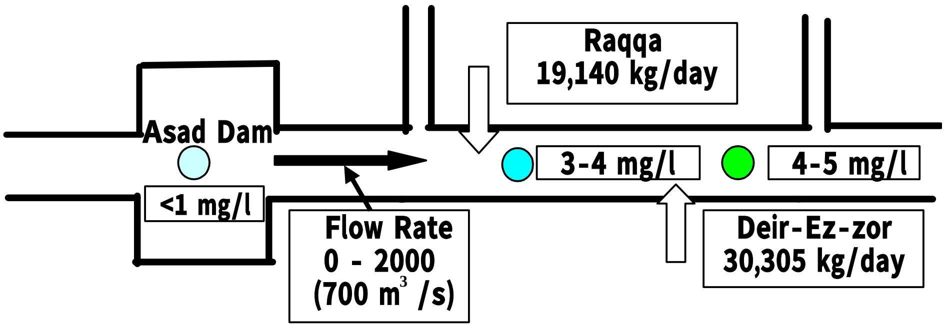


Figure 8.3.4 Current BOD Influent Loads and Conditions of Water Quality in the Euphrates River

A detailed pollution analysis cannot be done as the flow rate of the Euphrates River at the time of the water quality survey is not available. Under the condition of the low water runoff at 200m^3/s and the assumption that the runoff loads flowing into the river at Raqqa and Deir-Ez-zor are completely mixed with the river water, the BOD loads at Raqqa and Deir-Ez-zor are estimated at approximately 2.1mg/l (1.1mg/l of the additional pollution load to the BOD load of 1mg/l at the Asad Dam) and 4mg/l, respectively. These figures roughly correspond with the study results. Under the condition of the flow rate of 700m^3/s, the annual average flow rate of the Euphrates River, the BOD loads at Raqqa and Deir-Ez-zor are estimated at approximately 1.3mg/l and 1.8mg/l, respectively, which satisfy the target BOD load of 2mg/l by small margins.

b) Other River Basins

As the rivers other than the Euphrates River are medium- and small-sized rivers with annual average flow rates of less than 10m^3/s and have relatively large longitudinal distances, self-purification of river water is expected through precipitation, decomposition and intake by organisms until it enters lakes or reservoirs of dams. As mentioned above, using the flow rates and runoff loads, concentrations of pollutants in the river water under the condition of the complete mixing were calculated. By comparing the calculated figures with the actual measurements, the rates of removal (or purification) by the self-purification were calculated for each of the rivers included in this project. **Table 8.3.14** shows the calculated water quality indicators and removal (purification) rate of each river. These purification rates will be used for predicting the effects of various measures to be taken for pollution load reduction on improvement of quality of the river water.

Table 8.3.14 Calculated Water Quality Expressed in terms of BOD and T-N and Removal Rates through Self-purification in the Khabour, Barada/Awaj and Yarmouk Rivers.

River Name	Governorate	Flow Rate m^3/sec	Method	BOD_5			T-N		
				Runoff load kg/day	Water Quality mg/l	Self-purification Rate	Runoff load kg/day	Water Quality mg/l	Self-purification Rate
Khabour	Hassakeh	5.3	Calculated value	30,853	67	0.91	6,231	14	0.07
			Actual measurement		6 (1-11)			13 (3-29)	
Yarmouk	Dar'aa Qunetra	3.6	Calculated value	20,841	67.6	0.67	4,166	14	0.00
			Actual measurement		22 (20-30)			29 (12-54)	
Barada/Awaji	Rural Damascus Damascus city	3.9	Calculated value	74,314	221	0.94	23,650	70	
			Actual measurement		13 (3-33)				

Note) Self-purification; 1-(actual measurement / calculated value)

c) Coastal Area (Mediterranean Sea Basin)

Table 8.3.15 shows the input conditions of the water quality model (a simple non-conservative model). A bathymetric chart of the sea area created from the input depth data is shown in **Figure 8.3.3** above.

Table 8.3.15 Input Conditions of Prediction Models

Input item	Remarks
1. Coastal topography and water depth	The nautical charts ([LATTAQUIE TO SOUR AND FAMAGUSTA] drawn on a scale of 1:300,000) published by the United Kingdom, on 27th August 1994 were used.
2. Influent water quality/ influent load	As shown in **Table 8.3.16**.
3. Boundary conditions	Hydraulic model: No consideration was given for the change in the sea level. The direction and velocity of the wind were set at south and 2m/s, respectively. Water quality model: The background concentration of 0 is set for coliforms (fecal coliforms)

Table 8.3.16 Influent Water Quality and Runoff Load in Coastal Area

River Name	Discharge	Total Coliform	
	m^3/day	MPN/100ml	MPN/day
Lattakia	1.32	1.7.E+07	1.98E+16
Tartous	1.04	1.8.E+07	1.62E+16

Reproducibility of the water quality model was examined in water quality simulation using data from existing water quality surveys as verification data. **Figure 8.3.5** shows the result of the water quality simulation for fecal coliforms. Comparison of the simulation results and actual measurements (see **Table 3.4.5**) shows the correspondence between the distribution of fecal coliforms predicted by the water quality simulation and the actual measurements. This fact indicates that, in general, this model has reproduced the current water quality condition in the target sea area.

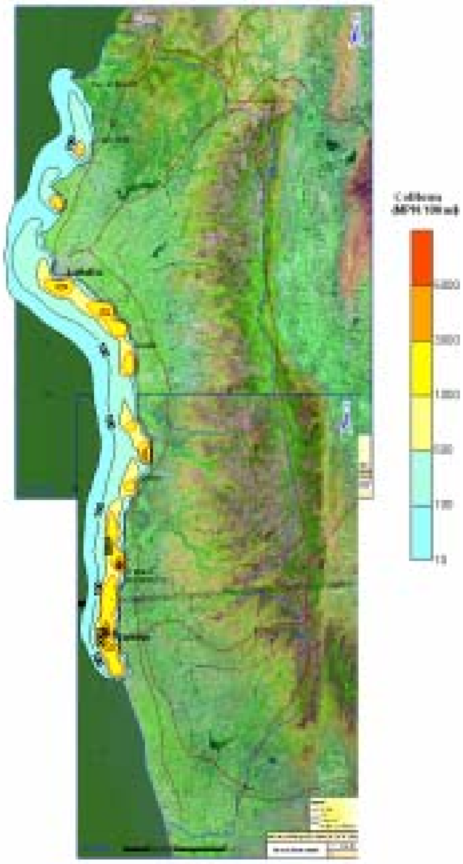


Figure 8.3.5 Calculation Results for Fecal Coliform by Water Quality Simulation in Mediterranean Region (Present: 2006)

8.3.4 Future Water Pollution Analysis for Surface and Sea Water

(1) Results of the Calculation of the Discharge, Runoff Loads in each Governorate

The results of the calculation for discharge and runoff loads in each governorate in Cases 1 to 3 shown in the **Table 8.3.13** above, are given in the Appendix attached at the end of the document. **Figures 8.3.6** shows the future as well as current runoff loads, respectively, of each governorate. The following are the characteristics of the pollution loads in each governorate.

Euphrates River Basin

In Case 1 (no measurement), the influent pollution load to the Euphrates River (runoff load) will increase to approximately twice the current level for each item.

In Case 2 (future development of a sewerage plant with the capacity similar to that of the existing one), the runoff BOD and COD loads will remain at more or less the same levels as the current ones. However, as the T-N loads will increase to 1.3 times the respective current levels, T-N loads will also increase, there is concern over further acceleration of the eutrophication in the Euphrates River.

In Case 3 (future development of a sewerage plant with a removal rate higher than that of the existing one), the runoff BOD and T-P loads will remain at the same levels as the current ones

(0.98 times for the both items), while the COD and T-N loads will increase to 1.1 time the current levels, at Raqqa. At Deir-Ez-zor, while the COD load will remain at the same level as the current one, the BOD, T-N and T-P loads will be reduced to approximately 0.9 times the current levels. These figures show that it will be possible to reduce the influent pollution loads close to the current levels through improvement of sewerage system in 2025.

Khabour River Basin

In Case 1, the influent runoff load to the Khabour River will increase to approximately 1.4 times the current level for each item.

In Case 2, the BOD and COD loads will be reduced to 0.7 and 0.8 times the respective current levels. However, as the runoff T-N and T-P loads will increase to 1.6 times the current levels, respectively, there is concern over further acceleration of the eutrophication in the water area.

In Case 3, the runoff loads will be reduced to 0.5 to 0.8 times the current levels. However, the underground infiltration loads will increase to 1.3 times the current level. At Hassakeh, in particular, as pollution load from irrigated farmland accounts for significant part of pollution load, the water-saving irrigation is considered as an effective measure to reduce the pollution load.

Barada / Awaj River Basin

In Case 1, the influent runoff load to the Barada/Awaj River will increase to approximately 1.4 times and twice the current levels in Damascus City and Rural Damascus, respectively.

In Case 2, the BOD, COD, T-N and T-P loads will increase to 1.4, 1.8, 1.2 and 1.2 times the respective current levels in Damascus City, which already has a well-developed sewerage system. Meanwhile, in Rural Damascus, the BOD and COD loads will be reduced to 0.5 and 0.8 times the respective current levels.

In Case 3, although the COD load will increase to 1.8 times the current level, the BOD, T-N and T-P loads will be reduced to 0.8, 0.6 and 0.3 times the respective current levels in Damascus City. Meanwhile, the loads will be reduced to 0.4 to 0.9 the current levels in Rural Damascus.

Coastal area (Mediterranean Sea Basin)

In Case 1, the influent runoff loads to the Mediterranean Sea will increase to 1.4 to 1.5 times the current levels.

In Case 2, the BOD and COD loads will be reduced to 0.4 and 0.8 times the respective current levels. However, the T-N and T-P loads will increase to 1.1 times and approximately twice the respective current levels.

In Case 3, the runoff loads will be reduced to 0.4 to 0.8 times the current levels.

Yarmouk River Basin

In Case 1, the influent runoff loads to the Yarmouk River will increase to 1.6 to 1.8 times the current levels.

In Case 2, the BOD and COD loads will be reduce to 0.6 and 0.7 times the respective current levels. However, the runoff T-N and T-P loads at Dar'aa will increase to 1.2 and approximately 1.9 times, respectively, and those at Quneitra will increase to 1.1 and approximately 1.6 times, respectively.
In Case 3, the runoff loads will be reduced to 0.6 to 0.9 times the current levels.

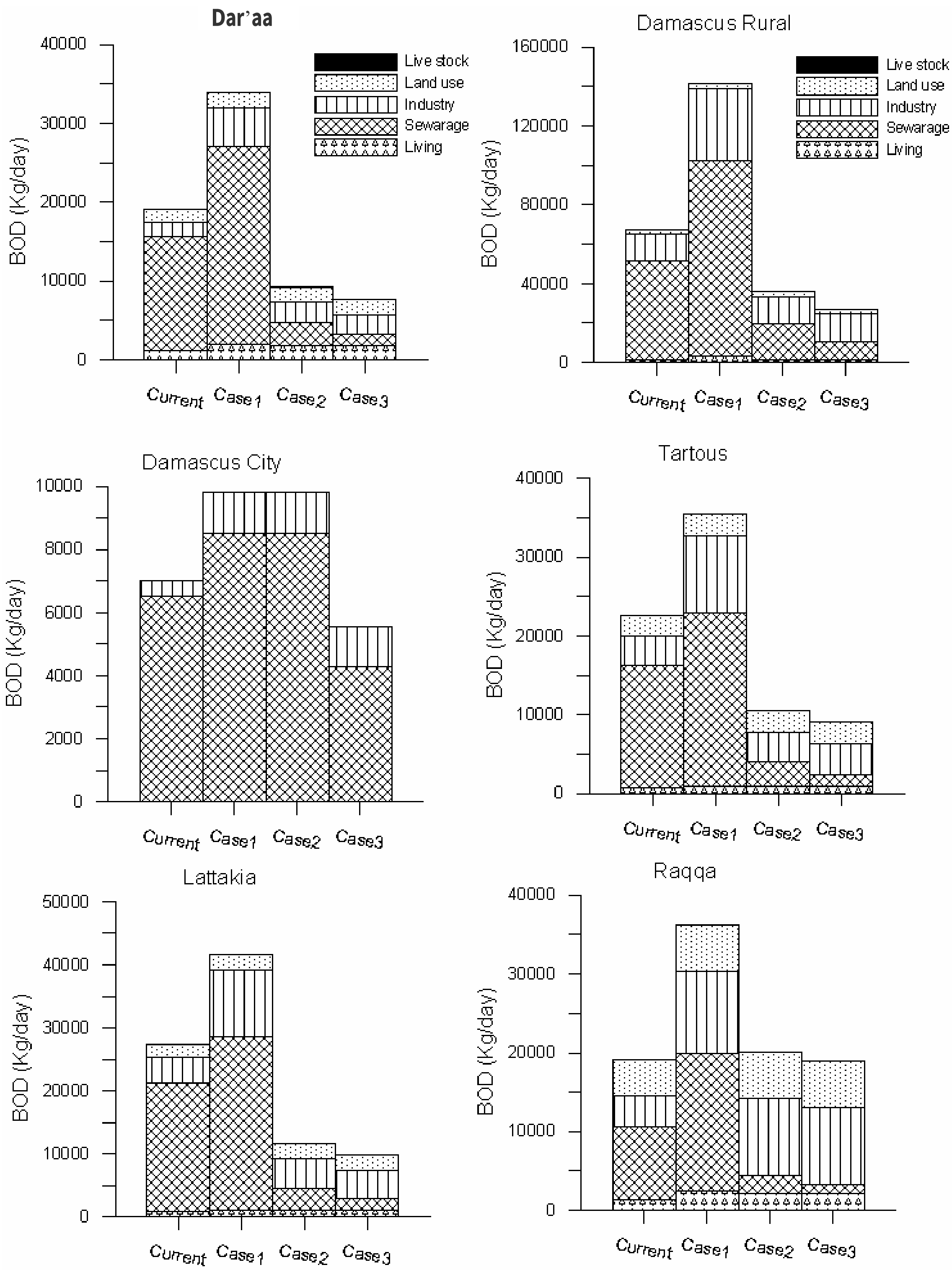


Figure 8.3.6 (1) Future Runoff Load in Governorates (BOD)

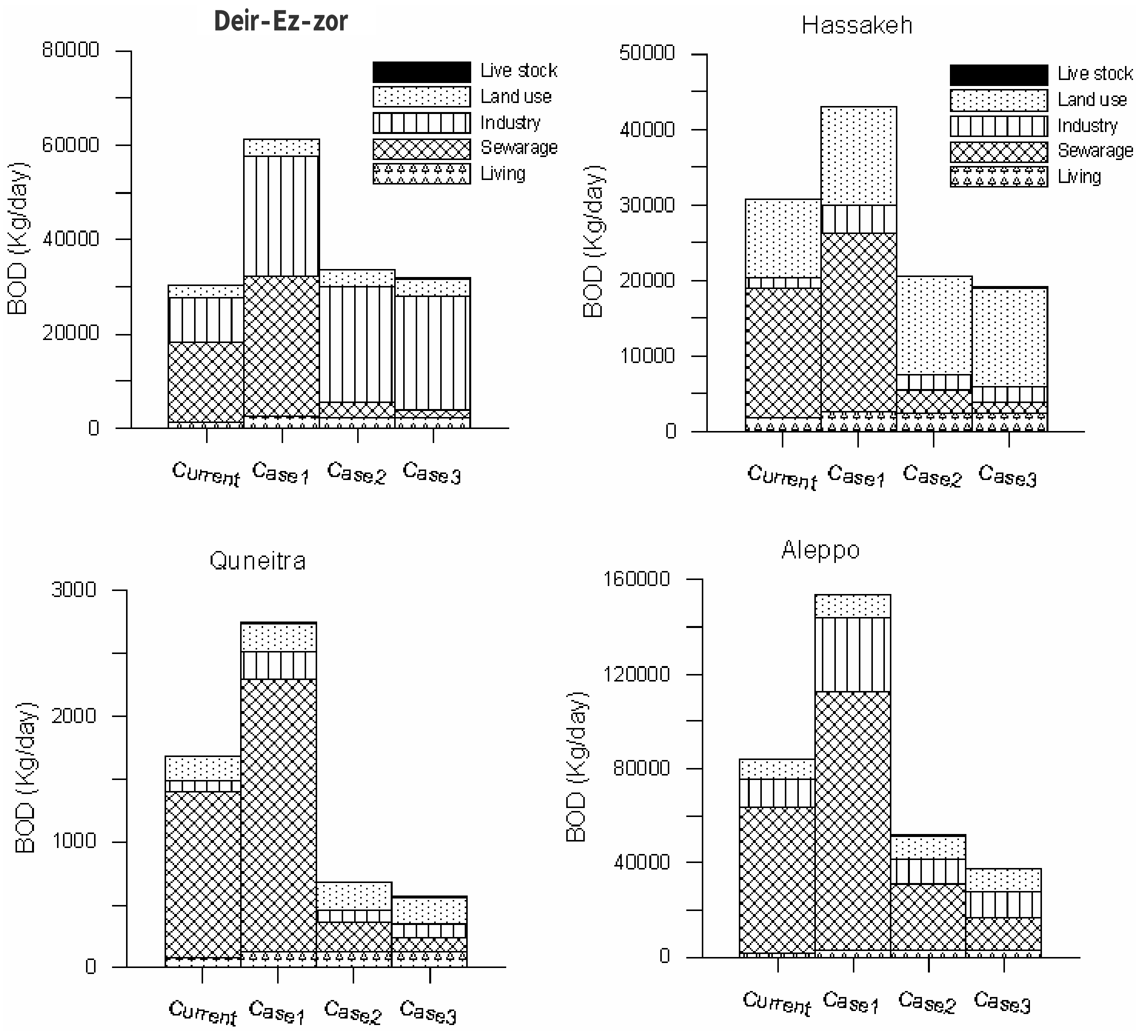


Figure 8.3.6 (2) Future Runoff Load in Governorates (BOD)

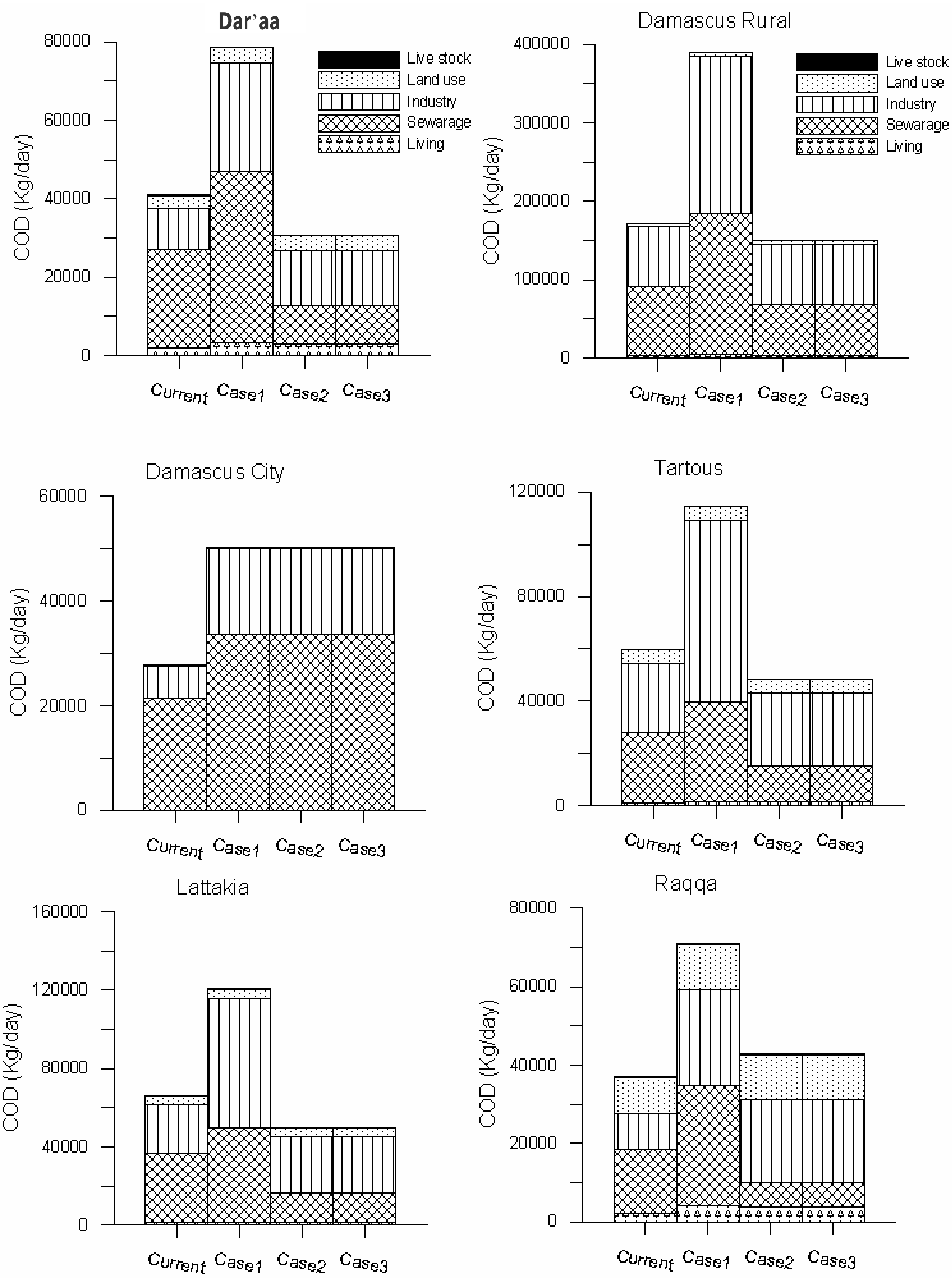


Figure 8.3.6 (3) Future Runoff Load in Governorates (COD)

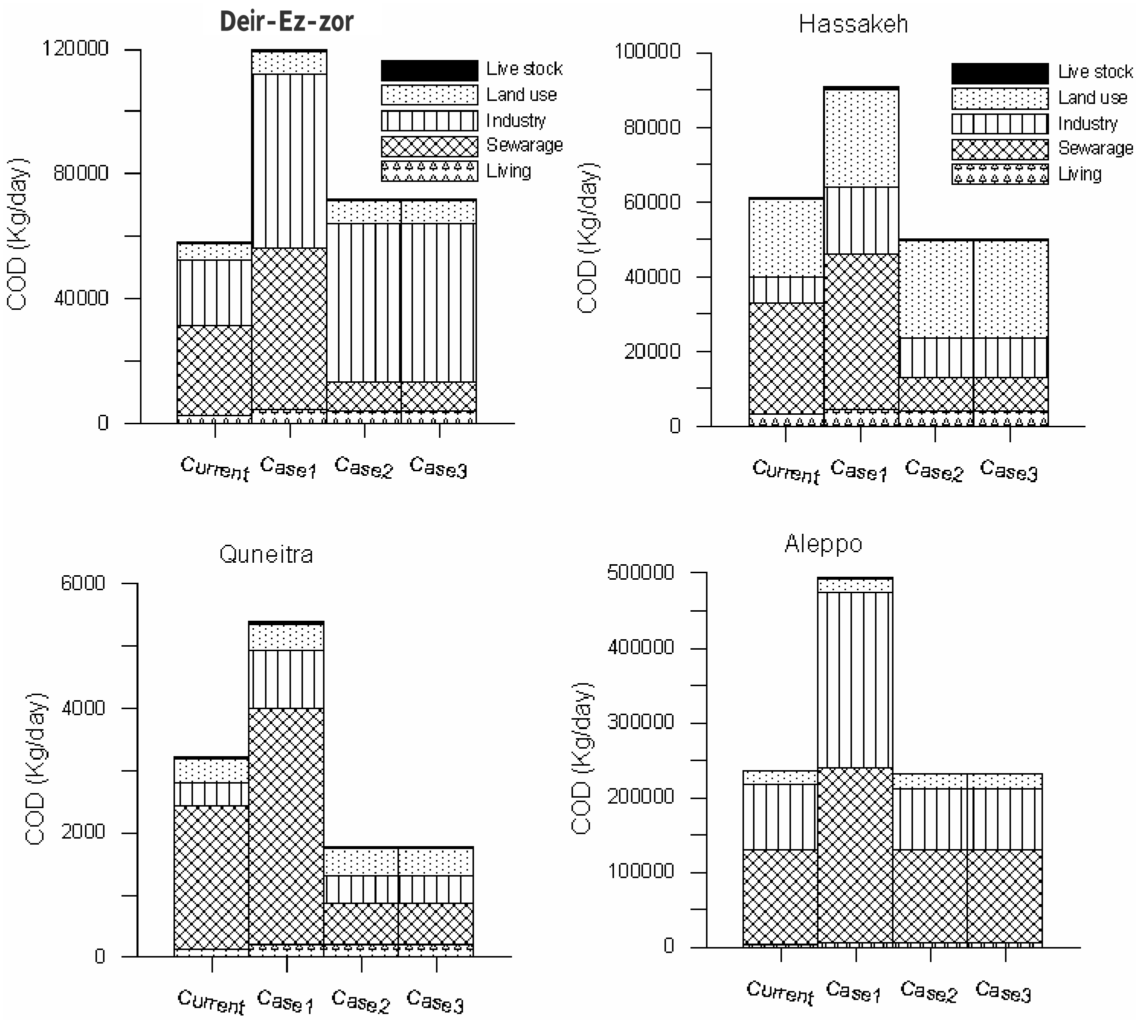


Figure 8.3.6 (4) Future Runoff Load in Governorates (COD)

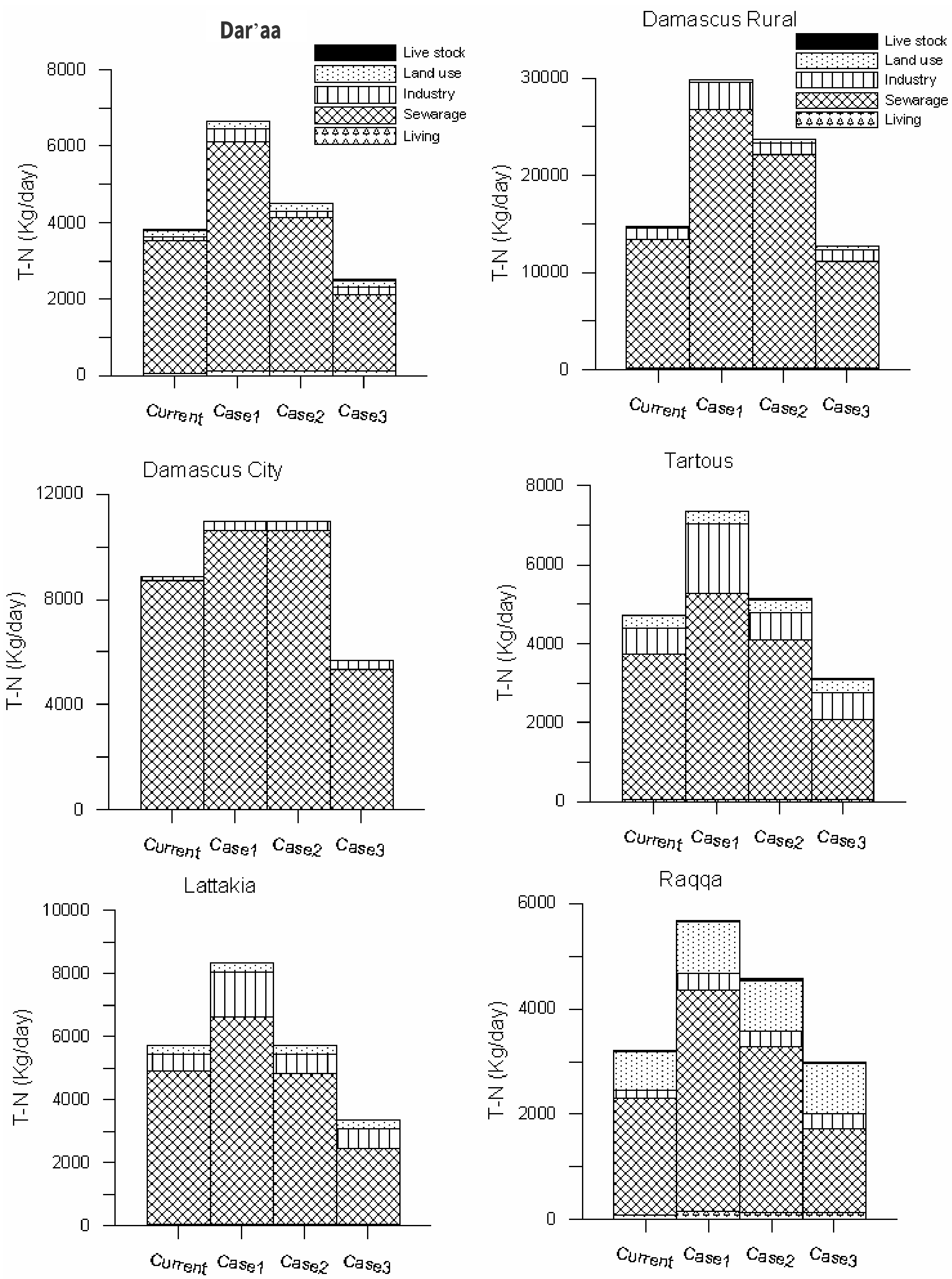


Figure 8.3.6 (5) Future Runoff Load in Governorates (T-N)

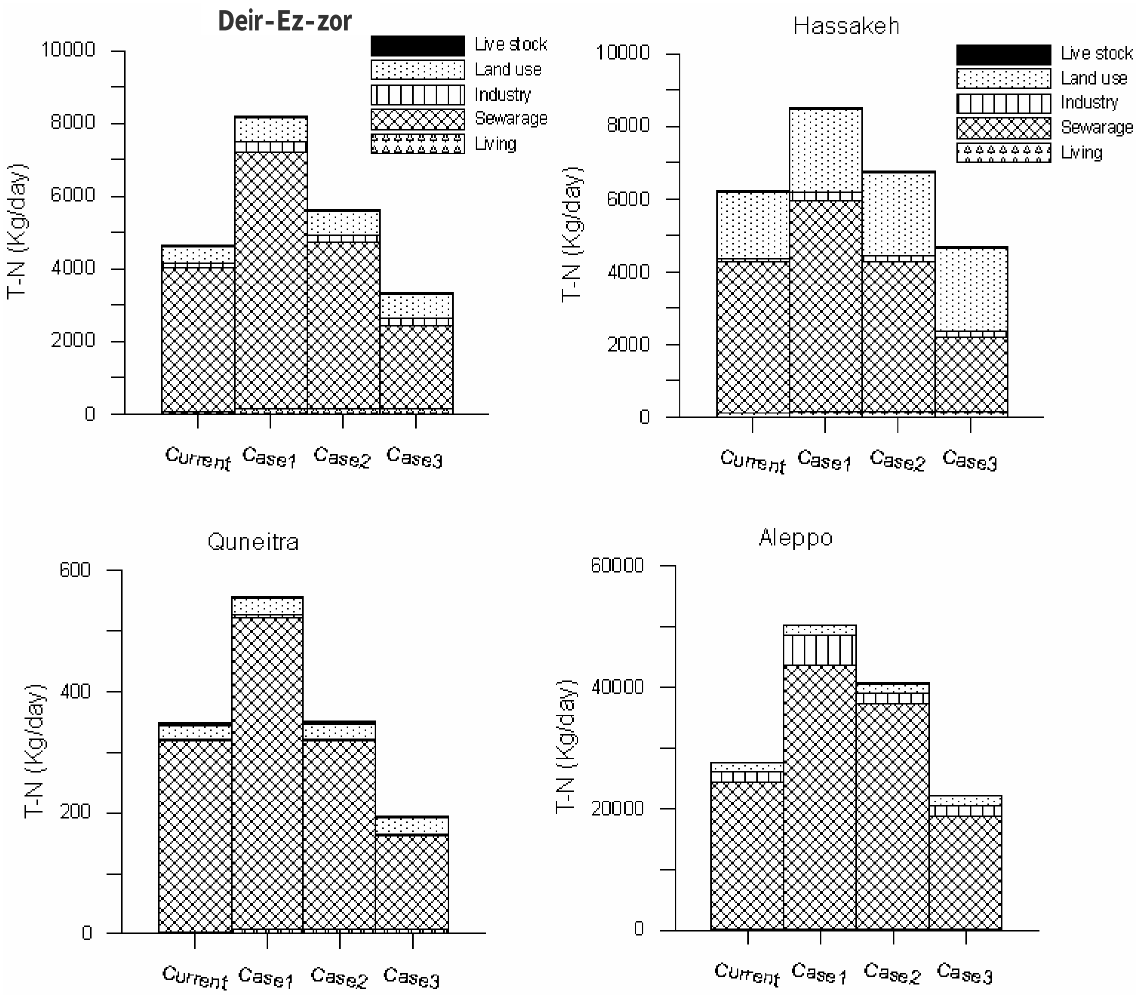


Figure 8.3.6 (6) Future Runoff Load in Governorates (T-N)

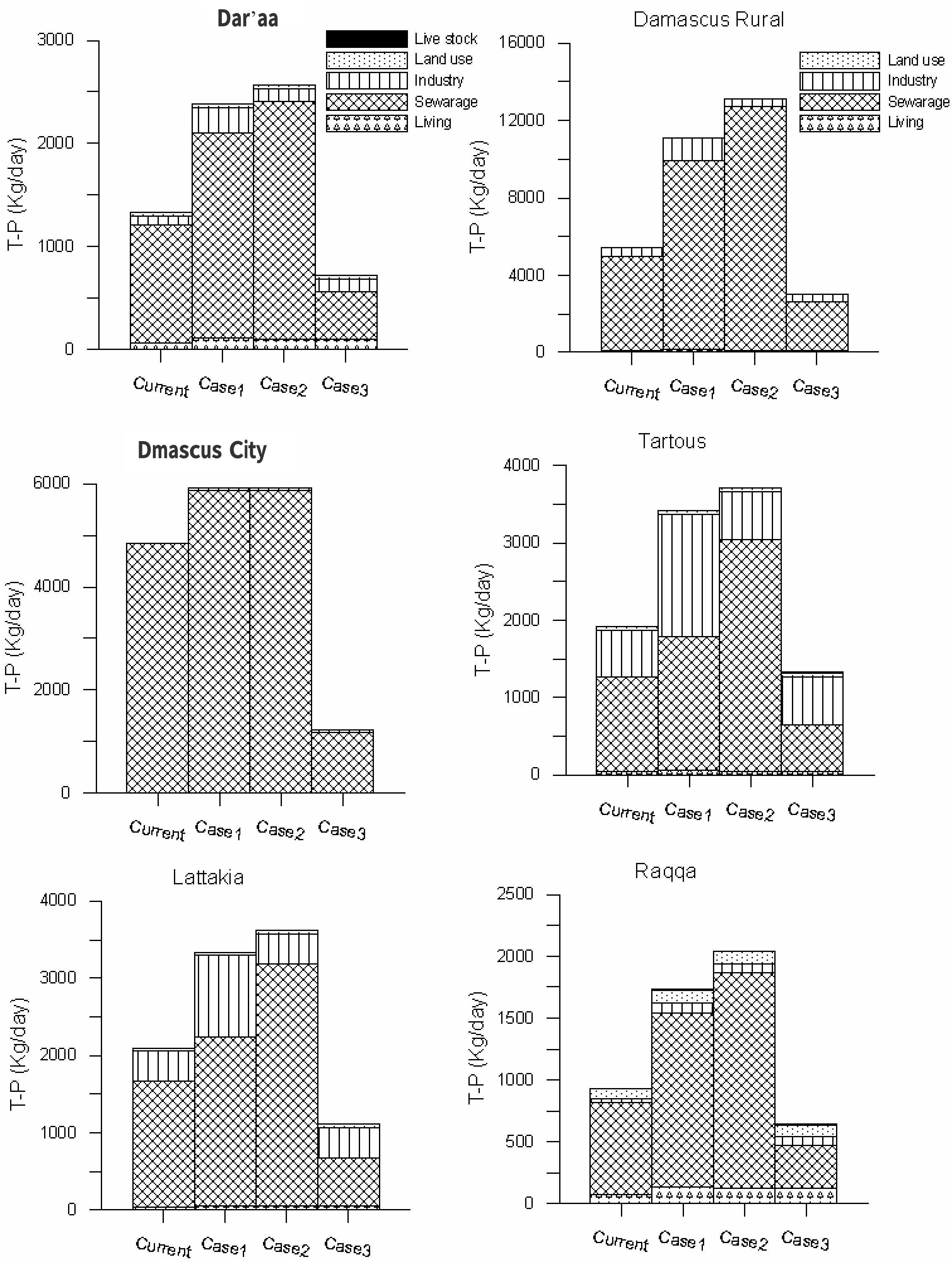


Figure 8.3.6 (7) Future Runoff Load in Governorates (T-P)

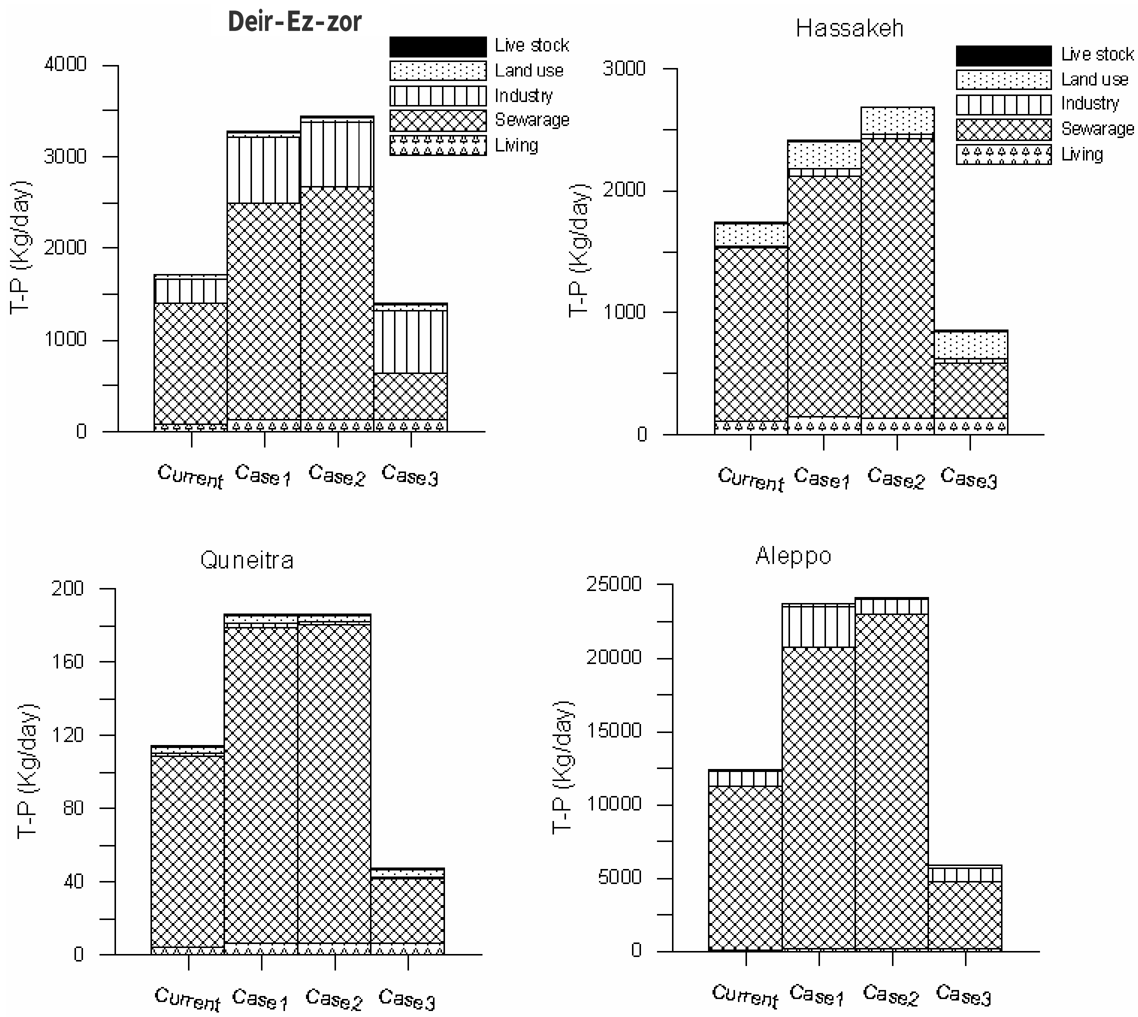


Figure 8.3.6 (8) Future Runoff Load in Governorates (T-P)

(2) Future Water Quality in the Target Water Basins

The average water quality of each basin as a whole was estimated with the average flow rate and the purification rate of each river on the basis of the current runoff load and future runoff loads estimated for Cases 1 to 3 of each governorate.

a) Euphrates River Basin

Figure 8.3.7 shows the current BOD water qualities and estimated BOD water qualities in future (in Cases 1 to 3) in the Euphrates River. It is expected that the development of the sewerage system will make the water quality in the Euphrates River satisfy the target of the (proposed) environmental standard for BOD (BOD: 2mg/l or less) on annual average.

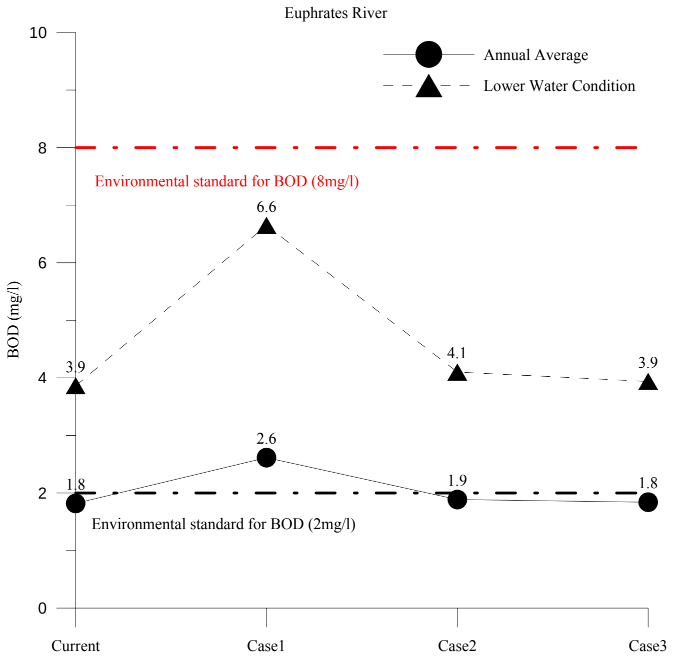


Figure 8.3.7 Estimated BOD Water Qualities in the Euphrates River

b) Other River Basins

Figure 8.3.8 shows the current BOD water qualities and the estimated BOD water qualities in future (in Cases 1 to 3) in the Khabour, Yarmouk and Barada/Awaj Rivers.

It is expected that the development of the sewerage system will make the water qualities in the Khabour and Barada/Awaj Rivers satisfy the target of the (proposed) environmental standard for BOD (BOD: 8mg/l or less) on annual average. However, the water quality in the Yarmouk River is not expected to satisfy the (proposed) standard according to this study, due to the very high present water quality, although improvement in the water quality is seen. It is apparent that the present BOD concentration of 33 mg/l is extremely unsuitable for the drinking water source. As the available water quality data were very few, accumulation of water quality monitoring data is desired.

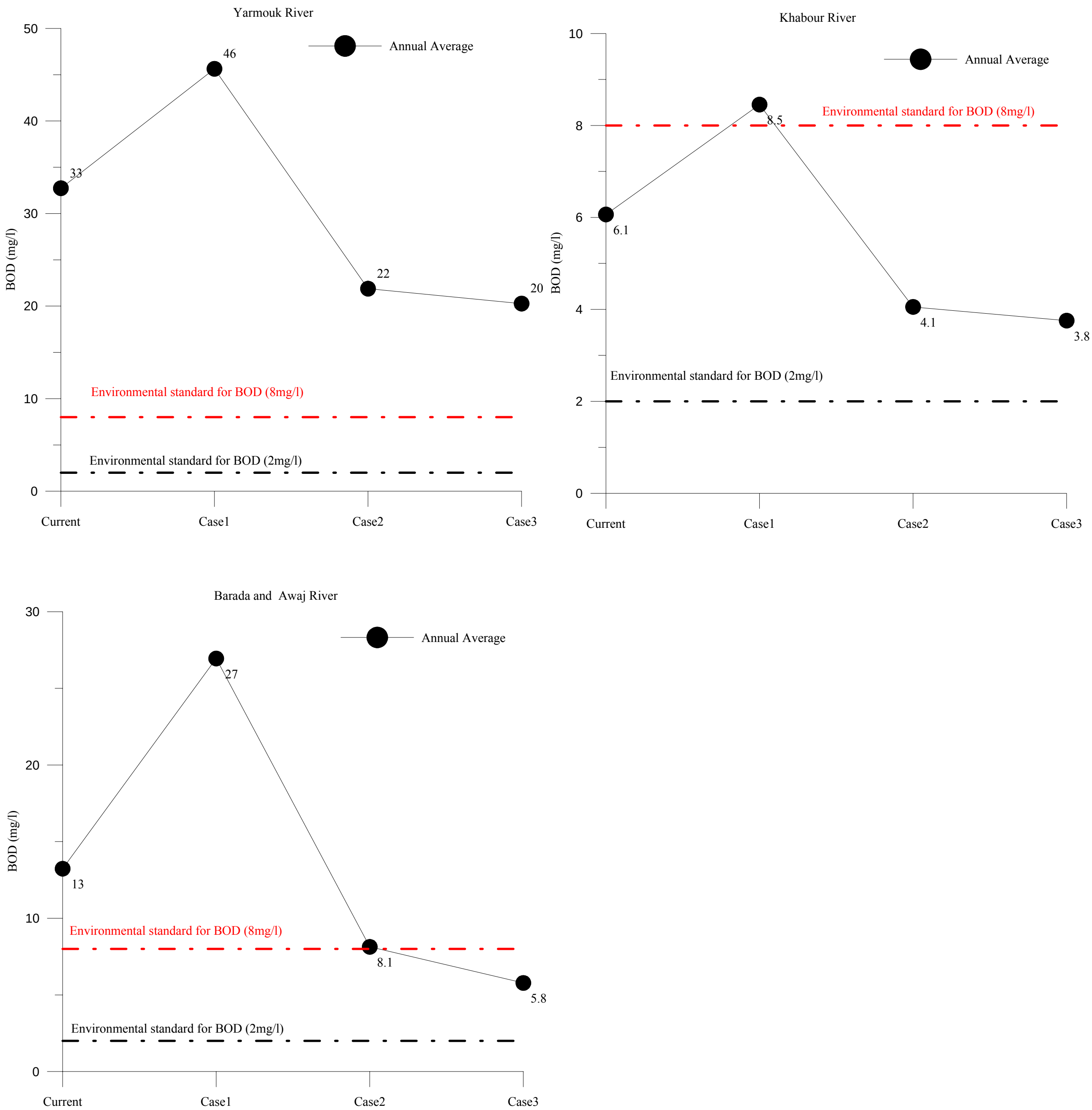


Figure 8.3.8 Estimated BOD water qualities in the Khabour, Yarmouk and Barada/Awaj Rivers

c) Coastal Area (Mediterranean Sea Basin)

Using the water quality model examined in this study, the effect of the sewerage system development on water quality improvement in the Mediterranean Coastal Area was examined. **Table 8.3.17** shows the influent load condition of fecal coliforms in future, in Cases 1 and 2. In Japan, the concentration of 10^3MPN/100ml is used as the standard coliform concentration in discharge from secondary sewerage treatment plants. Assuming the coliform treatment capacity similar to the capacity of sewerage plants in Japan for the plants in Syria, the influent load condition for coliforms was established. The coliform concentration in the influent is higher than that in the water quality of sewerage discharge (10^5MPN/100ml) because the former includes the load expected from the untreated wastewater from pit latrines. **Figure 8.3.9** shows the results of the water quality simulation for fecal coliforms in each case.

Table 8.3.17 Influent Water Quality and Runoff Load in Coastal Area (Case1 and Case2)

(Case 1: Without Measure)

River Name	Discharge	Total Coliform	
	m^3/s	MPN/100ml	MPN/day
Lattakia	1.32	2.4.E+07	2.77E+16
Tartous	1.04	2.6.E+07	2.34E+16

(Case 2 and Case3: With Measure)

River Name	Discharge	Total Coliform	
	m^3/s	MPN/100ml	MPN/day
Lattakia	1.32	1.0.E+05	1.14E+14
Tartous	1.04	1.0.E+05	8.99E+13

The following are the summary of the results of the water quality simulation in each case.

The development of the sewerage system will significantly reduce the coliform concentration in the Mediterranean Coastal Area. It is expected that the development of the sewerage system will make the water quality in Mediterranean Coastal Area satisfy the target of the (proposed) environmental standard of water quality (of fecal coliform concentration of 10^3MPN/100ml).

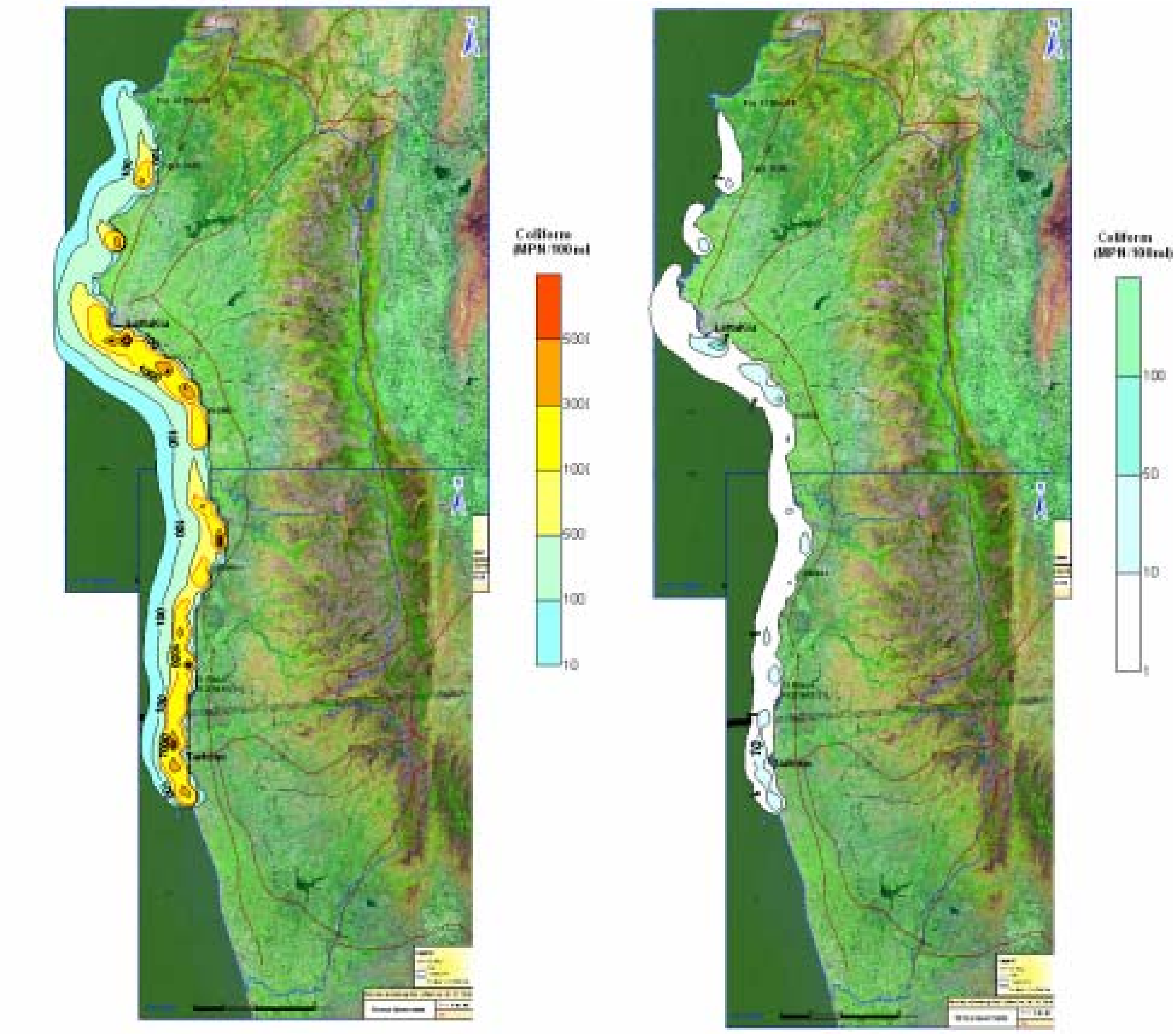


Figure 8.3.9 Calculation Results for Fecal Coliform by Water Quality Simulation in Mediterranean Region (Case1 and Case2/Case3: 2025)

(3) Load Reduction of Industrial Discharge

Figure 8.3.6 as a whole shows that the sewerage treatment can significantly reduce organic pollutants such as BOD discharged into public waters. In estimating pollution loads for Case 2 and Case 3, it was assumed that only sewage treatment is provided, and no load reduction is taken into account for the industrial wastewater. As can be seen in **Figure 8.3.6**, however, the industrial BOD loads remains with a significant share to the total run-off loads, when the sewage treatment is provided. For Raqqa and Deir-Ez-zor, in particular, only providing sewage treatment does not contribute to the total BOD loads reduction against the present loads, due to the large industrial pollution loads. This means reduction of industrial pollution loads is necessary even after the sewage treatment is done, in order to achieve the water quality preservation of public waters as a comprehensive measure. The Syrian effluent standards discharged to the external environment (**Table 3.3.1**) could be a ground for compulsory loads reduction of industrial wastewater.

Table 8.3.18 shows a comparison of industrial loads by Governorate in 2025 before and after the legal compliance.

Table 8.3.18 Comparison of Industrial Loads by Governorate before and after Legal Compliance

		2025 before legal compliance			2025 after legal compliance			difference	
		flow volume	water quality	load	flow volume	water quality	load	reduced load	reduction percentage
		m^3/day	mg/l	kg/day	m^3/day	mg/l	kg/day	kg/day	%
Lattakia	BOD	11,309	514	5,803	11,309	40	452	5,356	92.2
	COD		3183	35,998		150	1,606	34,302	95.3
	T-N		68	771		55	622	149	19.3
	T-P		43	486		15	170	316	65.1
Tartous	BOD	5,379	906	4,876	5,379	40	215	4,661	95.6
	COD		6411	34,482		150	807	33,677	97.7
	T-N		163	876		55	296	580	66.2
	T-P		146	783		15	81	702	89.7
Deir-Ez-zor	BOD	42,083	719	30,244	42,083	40	1,683	28,561	94.4
	COD		1513	63,677		150	6,313	57,364	90.1
	T-N		6.7	284		6.7	284	0	0
	T-P		21	866		15	631	235	27.1
Hassakeh	BOD	5,218	480	2,504	5,218	40	209	2,295	91.7
	COD		2536	13,233		150	783	12,450	94.1
	T-N		33	172		33	173	0	0
	T-P		8.4	44		8.4	44	0	0
Raqqa	BOD	33,224	370	12,284	33,224	40	1,329	10,955	89.2
	COD		787	26,150		150	4,984	21,166	80.9
	T-N		11	366		11	366	0	0
	T-P		2.6	86		2.6	86	0	0
Dar'aa	BOD	4,985	623	3,107	4,985	40	199	2,908	93.6
	COD		3512	17,508		150	748	16,760	95.7
	T-N		44	218		44	218	0	0
	T-P		31	155		15	75	80	51.8
Rural Damascus	BOD	75,091	232	17,449	75,091	40	3,004	14,445	82.8
	COD		1286	96,531		150	11,264	85,268	88.3
	T-N		21	1,601		21	1,601	0	0
	T-P		6.5	487		6.5	487	0	0
Aleppo	BOD	116,670	115	13,425	116,670	40	4,667	8,758	65.2
	COD		869	101,337		150	17,501	83,837	82.7
	T-N		19	2,183		19	2,183	0	0
	T-P		10	1,194		10	1,194	0	0
Quneitra	BOD	142	905	128	142	40	6	122	95.6
	COD		3880	549		150	21	528	96.1
	T-N		19	3		19	3	0	0
	T-P		12	2		12	2	0	0
Damascus	BOD	42,508	38	1,606	42,508	38	1,606	0	0
	COD		485	20,609		150	6,376	14,233	69.1
	T-N		10	432		10	432	0	0
	T-P		1.4	58		1.4	58	0	0

Table 8.3.18 Comparison of Industrial Loads by Governorate before and after Legal Compliance

		2025 before legal compliance			2025 after legal compliance			difference	
		flow volume	water quality	load	flow volume	water quality	load	reduced load	reduction percentage
		m^3/day	mg/l	kg/day	m^3/day	mg/l	kg/day	kg/day	%
Total	BOD	336,608	289	97,431	336,608	40	13,370	78,061	80.1
	COD		1218	410,076		150	50,491	359,585	87.7
	T-N		21	6,906		18	6,177	729	10.6
	T-P		12	4,160		8.5	2,862	1,334	32.1

Note) Legal regulations: BOD 40mg/l, COD 150mg/l, T-N 55mg/l, T-P 15mg/l (in case of discharged to rivers)

The Table indicates that in order to meet the legal compliance, industrial organic pollution loads (BOD and COD) are required to reduce to a considerable level, since the BOD and COD concentration of industrial discharges is very high despite the rather stringent regulations. Industrial discharges from most Governorates need to achieve more than 80% removal of BOD and COD loads. On the other hand, the regulation does not require so much reduction in terms of T-N and T-P due to the less stringent standards compared to BOD and COD.

Table 8.3.19 shows the run-off BOD loads in 2025 Case 3 by basin when the industrial loads are reduced to the stipulated level by the water quality regulation. The Table implies that if all the industrial discharges meet the regulation, the run-off BOD loads will further be reduced to a level of 56-87% against the original Case 3 (providing sewage treatment of an efficient process). This means the receiving water quality could further be improved to 56-87% against the values shown in **Figure 8.3.8**. Regulation of industrial discharges is especially effective for Euphrates and Coastal basins.

However, the water quality criteria required in the standards are too stringent for the present Syrian situations, and it would be very difficult for all the enterprises (including small and medium scale enterprises) to comply with these standards simultaneously. A step-by-step improvement, which may begin with the major national industries, would be vital. Details of the countermeasures for industrial wastewater control will be discussed in Chapter 8.5.

Table 8.3.19 Run-off BOD Loads in 2025 Case 3 after Industrial Loads Regulations

(kg/day)

Basin	① Run-off load in 2025 Case 3	② Reduction required for industrial load	③=①-② 2025 Case 3 after reduction of industrial load	④=③/①x100 percentage of load after industrial load reduction	Remarks
Euphrates	88,486	48,274x0.8 = 38,619	49,867	56.4	Aleppo, Raqqa, Deir-Ez-zor
Khabour	19,104	2,295x0.8 = 1,836	17,268	90.4	Hassakeh

Table 8.3.19 Run-off BOD Loads in 2025 Case 3 after Industrial Loads Regulations

(kg/day)

Basin	① Run-off load in 2025 Case 3	② Reduction required for industrial load	③=①-② 2025 Case 3 after reduction of industrial load	④=③/①x100 percentage of load after industrial load reduction	Remarks
Yarmouk	8,275	3,030x0.8 = 2,424	5,851	70.7	Dar'aa, Quneitra
Barada/Awaj	32,452	14,445x0.8 = 11,556	20,896	64.4	Damascus, Rural Damascus
Coastal	18,961	10,017x0.8 = 8,014	10,947	57.7	Tartous, Lattakia

8.3.5 Water Pollution Analysis for Groundwater

As mentioned in Chapter 3, Damascus Rural Governorate heavily relies on groundwater as drinking water sources, and contamination of groundwater is a serious problem. Consequently, the groundwater pollution analysis shall be carried out for Damascus Rural Governorate.

However, strict analysis on groundwater pollution mechanism will be time consuming and also high professional technology will be needed. Therefore, a simplified analysis method, which observes the relationship between magnitude of pollution load discharged into groundwater layer and groundwater quality, is employed.

The complex pollution mechanisms of groundwater are regarded as a black box, focusing only on the relation between the current pollution loads (input) channeled underground and the current water quality of underground water (output). Then, evaluation shall be made as to the extent to which the future pollution loads affect on the groundwater quality. Total nitrogen (T-N) is used for the parameter of water quality.

(1) Contribution of Pollution Loads to Groundwater Contamination.

As described in Chapter 3, groundwater in the south-east area of Rural Damascus is seriously contaminated. **Table 8.3.20** presents the NO_3 concentration data provided by DAWSSA. As shown, NO_3 concentration exceeds 50 mg/l (WHO standard) at 280 points out of the total 306 observation points. The average of these data is computed at 77.0 mg/l, which also considerably exceeds the WHO standard.

Table 8.3.20 Distribution of Groundwater NO_3 Concentration

Concentration range	Number of Point	Percentage
Less than 50mg/l	26	8.5
From 50 to 100mg/l	232	75.8
From 100 to 150mg/l	41	13.4
From 150 to 200mg/l	6	2.0
More than 200mg/l	1	0.3
Total	306	100.0

It is obvious that such contamination is caused by all pollution sources such as domestic, industrial wastewater, STP effluent and non-point sources generated from Damascus and Rural Damascus. However, it is very difficult to investigate how much portion of the pollution loads will affect the groundwater quality.

A part of pollution loads discharged from various pollution sources will infiltrate into the soil. In addition, the soil has the function of filtering and adsorbing pollutants through the action of its particles, providing habitats for microorganism useful for polluted water purification and serving as the base for useful plants. Wastewater is purified through physicochemical action such as filtration and adsorption provided by the soil, and biological action such as the metabolism of the microorganism inhabiting it.

In the biological purification mechanism, in an aerobic condition where sufficient oxygen is present in the soil surface and around the areas where wastewater flows, the oxidation of organic substances in the wastewater to CO_2 by BOD decomposing bacteria and the oxidation of nitrogen compounds (nitrification) by nitrifying bacteria progress. Also, suspended solids are decomposed by the work of soil animals and the occlusion of the soil is removed. In a slightly aerobic to anaerobic condition, where oxygen is present at a low concentration or absent in the depth of the soil, nitrate or nitrite nitrogen is reduced by facultative anaerobic bacteria and nitrogen is removed as a N_2 gas (de-nitrification).

No data is available to numerically explain these mechanisms, and therefore, this Study assumes the infiltration ratio as follows, and the purification (de-nitrification) ratio is neglected, although it is somewhat a daring assumption.

Table 8.3.21 Assumption for Infiltration Ratio and Purification Ratio

Category	Infiltration Ratio	Purification Ratio	Remarks
Sewerage with a concrete outfall channel	0.5	0.0	Adraa STP, Proposed STP
Sewerage without a concrete outfall channel	0.9	0.0	Outfall of untreated sewage
Other pollution sources	0.9	0.0	

Under this assumption, the T-N infiltration loads are calculated. The result is presented in

Table 8.3.22. The loads infiltrated into groundwater aquifer are estimated to be 20.8 t/d, 37.6 t/d, 22.1 t/d, 13.9 t/d, in 2006, 2025 Case1, 2025 Case2, 2025 Case3, respectively. The result indicates if no measures are taken, T-N loads in 2025 will increase to 1.8 times against 2006. Furthermore, even if sewage treatment is provided by the conventional method, the loads in 2025 will slightly increase against 2006. The Table suggests that introduction of the treatment process with nitrogen removal (e.g. OD system) be essential for both existing Adraa and proposed STPs, in order to reduce the T-N loads infiltrated into the aquifer in the future.

Table 8.3.22 T-N Infiltration Loads

Present (2006)

Compartmentation of Pollution Load		T-N Discharge Load in 2006 (kg/day)			Infiltration Rate	T-N Infiltration Load in 2006 (kg/day)		
		Rural Damascus	Damascus	Total		Rural Damascus	Damascus	Total
Point Load	Living System	1,009.1	35.3	**1,044.4**		908.2	31.8	**940.0**
	Sewerage System	13,380.4	8,724.6	**22,105.0**	(a)Sewerage : 0.5	12,042.4	4,362.3	**16,404.7**
	Industry	1,324.0	163.0	**1,487.0**	(with concrete out fall)	1,191.6	146.7	**1,338.3**
	Sub-Total	**15,713.5**	**8,922.9**	**24,636.4**	(b)Sewerage : 0.9	**14,142.2**	**4,540.8**	**18,682.9**
Non-Point Load	Land Use System	2,113.7	54.1	**2,167.8**	(sinple excavation)	1,902.3	48.7	**1,951.0**
	Live Stock System	156.1	9.1	**165.2**	(c)Others : 0.9	140.5	8.2	**148.7**
	Sub-Total	**2,269.8**	**63.2**	**2,333.0**		**2,042.8**	**56.9**	**2,099.7**
Grand-Total		**17,983.3**	**8,986.1**	**26,969.4**		**16,185.0**	**4,597.7**	**20,782.6**

CASE-1 (2025)

Compartmentation of Pollution Load		T-N Discharge Load in 2025 CASE-1 (kg/day)			Infiltration Rate	T-N Infiltration Load in 2025 CASE-1 (kg/day)		
		Rural Damascus	Damascus	Total		Rural Damascus	Damascus	Total
Point Load	Living System	1,997.3	53.7	**2,051.0**		1,797.6	48.3	**1,845.9**
	Sewerage System	26,553.4	10,619.5	**37,172.9**	(a)Sewerage : 0.5	23,898.1	5,309.8	**29,207.8**
	Industry	3,508.2	432.0	**3,940.2**	(with concrete out fall)	3,157.4	388.8	**3,546.2**
	Sub-Total	**32,058.9**	**11,105.2**	**43,164.1**	(b)Sewerage : 0.9	**28,853.0**	**5,746.9**	**34,599.9**
Non-Point Load	Land Use System	3,046.6	35.2	**3,081.8**	(sinple excavation)	2,741.9	31.7	**2,773.6**
	Live Stock System	207.2	12.0	**219.2**	(c)Others : 0.9	186.5	10.8	**197.3**
	Sub-Total	**3,253.8**	**47.2**	**3,301.0**		**2,928.4**	**42.5**	**2,970.9**
Grand-Total		**35,312.7**	**11,152.4**	**46,465.1**		**31,781.4**	**5,789.4**	**37,570.8**

CASE-2 (2025)

Compartmentation of Pollution Load		T-N Discharge Load in 2025 CASE-2 (kg/day)			Infiltration Rate	T-N Infiltration Load in 2025 CASE-2 (kg/day)		
		Rural Damascus	Damascus	Total		Rural Damascus	Damascus	Total
Point Load	Living System	1,042.2	53.7	**1,095.9**		938.0	48.3	**986.3**
	Sewerage System	21,986.3	10,619.5	**32,605.8**	(a)Sewerage : 0.5	10,993.2	5,309.8	**16,302.9**
	Industry	1,601.0	432.0	**2,033.0**	(with concrete out fall)	1,440.9	388.8	**1,829.7**
	Sub-Total	**24,629.5**	**11,105.2**	**35,734.7**	(b)Sewerage : 0.9	**13,372.0**	**5,746.9**	**19,118.9**
Non-Point Load	Land Use System	3,046.6	36.2	**3,082.8**	(sinple excavation)	2,741.9	32.6	**2,774.5**
	Live Stock System	207.2	12.0	**219.2**	(c)Others : 0.9	186.5	10.8	**197.3**
	Sub-Total	**3,253.8**	**48.2**	**3,302.0**		**2,928.4**	**43.4**	**2,971.8**
Grand-Total		**27,883.3**	**11,153.4**	**39,036.7**		**16,300.5**	**5,790.3**	**22,090.7**

CASE-3 (2025)

Compartmentation of Pollution Load		T-N Discharge Load in 2025 CASE-3 (kg/day)			Infiltration Rate	T-N Infiltration Load in 2025 CASE-3 (kg/day)		
		Rural Damascus	Damascus	Total		Rural Damascus	Damascus	Total
Point Load	Living System	1,042.2	53.7	**1,095.9**		938.0	48.3	**986.3**
	Sewerage System	10,993.1	5,309.8	**16,302.9**	(a)Sewerage : 0.5	5,496.6	2,654.9	**8,151.5**
	Industry	1,601.0	432.0	**2,033.0**	(with concrete out fall)	1,440.9	388.8	**1,829.7**
	Sub-Total	**13,636.3**	**5,795.5**	**19,431.8**	(b)Sewerage : 0.9	**7,875.4**	**3,092.0**	**10,967.5**
Non-Point Load	Land Use System	3,046.6	36.2	**3,082.8**	(sinple excavation)	2,741.9	32.6	**2,774.5**
	Live Stock System	207.2	12.0	**219.2**	(c)Others : 0.9	186.5	10.8	**197.3**
	Sub-Total	**3,253.8**	**48.2**	**3,302.0**		**2,928.4**	**43.4**	**2,971.8**
Grand-Total		**16,890.1**	**5,843.7**	**22,733.8**		**10,803.9**	**3,135.4**	**13,939.3**

Review of Estimated T-N Loads

The estimated T-N load in 2006 is reviewed based on another information to verify its relevance. Regarding the groundwater resources volume in Barada/Awaj basin, estimation of MOI is 838 million m^3/anum (including 165 million m^3/anum of spring water) in 2004, while the World Bank estimated to be 302 million m^3/anum in 2003, showing a large difference. This comes to a volume of 1,844 – 827 thousand m^3/day. In terms of groundwater quality, the average NO_3 concentration monitored by DAWSSA is 77 mg/l as presented earlier. This gives 17.4 mg/l (77 ×0.226) as NO_3-N. Then, the nitrogen load in the aquifer is calculated as:

32,100 kg/d (1,844×17.4) ～ 14,400 kg/d (827×17.4) : average 23,300 kg/d

Therefore, the estimated T-N infiltration load of 20,800 kg/d in 2006 is considered appropriate when compared to this figure.

(2) Future Water Quality Prediction

Based on the infiltration T-N loads estimated earlier, the average future ground water quality is computed as shown in **Table 8.3.23**. As shown, only Case 3 can meet the proposed water quality standard (12mg/l as T-N), and almost meet the WHO standard (50mg/l as NO_3).

Table 8.3.23 Result of Future Water Quality Prediction

	2006	2025 Case 1	2025 Case 2	2025 Case 3
T-N Infiltration Load (kg/d)	20,783	37,571	22,091	13,939
Rate against 2006	1.00	1.81	1.06	0.67
Water Quality as T-N (mg/l)	17.4	31.5	18.4	11.7
Water Quality as $NO_{3\ (mg/l)}$	77.0	139.4	81.6	51.6

8.3.6 Conclusions

(1) Impact of Sewerage Development on Public Water Quality

1) Euphrates River

It is expected that the development of the sewerage system will make the water quality in the Euphrates River satisfy the target of the (proposed) environmental standard for BOD (BOD: 2mg/l or less) on annual average. However, notable improvement on the river water quality is not expected due to the large load of industrial discharge.

2) Khabour, Barada/Awaj, Yarmouk River

For Khabour and Barada/Awaj Rivers, the sewerage system development will satisfy the target of the (proposed) environmental standard for BOD (BOD: 8mg/l or less) on annual average. However, the water quality in the Yarmouk River is not expected to satisfy the (proposed) standard according to this study, due to the very high present water quality, although improvement in the water quality is seen. It is apparent that the present BOD concentration of 33 mg/l is extremely unsuitable for the drinking water source. As the available water quality data were very few, accumulation of water quality monitoring data is desired.

3) Mediterranean

It is expected that the development of the sewerage system will make the water quality in Mediterranean Coastal Area satisfy the target of the (proposed) environmental standard of water quality (of fecal coliform concentration of 1000 MPN/100ml).

(2) Impact of Sewerage Development on Groundwater Quality

For the groundwater quality improvement in Barada/Awaj basin, sewerage system development with a nitrogen removal process only can meet the proposed water quality standard (12mg/l as T-N), and almost meet the WHO standard (50mg/l as NO_3).

(3) Necessity of Industrial Load Reduction

In addition to the sewerage development, if all the industrial discharges meet the Syrian regulation, the run-off BOD loads will further be reduced to a level of 56-87%. Regulation of industrial discharges is especially effective for Euphrates and Coastal basins.

8.4 Recommendations

8.4.1 Strategy for Water Pollution Control

(1) Strategy for Sewerage System Development

Without the sewerage system development, the public water quality will be getting worse and worse. It has been predicted that in 2025, water quality of Euphrates, Yarmouk, Khabour Rivers will worsen to 1.4 times of the present quality, while Barada/Awaj surface and ground water quality is almost doubled, due to the rapid growth of population and increasing economic, industrial activities in the future. To cope with this anticipated situation, the sewerage system need to be developed as fast as possible, however, investments must be in an efficient manner. The JICA Study Team recommends that prioritization of sewerage investments should be based on the expected effectiveness of the water quality improvement in public waters. In other words, how much improvement in the public water quality is expected by developing the sewerage system.

In this regard, the following prioritization is proposed.

A: Barada/Awaj basin (Rural Damascus)
B: Coastal basin, Yarmouk basin (Lattakia, Tartous, Dar'aa)
C: Euphrates basin, Khabour basin (Deir-Ez-zor, Raqqa, Hassakeh)

It should be noted that in developing the sewerage system for Rural Damascus, adoption of the treatment method with a nitrogen removal process is vital to prevent groundwater from contamination. In addition, the existing treatment system in Adraa STP needs to be upgraded to a system that can remove nitrogen. Needless to say, sewage treatment method shall be appropriately selected based on the locality of target service areas in each Governorate.

Finally, consistency should be maintained between the investments for STPs and those for sewer networks.

(2) Recommendation of Countermeasures for Industrial Wastewater Control

Industrial wastewater is the biggest pollution source except for domestic wastewater. Additionally, part of wastewater from factories may contain hazardous substance. Such as high polluted or high-contaminated wastewater of factory may cause water pollution or contamination in a public water bodies. The treatment method and strategies for countermeasures concerning industrial wastewater are mentioned below.

- Recommendation concerning the high polluted and contaminated wastewater/ sludge
  - Olive mill factory

  Construction of treatment plant for olive mill wastewater (OMW) is needed. Lagoon with drying bed is applicable for OMW. OMW shall be conveyed to this treatment facility by tank lorry.
  - Sugar factory

  It is recommended that wastewater collection system is divided into flume wastewater and Steffen wastewater[*1)]. Flume wastewater[*2)] is treated by sedimentation and oxidation pond process. The treatment methods for Steffen wastewater adopt a lagoon system with drying bed same as treatment method of olive mill wastewater.

  Note) *1) As sugar extracted from Sugar Beet contains many impurities, it must be refined. Refinery method is called "Steffen Method". Wastewater generated through refinery process was called as "Steffen Wastewater".

  *2) Sugar beet is washed first and conveyed to next process by this washed wastewater flowing in flume. "Flume Waste" means this wastewater used for washing and conveyance.
  - Tannery factory

  Pre-treatment process (screen, pH control, sedimentation, and coagulation process) for discharging to sewer networks and treatment process (screen, pH control, sedimentation, Biological treatment process and coagulation process) are recommended. It is also recommended that the small-scale factory is relocated to Industrial zone with tannery excusive area.
  - Sludge containing a toxic substance

  Planning and construction concerning disposal site (plant) for the sludge that contains hazardous substance is recommended.

- Recommended countermeasures for pollution control management of industrial wastewater
  - Upgrading and expanding of "Cleaner Production"
  - Introduction of "Industrial Pollution Control Manager (e.g.)" system
  - Introduction of "Commendation for the excellent factory and for the excellent

activates by citizen / citizens' organization" system

The details of treatment method and countermeasures for pollution control management of industrial wastewater are given in Chapter 8.5.

(3) Other Pollution Sources Issues

According to the information from Ministry of Agriculture, it is found that the livestock farm have no wastewater discharging system, and all the wastes are discharged to agricultural area such as solid. Therefore, it is judged that there is no serious influence to the water pollution problem by wastewater from the livestock barn in Syria.

8.4.2 Recommendation on Capacity Development of Sewerage Sector

(1) Strategy for Establishing Sewerage Development Plan

Regarding the existing sewerage master plans for the Governorates, the JICA Study Team observes that some are too old in the preparation year and are technically poor as a whole. In general, the Master Plan provides long-term targets for sewage works in the Governorate and shall be used as the guidelines in implementing specific programs of sewerage construction. In this regard, they could not be served as the guidelines for the sewerage development.

In consideration of these matters, this Study will, first of all, draw a macroscopic picture for sewerage development (referred to as the "Macro Plan") covering priority areas of the target 7 Governorates, in order to ensure the efficient construction of sewerage infrastructure. The plan shall include:

- Long-term goal of sewerage coverage areas, served population, etc.
- Number of sewage treatment plants (STPs) to be constructed
- Basic plan for treated wastewater reuse and sludge treatment (e.g. irrigation areas, type of crops, cooperative sludge treatment)
- Basic plan for operation and maintenance of sewerage facilities (e.g. Standardization of facilities, cooperative O&M in order to establish an efficient O&M system)
- Basic plan for phased construction (e.g. effect of sewerage development in improvement of water quality in public waters and drinking water sources, prioritizing and time scheduling for sewerage construction programs in each of the areas)

In establishing the Macro Plan, a river basin grounded approach will be employed. In other words, the sewage treatment plan for a certain basin should not exert negative impacts on the existing water environment of that basin, or on that of other river basins by changing the sewage disposal point.

Secondly, the Study will establish a master plan for one specific core city (or area) in each of 7 target Governorates. This will include planned service area, service population, sewage quantity and quality, planning of major trunk sewers route and their diameters, proposed pumping stations and STP, project phasing, capital and O&M cost estimation for the proposed systems, O&M plan including necessary number of staff, proposals for tariff setting and so on.

In order for the M/P to cover substantially wide areas, taking these procedures is essential to establish the optimal plan. The details of the planning methods and procedures for the Master Plan will be presented in this Study Report as a technical transfer tool. Referring to these methods and procedures, the Syrian C/P side needs to prepare the plan by themselves for the areas other than the priority area to be prepared by the JICA Study Team.

(2) Strategy for Institutional and Financial Reform

As mentioned in Chapter 4, GTZ is currently providing technical support to MHC, and it seems that most of the legislative, institutional arrangement surrounding the water and sewerage sector would be fulfilled through their support.

Likewise, the financial and cost recovery issues are being dealt with by a component of this program, and most part of these aspects will be fulfilled as a result of these activities for improvement primarily of the water supply management.

This Study will examine and propose on various sewerage tariff levels including recovery of investment costs based on detailed surveys for capital and O&M cost estimation for the M/P priority projects in the target 7 Governorates. These results will be able to serve as a baseline for setting the appropriate levels of sewerage tariff and government subsidies as well as for building a government subsidy system for sewerage projects in the long-term perspective. Thus, the outcome obtained from such examinations shall be provided to MHC as recommendations from the JICA Study, for a basis of the cost recovery policy of sewerage sector.

(3) Strategy for Organizational Strengthening

The JICA Study Team considers that capacity uplift for project implementation and O&M is the most important technical issues for the Syrian sewerage sector to sustain their work. Therefore, this Study will focus on the organization and capacity building of the Executor for the sewerage projects, namely, the sewerage directorate of the Establishments and the Sewerage Company. When specific projects commence in each Governorate, they have to deal with the whole cycle of the projects including project preparation, tender, construction, operation and maintenance and so on. This Study will provide proposals and recommendations on the necessary organization structure and management plan for the executing agency in the target 7 Governorates, as well as on the necessary technical assistance scheme.

8.4.3 Recommendation on Other Countermeasures

Main sources of water pollution consist of domestic wastewater, industrial wastewater and agricultural wastewater (effluent from livestock barn) as point sources, and non-point sources of agricultural area, urbanized area and forest and uncultivated areas. Of these pollution sources, it is very important to implement countermeasures for pollution control resulting from point sources including domestic, industrial and agricultural wastewaters. The pollution control measures for domestic wastewater have already been mentioned in Section 8.4.2 as Strategy for Establishing Sewerage Development Plan. In this section, countermeasures for industrial and agricultural wastewater pollution control are discussed.

(1) Countermeasures concerning Agricultural Wastewater (wastewater of livestock barn)

On the basis of information from Ministry of Agriculture and results of the field survey, existing condition of wastewater from livestock sources is described below. The livestock of Syria consist of cow for meat and milk, sheep, goat and others (camel, donkey, horse, etc). These livestock normally stay outdoors during daytime and some livestock are bred in the barn only at night. Moreover, the numbers of livestock raised at the farm of livestock industry is very small (refer to **Table 8.4.1**). From this Table it is observed that about 32,000 cows and 7,500 sheep are raised in livestock farms. These farms do not have wastewater treatment facilities, and the wastes of these farms are collected as solid waste. The collected wastes are applied to farmland after solar drying. Therefore, it is judged that there is no serious influence on the water pollution problem by wastewater from the livestock barn in the Syria.

Table 8.4.1 Number of farms and livestock in livestock industry

Governorate	Cow			Sheep		
	No. of farm	Capacity (heads)	Heads Raised in Farms	No. of farm	Capacity (heads)	Heads Raised in Farms
Lattakia	28	627	172	1	100	0
Tartous	110	1,996	2,446	2	730	0
Deir-Ez-zor	9	382	119	1	100	0
Hassakeh	43	509	320	5	370	495
Raqqa	0	0	0	2	0	1,740
Dar'aa	189	6,765	17,203	10	2,093	2,969
Rural Damascus	102	2,821	1,767	0	0	0
Aleppo	11	1,955	1,677	0	0	0
Hama	80	2,401	1,685	3	2,783	1,398
Homs	142	4,251	3,044	3	0	703
Idleb	62	1,268	2,497	3	100	175
Sweida	62	1503	840	3	510	0
Qunetra	0	0	0	0	0	0
Damascus	0	0	0	0	0	0
Total	838	24,478	31,770	32	6,686	7,480
Total numbers of livestock in Syria	Cow	Goat	Sheep	Buffalo	Note	
	709	691	11,060	3	(×1000 heads, 2006)	

Source) Ministry of Agriculture (2006)

The following description is not the countermeasure for agricultural wastewater, but is a recommendation for problem of irrigation water in Rural Damascus. It is said that an adverse effect for farm products occurred by irrigation water in Adraa and Ghouta areas of Rural Damascus.
In the Adraa area, the treated water of the Adraa STP is reused for irrigation. According to the results of water quality analysis, concentration of Ammonia Nitrogen in the treated wastewater is in excess of the water quality standards for agricultural use. However, the actual condition and cause of this problem is not clear in the both areas.

For the reasons mentioned above, recommendations have been made for irrigation water in Rural Damascus by responsible organizations are shown in **Table 8.4.2**. While, present condition and countermeasures proposed by the Study Team are presented in **Table 8.4.3**.

Table 8.4.2 Recommendations made by responsible organizations for Irrigation Water in Rural Damascus

Recommendation	Note	Responsible Organization
Investigation of actual conditions and causes of problem	Since the cause is unknown, a required countermeasure is not taken.	Ministry of Agriculture
Raise the level of wastewater treatment of the Adraa STP.	The Ministry of Housing and Construction is considering advanced processing of the Adraa STP.	Ministry of Housing and Construction

Table 8.4.3 Present Condition of Adraa STP and applicable remedial Measures proposed by the Study Team

Issues	Present Status	Applicable Remedial Measures
Re-use of treated wastewater	As treated wastewater contains high concentration of nutrients, farmers have not been utilized it affirmatively.	Introduction of additional treatment shall be examined to upgrade the quality of treated wastewater.
Insufficient aeration time	Compared with incoming wastewater flow, total capacity of currently operated aeration tank is not enough to attain proper treatment efficiency. Total capacity of existing aeration tank is 95,200 m^3. Based on this total capacity of existing aeration tanks, actual plant capacity was calculated with standard BOD-SS loading of 0.3 kgBOD/kgSS day, incoming BOD concentration of 300 mg/l and MLSS of 2,500 mg/l. Result was 238,000 m^3/day. Compared with design capacity of 485,000 m^3/day, actual plant capacity is too small. Incoming BOD concentration of 300 mg/l was set based on incoming BOD data shown in **Figure 5.2.19**. It's higher than 90% of those of total samples.	Total number of existing aeration tank is 56. To secure necessary aeration time against incoming wastewater flow, number of aeration tank in operation shall be increased. Additional construction of aeration tank or introduction of high-efficiency aeration device is needed to secure necessary aeration time. Maintenance of necessary aeration time will lead to the improvement of treated wastewater quality.
Return supernatant from Sludge Treatment	Return supernatant from sludge treatment process is currently discharged into the pit just upstream of inlet PS. It seems that this return supernatant has been aggravated sewage treatment efficiency.	To terminate the discharge of supernatant generated in sludge treatment process, its operation must be terminated.

Table 8.4.3 Present Condition of Adraa STP and applicable remedial Measures proposed by the Study Team

<table>
<tr><th>Issues</th><th>Present Status</th><th>Applicable Remedial Measures</th></tr>
<tr><td>Process</td><td>According to the wastewater quality analysis on samples taken at a) Inlet (Not including supernatant) and b) discharge pit of inlet PS(Including supernatant), results were as follows:
<table><tr><th>Indices</th><th>Inlet</th><th>Pump Discharge</th></tr><tr><td>SS</td><td>136</td><td>258</td></tr><tr><td>COD</td><td>275</td><td>435</td></tr></table>Date) 5th July 2006

This apparently shows the adverse effect by the said supernatant.</td><td rowspan="2">Namely, operation of sludge thickening and anaerobic sludge digestion process shall be stopped.

Withdrawn sludge shall be discharged to sludge drying bed directly. This is only temporally measure.

As sludge drying bed has odor issue, it cannot be long-term solution. As stated earlier, land for additional aeration tank might be needed in the future. Since generated sludge amount increases through the future, drastic countermeasure shall be proposed to attain stable sludge treatment performance.

Employment of mechanical sludge dewatering unit is applicable. Existing vast land occupied by sludge drying bed can be converted to construction land for additional aeration tank.

Introduction of mechanical sludge mixing device to digestion tank can be another option to optimize the existing tanks.

Sludge composting can be another option of sludge treatment but market research to farmers shall be conducted in advance. Upon planning of composting of generated sludge, introduction of fermentation process is indispensable to reduce the sludge volume and to stabilize the nature of the products. This process is also effective in extinction or inactivation of parasite eggs and germs.</td></tr>
<tr><td>Low efficiency in Sludge Treatment Process</td><td>The JICA Study Team observed that primary sludge was very thick. This might has been caused low efficiency in Sludge Digestion process as sludge mixing by gas is supposed to be unsuccessful owing to the said sludge nature. This resulted in poor fermentation in digestion tank.

Low efficiency can be verified by analysis result on VSS:
<table><tr><th>Indices</th><th>Before Digestion</th><th>Digested Sludge</th></tr><tr><td>VSS (%)</td><td>58</td><td>47.9</td></tr></table>Date) 5th July 2006</td></tr>
</table>

(2) Countermeasures concerning Industrial Wastewater

Industrial wastewater is the second biggest pollution load next to the domestic wastewater. Untreated effluent from factories may contain hazardous substances. Highly polluted effluents or industrial effluents with high level of contamination cause water pollution or contamination of public water bodies.

Problems concerning industrial wastewater and countermeasures under present regulation are shown in **Table 8.4.4.**

Table 8.4.4 Problems concerning Industrial Wastewater and Countermeasures under Present Regulation

Items		Contents
Countermeasures under present regulation	Monitoring system and data management	Before carrying out the monitoring project by JICA, periodical water quality surveillance for industrial wastewater was not carried out. The following investigations were conducted. Ministry of Irrigation: In order to investigate the cause of pollution /contamination of river, the water quality analysis of industrial wastewater was carried out. Ministry of Local Administration and Environment: The water quality analysis of industrial wastewater was mainly conducted by residents' complaint. Ministry of Industry: Irregular investigation was conducted for factories that had problems with wastewater quality. In addition to the above situations, results of the investigation were managed by each enforcing organization.
Problems concerning industrial wastewater	Administrative guidance	Sufficient effect of administrative guidance is not acquired. Based on the results of the water quality survey for industrial wastewater, it has become clear that wastewater quality in many factories does not satisfy effluent standards.
	Olive mill wastewater	Many olive mills are small scale and their operation is seasonal. In addition, treating wastewater in a factory is not easy because of its high concentration. In the present condition, number of wastewater disposal sites for olive mills is insufficient, and these mills have become additional sources of water pollution.
	Tannery wastewater	Usually tannery wastewater contains high concentration of suspended substances (organic and inorganic) and chromium. Many small-scale tannery factories discharge wastewater into river or sewer networks without any treatment.
	Sludge that contained hazardous substances	At present, disposal of sludge containing hazardous substances is not managed. It seems that the sludge containing hazardous substances is disposed off with normal sludge.
Countermeasures under present regulation	Monitoring system and data management	Ministry of Local Administration and Environment is establishing the water quality monitoring system containing industrial wastewater. Furthermore, the data management system containing the results of water quality survey by other organizations is also established.

Table 8.4.4 Problems concerning Industrial Wastewater and Countermeasures under Present Regulation

Items		Contents
	Planning and Construction of industrial zone (Including an exclusive tannery factory area)	Current situation of planned or under construction four units of industrial zones are shown in **Table 8.4.5**. Adraa industrial zone has an exclusive tannery factory area, and relocation of tannery factory is possible. Furthermore, the Adraa industrial zone has three treatment plants, first is industrial wastewater in the whole area and second is tannery wastewater treatment unit. The third is treatment plant for industrial water. Treated effluent from the Adraa STP is purified in this plant, and supplied to factories in this industrial zone. Not only tannery factories but also relocation of other factories is recommended. Moreover, establishment of new factory in industrial zone is also recommended.
	Aid fund and subsidy system for construction costs of treatment facilities and exemption of tax	Based on the information of Ministry of Local Administration and Environment, including exemption of the tax for import of pollution control facilities is under consideration as ministerial decree.

Table 8.4.5 Planned or under Construction Industrial Zones

Name	Industrial area (Whole Area)	Percent complete	No. of operated factories (No. of planned factories)	Wastewater Treatment plant
Aleppo	1,162ha (4,412ha)	50%	123 (810 factories)	100,000m^3/day Under study
Homs	938 ha (2,500ha)	-	50 (237 factories)	66,000m^3/day Under study
Adraa	1,610ha (7,000ha)	20%	65 (936 factories)	Three plants for reuse, tannery wastewater and wastewater treatment.
Deir-Ez-zor	- (1,200 ha)	Under study		

Source) Ministry of Local Administration and Environment

In addition to the above countermeasures, following countermeasures are recommended as promotional incentive schemes for the industrial wastewater treatment and reduction of pollution load. (See **Table 8.4.6**)

Table 8.4.6 Countermeasures concerning Industrial Wastewater

Items	Countermeasures	Responsible Administrative organization
Olive mill factory	Construction of treatment plant for olive mill wastewater (OMW) is recommended. Lagoon with drying bed as OMW treatment method and conveyance system of OMW by tank lorry to the treatment plant are proposed. [1)]	Ministry of Industry (Chamber of Industry)
Tannery factory	Relocation of small-scale tannery factories and electroplating	Ministry of Industry

Table 8.4.6 Countermeasures concerning Industrial Wastewater

Items	Countermeasures	Responsible Administrative organization
	factories to industrial zone, and construction of treatment facilities. Not only for the above-mentioned factories but also for other factories, relocation to the industrial zone is recommended.	
The sludge that contains hazardous substance	Planning and construction of disposal site (plant) for the sludge containing hazardous substances is recommended.	Ministry of Housing and Construction
Strengthening of regulations	According to the results of water quality monitoring for industrial wastewater, control for illegal factories that do not observe the effluent standard regulation needs to be strengthened.	Ministry of Local Administration and Environment
Strengthening of administrative guidance	According to the results of water quality monitoring for industrial wastewater, administrative guidance for illegal factories needs to be strengthened.	Ministry of Industry
Introduction of "Industrial Pollution Control Manager: IPCM (e.g.)"	Introduction of IPC manager (e.g.) is recommended as a measure for advancing administrative guidance effectively and promptly.	Ministry of Industry
Upgrading and expanding of "Cleaner Production" 2)	Implementation of "Cleaner production" at site of production factories under instruction of " Industrial Pollution Control Manager (e.g.)" can be expected to bring large advantages in terms of the industrial wastewater pollution load reduction.	Ministry of Industry
Introduction of "Commendation for the excellent factory and for the excellent activities by citizen / citizens' organization" system	In order to achieve a good output from the factory manager responsible for carrying out activities concerning a positive environmental countermeasure, the systems of incentives are required to be established. For this purpose, it is recommended that social evaluation and name recognition be awarded to a factory manager by the "commendation for the excellent factory". Similarly, establishment of "Commendation for the excellent activities by citizen / citizens' organization" system is also recommended, and it is expected that social acknowledgement of activities for environment would lead to the improvement in consciousness towards environment.	Ministry of Local Administration and Environment & Ministry of Industry

Note) 1) The treatment method is described in Chapter 8.5.
2) "Cleaner production" is described in Chapter 8.5.
3) Outline of "Industrial Pollution Control Manager (e.g.)" is shown below.

< Outline of "Industrial Pollution Control Manager (e.g.)">

- As one of the countermeasures for preservation of the water environment, appropriate wastewater treatment and management in factory are required. In Japan, in factory where pollution is expected to occur due to its effluent, the factory manager has to assign a "person" as legal obligation at the factory to control pollution. The person is "manager in charge of pollution control in factory", and takes charge of the activities as listed below as his assignment in factory. Also in Syria, assignment of "IPC manager" in factories can significantly enhance the promotion of environmental administration.

- Surveillance of operation / operation method of production facilities
- Implementation of "Cleaner Production"
- Measurement and recording (condition of water use and wastewater)
- Action in emergency
- Operation and maintenance of treatment facilities
- Supervision of working method
- Reception and explanation to neighboring residents
- Report to administrative agency

8.5 Recommendation of Treatment Method for Problematic Industrial Wastewaters

In this section, based on the information and knowledge from the field survey and water quality survey for industrial wastewater, the following items are described.

- Situation of factory distribution and industrial wastewater treatment
- Results of water quality survey for industrial wastewater
- Treatment method for industrial wastewater
- Cleaner production

The above-mentioned items are explained below in detail.

(1) Regional Distribution and Treatment Situation of Industrial Wastewater

a) Regional Distribution of Factory

The factory in Syria can be classified under Public sector or Private sector. The former has produced important products concerning people life, and hold the base-industrial production of Syria. Number of factories categorized under public sector is 93, and consists of Tobacco factory (4 factories), food factory (19), sugar production (9), Textile (25), cement/construction materials (10), metal/ non-metal (13) and Chemical (13).

Total number of factories classified as private sector is 95,142. Of these, the factory with less than 5 employees contributes 90.6 %, and number of factories with 101 employees of more is only 128. (refer to **Table 8.5.1**)

Table 8.5.1 Number of Factory Classified by Number of Employee (Private sector)

Number of employee	No. of factory	Percentage (%)
Less than 5 persons	86,156	90.6
From 6 to 9 persons	5,905	6.3
From 10 to 50 persons	2,690	2.8
From 51 to 100 persons	183	0.2
More than 101 persons	128	0.1
Total	95,142	-

Source) Ministry of Industry

In terms of regional distribution of factory, about 59% of total factories in entire country is located in three governorates of Damascus, Rural Damascus, and Aleppo. If the governorates of Homs and Hama are added to the three above-mentioned governorates, the ratio of concentration will increase to about 75%. Corresponding ratio of the large-scale private factory with 101 employees or more is 79 % in three governorates and 92 % in five governorates, respectively. The percentage of factory located in the Master Plan Study area is 34 % of the total factories in entire country and 63 % of the large-scale private factory with more than 101 employees, respectively. (refer to **Table 8.5.2**)

Table 8.5.2 Number of Factories in Governorate

Governorate	Public sector		Private sector		Total	
Lattakia	8	8.6%	4,075	4.3%	4,083	4.3%
Tartous	2	2.2%	3,427	3.6%	3,429	3.6%
Deir-Ez-zor	4	4.3%	2,169	2.3%	2,173	2.3%
Hassakeh	2	2.2%	3,095	3.2%	3,097	3.3%
Raqqa	1	1.1%	1,865	2.0%	1,866	2.0%
Dar'aa	-	-	2,640	2.8%	2,640	2.8%
Rural Damascus	21	22.6%	14,374	15.1%	14,395	15.1%
Aleppo	19	20.4%	29,642	31.2%	29,661	31.1%
Hama	9	9.7%	7,126	7.5%	7,135	7.5%
Homs	7	7.5%	8,012	8.4%	8,019	8.4%
Idleb	4	4.3%	5,097	5.4%	5,101	5.4%
Sweida	1	1.1%	1,460	1.5%	1,461	1.5%
Qunetra	-	-	190	0.2%	190	0.2%
Damascus	15	16.1%	11,970	12.6%	11,985	12.6%
Total	93	100.%	95,142	100%	95,235	100.0%

Source) Ministry of Industry

b) Existing Situation of Wastewater Treatment (Public Sector)

According to data from the Ministry of Industry, existing condition of industrial wastewater treatment is discussed below.

Table 8.5.3 Existing Situation of Wastewater Treatment (Public Sector)

Existing situation of wastewater treatment	Number of factories	Composition ratio (%)
Wastewater discharged to Sewerages system with treatment facilities	25	43%
Treated wastewater discharged to the public water bodies (lagoon)	2	
Treated wastewater discharged to the public water bodies (sedimentation)	4	
Treated wastewater discharged to the public water bodies (septic tank)	1	
Treated wastewater discharged to the public water bodies (unknown)	4	
Wastewater reuse for irrigation or recycle	4	
Sub-total (treatment or reuse)	40	
Non-treated wastewater discharged to sewerage system (without treatment facilities)	17	57%
Wastewater discharged to the public water bodies without treatment	15	
No data	21	
Sub-total (non-treatment)	53	
Total	93	-

Source) Ministry of Industry

From the above data, it is observed that about 57 % of industries under public sector discharge effluent into the public water bodies without treatment (including sewerage system without treatment plant). About 43% of factories under the public sector have treatment facilities, however, it is not clear whether they have appropriate treatment facilities or not. (refer to **Table 8.5.3**)

Meanwhile, the data concerning existing condition of industrial wastewater treatment facilities of private sector factory is not available.

(2) Water Quality Survey for Industrial Wastewater

a) Contents of Water Quality Survey for Industrial Wastewater

The water quality analysis survey for industrial wastewater was carried out to obtain reference data to understand characteristics of industrial wastewater and to decide consideration for treatment process. The survey consists of water quality analysis of industrial wastewater in terms of various parameters and questionnaire survey to understand salient features of objective factories.

Detail contents of water quality survey for industrial wastewater and results of survey are described in Appendix 1 “Water Quality Survey for Industrial Wastewater”.

Questionnaire survey

The content of the questionnaire survey are itemized below:

- Basic information
- Production activity
- Water consumption and used raw materials
- Information on generated wastewater

- Wastewater treatment and requirement of facilities

Selection of factory (Type of industry)

The types of industry (or factories) that discharge industrial effluent containing high concentration of pollutant or hazardous substance were selected as target facilities for survey. Main target factories in this survey were selected from list of proposed factories by Ministry of Local Administration and Environment, and the final decision on target factories were made following suggestion from Ministry of Housing and Construction. Details on number of samples by type of industry are shown in **Table 8.5.4**.

Compared to the final selection of target factories, some points of difference with the proposal in the Inception Report are described below.

- According to the information from Ministry of Local Administration and Environment, it becomes clear that the cement factory has no wastewater. Therefore, it is excluded from the list of candidate for the investigation of the objective type of industry.
- Sugar factory has seasonal operation for two or three months from July to September. A refinery sugar factory in Homs had suspended operation for the maintenance. Therefore, sugar industry is excluded from the list of candidate for this investigation.
- According to the information from C/P, fertilizer product factory in Syria is only one in Homs. However, the factory has some product lines, and sampling points are selected at each wastewater pipes.
- Among other type of industry, electroplating, Paint, pharmaceutical, aluminum, battery and detergent industries are selected as the objective type of industry.

The objective factories are located in 10 Governorates (Damascus, Rural Damascus, Dar'aa, Tartous, Lattakia, Deir-Ez-zor, Hassakeh, Raqqa, Sweida, Homs, Aleppo), and nearly half of samples are collected in Rural Damascus.

Table 8.5.4 Number of Samples by Type of Industry

Type of Industry	No. of Samples
Olive mill factory	8
Canning factory	2
Paper factory	3
Tannery factory	6
Food factory	11
Textile factory	3
Paint factory	3
Electroplating factory	3
Oil Refinery	3
Pharmaceutical factory	3
Aluminum factory	4
Battery factory	1
Fertilizer &agricultural chemicals factory	7
Soap / detergent factory	4
Total	61

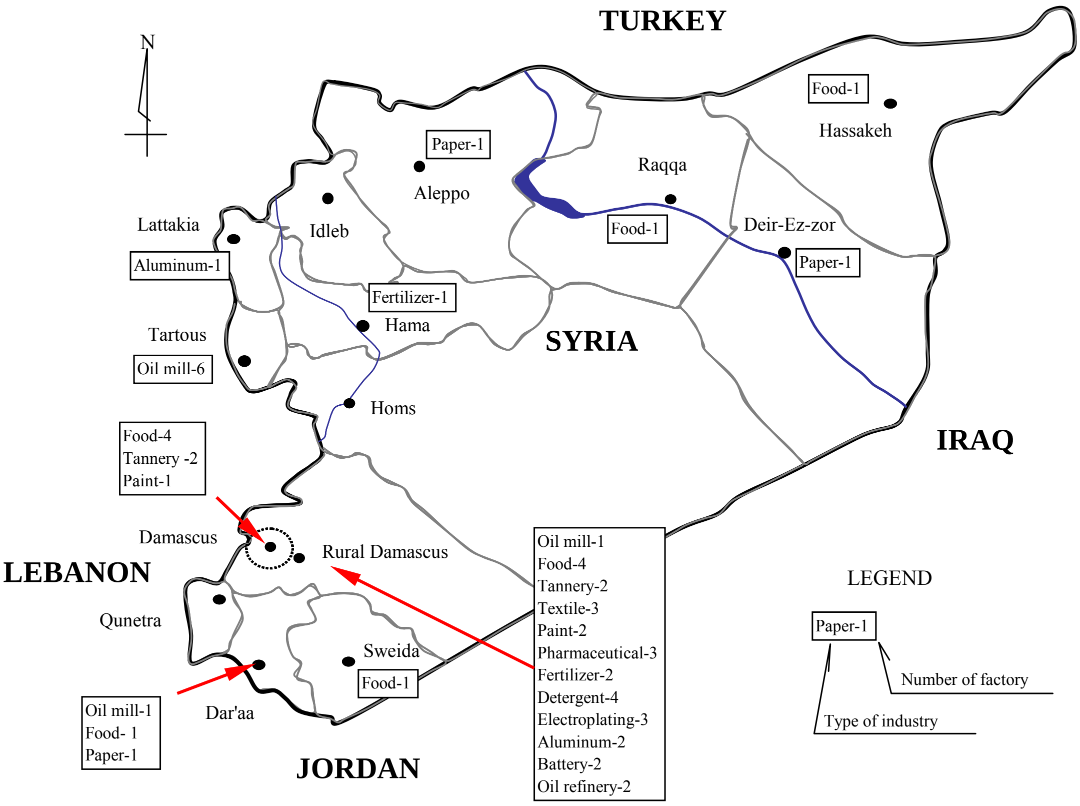


Figure 8.5.1 Location of the Objective Factory

Water quality parameters that have been analyzed for target industries are shown in **Table 8.5.5**

Table 8.5.5 Water Quality Analysis Item

Analysis Item	Type of Industry			
	Olive oil & Canning	Food	Paper	Others [1)]
Number of Sample (Total=61 samples)	10	11	3	37
Temperature	○	○	○	○
pH	○	○	○	○
Precipitable soil materials	○	○	○	○
Total Suspended Solids	○	○	○	○
Sulfide	○	○	○	○
Sulfate	○	○	○	○
Ammonia /Ammonium	○	○	○	○
Phosphate	○	○	○	○
Oils, grease	○	○	○	○
Boron			○	○
Cadmium			○	○
Chromium			○	○
Copper			○	○
Lead			○	○
Mercury			○	○
Nickel			○	○

Table 8.5.5 Water Quality Analysis Item

Analysis Item	Type of Industry			
	Olive oil & Canning	Food	Paper	Others 1)
Zinc			○	○
Cyanide			○	○
Arsenic			○	○
BOD	○	○	○	○
COD	○	○	○	○
TDS	○	○	○	○
Chloride	○	○	○	○
Fluoride			○	○
Pesticides	○			

1) Others: tannery, textile, electroplating, fertilizer, oil refinery, aluminum, paint, pharmaceutical, pesticide and detergent

b) Results of Water Quality Survey for Industrial Wastewater

Based on the water quality analysis survey for industrial wastewater, the main findings concerning the characteristics of wastewater are described below:

- Approximately 34% of analyzed samples in this survey do not satisfy the effluent standard in terms of pH for discharging into sewer networks. Of 61 analyzed samples, two samples were alkaline and 19 were found to be acidic, and maximum value of pH was observed as 10.2 in case of detergent factory and the minimum value of pH was 2.5 in case of refining factory for cooking oil. (refer to **Figure 8.5.2**)
- Especially, high-level of organic pollution (as BOD) is observed in effluent from olive mill and beer factory, and the level of BOD in effluents in this case is around 10,000 mg/l or more. Also, the level of BOD exceeds 2000 mg/l in effluents from paper, meat processing (including slaughterhouse) and yeast factories. In addition, the industries that discharge wastewater into sewer networks with BOD level exceeding the criteria (800 mg/l as BOD) include tannery, milk processing & dairy and cooking oil refinery factories. Therefore, high-concentration of organic pollution may be expected in discharges from eight types of industries. (refer to **Figure 8.5.3**)
- High-concentration of Ammonia Nitrogen (as NH_4-N) is detected in effluent from olive mill, tannery and yeast factory, and the wastewater from these factories is observed to include more than 200 mg/l of NH_4-N. In addition, factories that have wastewater with NH_4-N exceeding the criteria of discharging into sewer networks (100 mg/l as NH_4-N) are textile, cooking oil refinery and aluminum factories. (refer to **Figure 8.5.4**)
- More than 200 mg/l of Phosphate (as PO_4) is detected in olive mill, cooking oil refinery and detergent factory. In addition to the above mentioned, factories that have wastewater with PO_4 level exceeding the criteria of discharging into sewer networks (20 mg/l as PO_4) are paper, meat processing (including slaughterhouse) and painting factory. (refer to **Figure 8.5.5**)

- Factories that have wastewater with oil level exceeding the criteria of discharge into sewer networks (100 mg/l as saponifiable oils and grease and resinous materials, and 10 mg/l as metallic oil and grease) are painting, aluminum and battery factories.
- From the results of analysis, heavy metal and toxic substance are detected in all types of industries of surveyed factories except food industry, and it is necessary to monitor treatment and discharges into sewer networks or public water bodies. However, there are cases in which the presence of hazardous substances in effluent is not clear. Therefore, it is suggested that additional collection of information and analysis of data on hazardous substances through wastewater monitoring would be required before arriving at any conclusion in this regard. The list of the detected items is shown in **Table 8.5.6**.
- From the results of questionnaire survey, it is observed that the ratio of factories with installed treatment facilities among the targeted factory for investigation was 44% on average. Among these types of industry, the lowest ratio of effluent treatment installation was 14% in case of the olive mill factory. While analyzing, at least the presence of sedimentation process was judged to be a factory with treatment facilities. Also, the number of surveyed sample is very small. Therefore, it cannot be judged that 44% of factories have appropriate treatment process. On the contrary, it can be said that the rate of installation of treatment facilities is insufficient. (refer to **Table 8.5.7**)

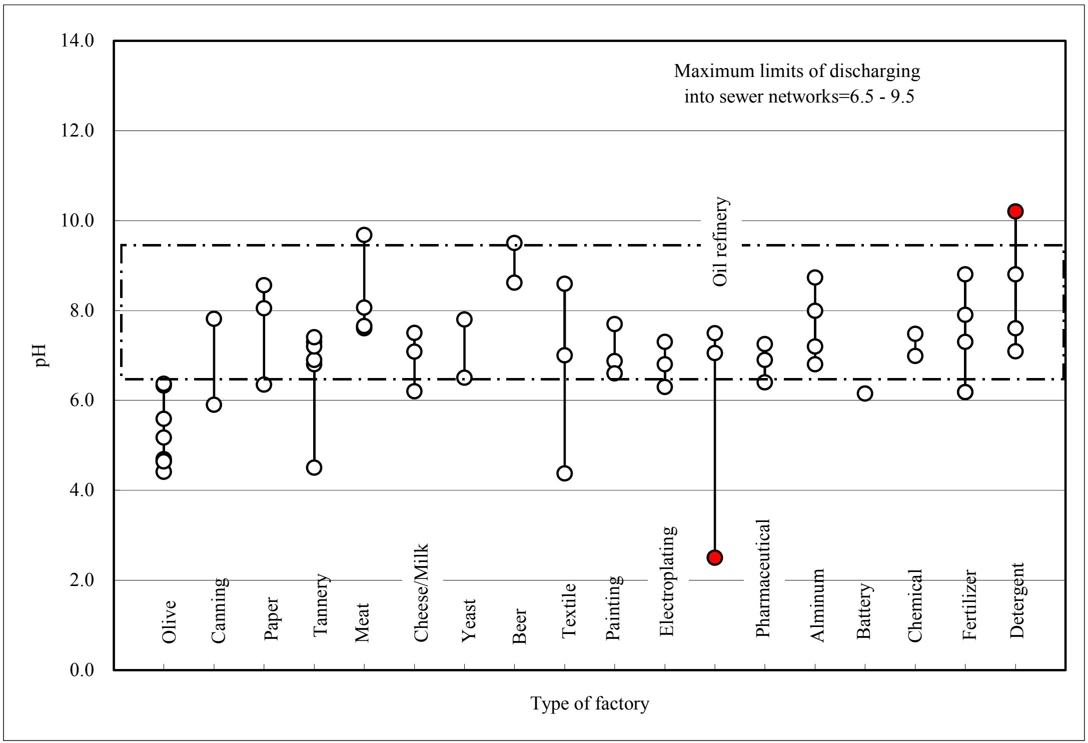


Figure 8.5.2 Results of Water Quality Survey for Industrial Wastewater (pH)

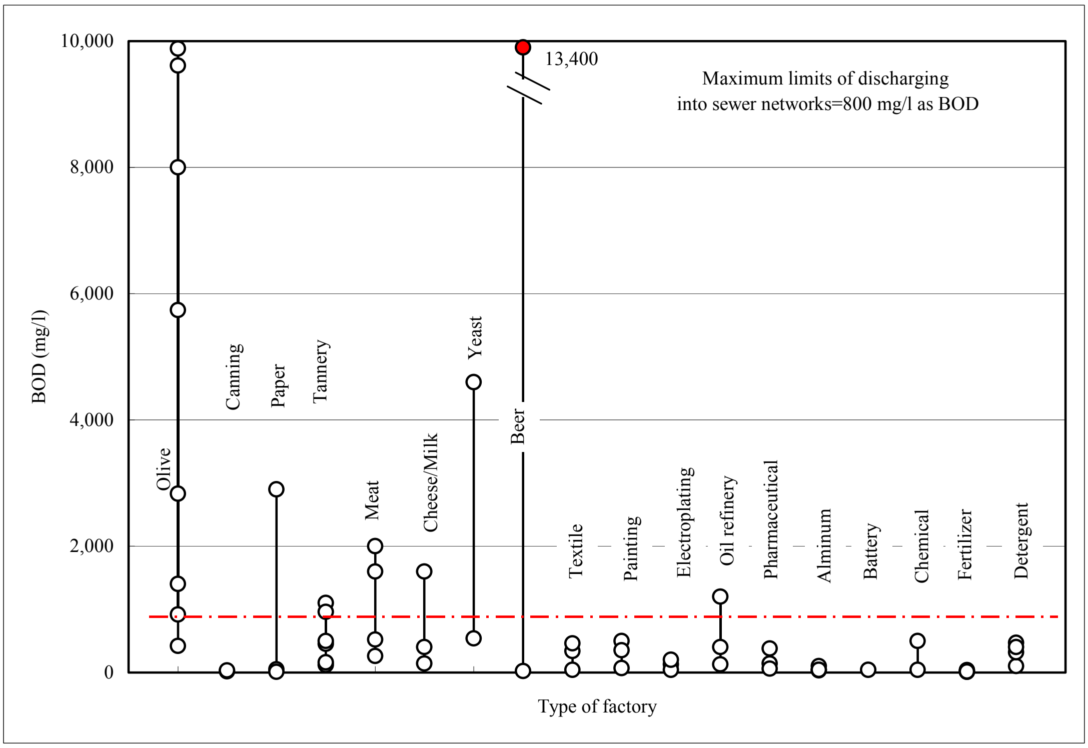


Figure 8.5.3 Results of Water Quality Survey for Industrial Wastewater (BOD)

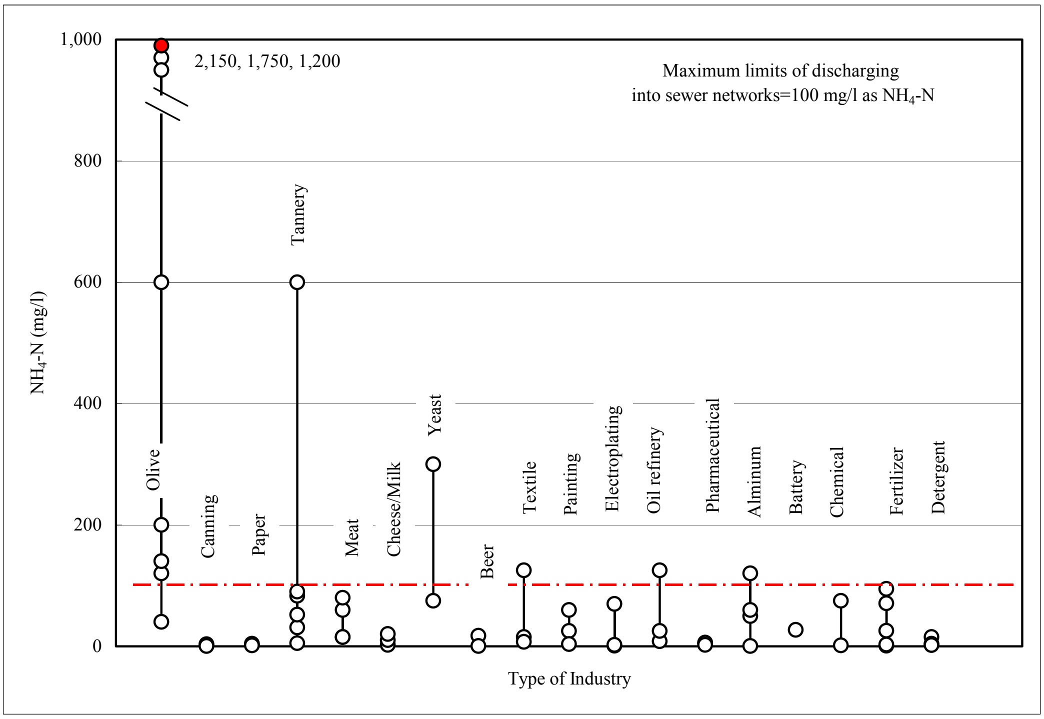


Figure 8.5.4 Results of Water Quality Survey for Industrial Wastewater (NH_4-N)

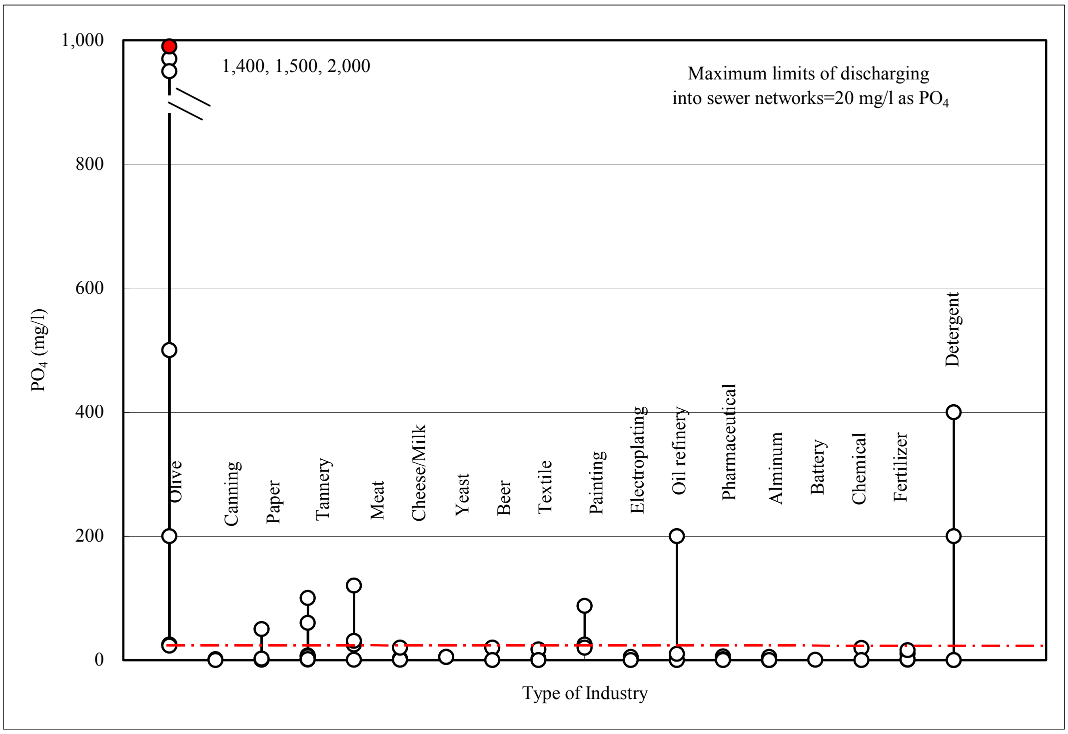


Figure 8.5.5 Results of Water Quality Survey for Industrial Wastewater (PO_4)

Table 8.5.6 Detected Hazardous Substances

Type of Industry	Detected Hazardous Substances
Paper factory	Boron, Chromium, Mercury
Tannery factory	Boron, Chromium, Copper, Lead, Mercury
Textile factory	Boron, Chromium, Copper, Mercury
Paint factory	Chromium, Copper
Pharmaceutical factory	Boron
Fertilizer factory	Boron, Cadmium, Mercury, Nickel, Zinc, Cyanide, Arsenic
Detergent factory	Boron, Chromium, Mercury
Electroplating factory	Boron, Chromium, Copper, Lead, Nickel, Zinc
Aluminum factory	Boron, Chromium, Copper, Nickel, Arsenic, Fluoride
Battery factory	Boron, Zinc
Oil refinery	Boron, Chromium, Lead, Zinc, Arsenic

Table 8.5.7 Number of Industries With or Without Effluent Treatment Facilities by Type of Industry

Type of Industry	Number of targeted factory for survey				
	Total	With treatment facilities		Without facilities	
Olive mill factory	7	1	14.3%	6	85.7%
Food factory	14	6	42.9%	8	57.1%
Paper factory	3	1	33.3%	2	66.7%
Tannery factory	4	3	75.0%	1	25.0%
Textile factory	3	1	33.3%	2	66.7%

Table 8.5.7 Number of Industries With or Without Effluent Treatment Facilities by Type of Industry

Type of Industry	Number of targeted factory for survey				
	Total	With treatment facilities		Without facilities	
Paint, pharmaceutical, fertilizer and detergent factory	13	7	53.8%	6	46.2%
Electroplating, aluminum and battery factory	7	3	42.9%	4	57.1%
Oil refinery	1	1	100.0%	0	0.0%
Total	52	23	44.2%	29	55.8%

(3) Industrial Wastewater Treatment (recommendations on applicable treatment method)

In this section, based on the information and knowledge from the field survey and industrial wastewater quality analysis, treatment method and system are described under following categories.

- Industrial wastewater with special conditions and problems:
  - Olive mill factory
  - Sugar factory
  - Tannery
  - Electroplating factory
  - Textile factory
- Industrial wastewater treatment of factories in area that has developed sewerage system (pre-treatment facilities)
- Industrial wastewater treatment of factories located in area that has no sewerage system (wastewater treatment facilities)

a) Industrial Wastewater with Special Conditions and Problems

This section focuses on factories that have special conditions and problematic wastewater, and applicable wastewater treatment method and system for these factories are explained.

Olive Mill Wastewater (OMW)

Aleppo has the largest number of olive mill factory, next is Tartous and Lattakia, and these three governorates contribute 78 % of the total factory. Seven governorates included in the Master Plan study area contribute about 44 % of the total number of factories in the entire country, Tartous and Lattakia have a high proportion of olive mill factory with more than 90 % of the total in the Master Plan study area. (refer to **Table 8.5.8**)

Characteristics of olive mill factory are as follows:

- The olive mill factory is historical and important industry for Syria
- These factories belong to private sector, and almost all factories are small scale.
- The olive mill factory is directly linked with the production area of olive.
- The olive mill factory has seasonal operation normally operating from October to

February, and discharges of wastewater from this type of industry are also limited to the same period.

Table 8.5.8 Number of Factories in Governorate

Governorate	Number of Factory Classified by Number of Employee					
	1 - 5	6 - 9	10-50	51-100	More than 101	Total
Lattakia	90	25	14	0	0	129
Tartous	119	44	25	0	0	188
Deir-Ez-zor	4	0	0	0	0	4
Hassakeh	0	1	0	0	0	1
Raqqa	0	0	0	0	0	0
Dar'aa	9	7	2	0	0	18
Rural Damascus	9	2	2	0	0	13
Aleppo	64	80	98	0	0	242
Hama	11	1	2	1	0	15
Homs	14	4	1	0	0	19
Idleb	44	17	23	0	0	84
Sweida	4	0	0	0	0	4
Qunetra	0	0	0	0	0	0
Damascus	3	0	1	0	0	4
Total	371	181	168	1	0	721

Source) Ministry of Industry (2006)

Characteristics of OMW are as follows:

- OMW contains high concentration of organic matter as BOD and COD.
- It contains residual olive oil and protein material and therefore has higher level of nitrogen and phosphate in it.
- These organic matters are contained in dispersed or suspended matters, emulsified or colloidal matters and soluble matters.
- Treatment efficiency of biological process is reduced due to its function as an antioxidant of high concentration poly-phenol.
- Water quality of OMW is shown in **Table 8.5.9**

In the results of Water Quality Survey for Industrial Wastewater, pH 4.4 as the lowest value in eight samples of OMW, and BOD 9,900 mg/l, COD 159,000 mg/l, SS 6,000 mg/l, NH_4-N 2,250 mg/l, PO_4 2,000 mg/l and TDS 13,000 mg/l as the maximum value in eight samples of OMW are detected.

Table 8.5.9 Characteristics of OMW

Item	Tunisia	'80 Germany	'88 Italy	UNDP [1)]	'07 Aleppo [2)]	'07 JICA [3)]
pH	5.2	-	-	4.7 – 5.2	-	4.4
SS (mg/l)	172,000	1,000	20,000 – 6,000	9,000	342	6,000
BOD (mg/l)	75,000	90,000 – 100,000	30,000 – 60,000	45,000 – 60,000	3,800	9,000
COD (mg/l)	196,150	120,000 – 130,000	100,000 – 150,000	35,000 – 41,000	-	159,000
NH_4-N (mg/l)	-	-	-	-	-	2,250
PO_4 (mg/l)	-	-	-	-	-	2,000
Oil & Grease (mg/l)	-	300-10,000	2,000 – 5,000	3,000 – 10,000	493	
Polyphenol (mg/l)	-	10,000 – 24,000	10,000 – 15,000	3,000 – 2,300	-	-

Note)
1) Having been left in a pit far beyond operation period (Jan. 2007)
2) UNDP Industrial Waste management for the Olive Oil Pressing Industries in Lebanon, Syria & Jordan
3) In the wastewater quality analysis of this Study, pH as minimum and others as maximum are detected. (Jan. – Feb. 2007)

➢ **OMW treatment situation in Syria**

In the Master Plan study area, the method adopted for treatment of OMW is disposal pond for evaporation. Currently, 4 disposal ponds have been constructed in Dar'aa. In case of Dar'aa, one third of OMW is treated using disposal pond, and two thirds of OMW is discharged into river. The discarded OMW in the disposal pond is dried by evaporation and infiltration during a period of two to four months.

Expected problems of the existing disposal pond system are as follows:

- Required number of disposal site is not sufficient.
- Lack of environmental consideration
- One disposal site in Dar'aa was closed because of an environmental problem (bad odor).
- Lack of consideration for groundwater contamination and no monitoring plan

➢ **Occurrence of water pollution and contamination**

According to the information obtained from the Ministry of Local Administration and Environment, in Lattakia, contamination of water sources (Deafe spring) by OMW in Torjarno, (Lattakia) has occurred in past. Three factories located in the upper basin were asked to stop its operations and disposal by governor's command. (November 2006)

➢ **Reference of treatment facilities: Lagoon with drying bed for OMW in Stax city, Tunisia**

Sfax (or Stax) city in Tunisia has constructed a lagoon with drying bed in 1999. This treatment system has produced good outcomes as follows:

- It has become possible to transport the OMW from all of Olive mill factories in Sfax city and its surrounding area to treatment plant by tank lorry shuttle transport.
- It has resulted into avoiding discharge of untreated OMW into public sewage networks and contaminating surroundings.
- It has also made possible to utilize OMW and dried sludge for agricultural use.

➢ **Planning of construction of lagoon system and Pilot plant of UASB for OMW**

The UNDP (Integrated Waste Management for the olive oil pressing industries in Lebanon, Syria & Jordan) is currently planning to establish a central lagoon for collecting OMW near Homs as first priority, and to establish a pilot plant (as experiment) of specified anaerobic treatment to treat OMW of coastal areas, as second priority. It is expected that the establishment of OMW treatment system by the above project will be a great advantage and reduce the pollution due to OMW.

➢ **Recommendation of investigation study for Reuse of treated OMW in irrigation**

In an olive mill factory in Dar'aa, OMW is treated by sedimentation process, and treated OMW is discharged to the agricultural area (olive tree field, 25,000 m^2) for irrigation since last 40 years. The main points explained by the farm owner are as follows:

- All of treated OMW is used for irrigation
- Sediment is used as boiler fuel.
- Pomace is sold off for the purpose of reuse.
- Change in groundwater quality in the surrounding wells has not been observed.

All the byproducts from OMW treatment of factory are reused, and it can be said that the treatment method of OMW is suitable for environment. It is recommended that evaluation study be carried out for detailed understanding of advantage/ disadvantage and its applicability in other areas. Water quality of treated OMW (one analysis sample) is shown in **Table 8.5.10**.

Table 8.5.10 Water Quality of Treated OMW
(Sampling at the Final Stage of Storage Tank)

Items	Results of analysis
pH	5.6
SS (mg/l)	1,080
Sulfide (S) (mg/l)	6.0
NH_4-N (mg/l)	220
PO_4 (mg/l)	23.0
Oil (mg/l)	0.1
BOD (mg/l)	1,400
COD (mg/l)	2,400
TDS (mg/l)	2,100

Source) Water Quality Survey for Industrial Wastewater (JICA, 2007)

- **Recommended treatment method**

Lagoon with drying bed as OMW treatment facilities is recommended such as existing disposal pond for evaporation. However, based on the existing problems, it is necessary that the following points are taken into consideration:

- OMW should be carried by tank lorry to the treatment plant, and operation should be performed under administrative management.
- As mentioned above, the treatment method adopts a lagoon system with drying bed.
- An environmental measure should be fully considered including monitoring for air and groundwater contamination.
- It is recommended that separate collection system be established for washing wastewater and olive juice wastewater after oil separation. Washing wastewater should be treated by sedimentation, oxidation pond process or septic tank. Only olive juice wastewater is conveyed to the treatment plant. However, when the treatment of washing wastewater is not fully achieved by abovementioned process, it should be also carried to treatment plant with olive juice wastewater.

Sugar Factory Wastewater

Main sugar factories include six factories in the public sector. The total number of factories in the private sector is 34, and these factories are small-scale factory with less than five employees. In the Master Plan study area, there are two factories in the public sector and 11 factories in the private sector. (See **Table 8.5.11**)

Table 8.5.11 Number of Factories in Governorate

Governorate	Number of Factory Classified by Number of Employee (Private sector)						Public sector
	1 - 5	6 - 9	10-50	51-100	More than 101	Total	
Lattakia	1	0	0	0	0	1	0
Tartous	1	0	0	0	0	1	0
Deir-Ez-zor	0	0	0	0	0	0	1
Hassakeh	2	0	0	0	0	2	0
Raqqa	1	0	0	0	0	1	1
Dar'aa	0	0	0	0	0	0	0
Rural Damascus	4	2	0	0	0	6	0
Aleppo	12	0	0	0	0	12	1
Hama	0	0	0	0	0	0	1
Homs	1	0	0	0	0	1	1
Idleb	0	0	0	0	0	0	1
Sweida	0	0	0	0	0	0	0
Qunetra	0	0	0	0	0	0	0
Damascus	10	0	0	0	0	10	0
Total	32	2	0	0	0	34	6

Source) Ministry of Industry (2006)

Sugar factory in Syria uses sugar beet as raw materials in the sugar production. Therefore, the sugar factory has seasonal operation for mainly three months from June to August every year, and discharge of wastewater is also limited to the same period.

➢ **Characteristics of Wastewater Quality**

Usually, the wastewater of sugar factory is classified into following three categories:

- Flume wastewater
  This wastewater consists of effluents from two sources including cleaning process and conveyance using water process. Quantity of generated wastewater is about eight times to ten times of sugar beet weight used, and it contains earth and sand, and small pieces of material. Normally, the level of BOD in this kind of wastewater is from 200 to 300 mg/l.
- Lime sludge wastewater
  Extract solution from sugar beet contains sugar and dross. Refinery process using lime generates lime sludge with dross, and its water content is 45% – 50%.
- Steffen wastewater (Steffen process waste/ wastewater)
  Blackstrap molasses is generated in the production process, its quantity is from 1% to 5% of sugar beet. Steffen wastewater is generated from the refinery process of blackstrap molasses. Normally, Steffen wastewater has high concentration of organic matter ranging from 100,000 mg/l to 300,000 mg/l.

The results of monitoring by Ministry of Local Administration and Environment (two analysis data) are shown in **Table 8.5.12.** However, it seems that this data on water quality is of comprehensive wastewater from sugar factory.

Table 8.5.12 Wastewater Quality of Sugar Factory

Governorate	SS (mg/l)	COD (mg/l)
Deir-Ez-zor	418	2,683
Raqqa	140	6,500

Source) Ministry of Local Administration and Environment (2007)

- **Existing Situation of wastewater treatment**

Sugar factory in Der-Ez-zor has treatment facilities using sedimentation process and oxidation pond. The wastewater of this factory is treated by treatment facilities and the effluent discharges into Euphrates River. Currently, there is no information about pollution problem, and it seems that occurrence of serious water pollution is avoided by seasonal operation of factory and huge amount of flow in the Euphrates River. However, in long run the pollution of limited water bodies at the discharge point could occur, and should be considered.

- **Recommended treatment process**

It seems that sedimentation and oxidation pond process are suitable for treatment of the flume wastewater, however, these process are not appropriate for treating the Steffen wastewater. Consequently, recommended treatment systems are listed below.

- Wastewater collection system should be divided into flume wastewater and Steffen wastewater.
- Lime sludge wastewater should be disposed as solid waste.
- Flume wastewater should be treated by sedimentation and oxidation pond process.
- For Steffen wastewater, the adopted method of treatment should be a lagoon system with drying bed, same as treatment method adopted in case of olive mill wastewater.
- It is recommended that possibility of utilization of treated effluent (valuable resource) for Steffen wastewater be examined.

Tannery Wastewater

Tanneries are concentrated in three Governorates of Damascus, Aleppo and Rural Damascus, and factories in these Governorates constitute 92% of total 282 factories of the entire country. Moreover, 68% of factories are located in Damascus, and most of these are concentrated in Zabadani area. (refer to **Table 8.5.13**)

Table 8.5.13 Number of Tannery in Governorate (Private Sector)

Governorate	Number of Factory Classified by Number of Employee					
	1 - 5	6 - 9	10-50	51-100	More than 100	Total
Lattakia	0	0	0	0	0	0
Tartous	0	0	0	0	0	0
Deir-Ez-zor	0	0	0	0	0	0
Hassakeh	0	0	0	0	0	0
Raqqa	0	0	0	0	0	0
Dar'aa	0	0	0	0	0	0
Rural Damascus	17	3	0	0	0	20
Aleppo	38	5	4	0	0	47
Hama	11	1	0	0	0	12
Homs	2	0	0	0	0	2
Idleb	9	0	0	0	0	9
Sweida	0	0	0	0	0	0
Qunetra	0	1	0	0	0	1
Damascus	171	13	7	0	0	191
Total	248	23	11	0	0	282

Source) Ministry of Industry (2006)

Characteristics of wastewater from tannery are as follows:

- Usually, wastewater is alkaline, and contains many organic and inorganic suspended substances.
- Wastewater contains chromium salt, which is used for tanning process.
- During processing of leather, wastewater is discharged intermittently, and therefore wastewater quality has a remarkable time jitter.
- From results of Water Quality Survey for Industrial Wastewater, wastewater quality of tannery (six analysis samples) is shown in **Table 8.5.14.**

Table 8.5.14 Results of Wastewater Quality Analysis (Tannery)

Items	Maximum	Minimum	Average (n=6 samples)
pH	7.6	4.5	6.7
SS (mg/l)	1,990	820	160
Sulfide (S) (mg/l)	5.5	0.1	2.4
NH_4-N (mg/l)	600	5.0	144
PO_4 (mg/l)	100	1.0	29
BOD (mg/l)	1,100	150	550
COD (mg/l)	10,900	146	5,120
TDS (mg/l)	33,500	1,780	13,100
Cr (mg/l)	30.0	0.04	11.2

Source) Water Quality Survey for Industrial Wastewater (JICA, 2007)

- **Existing situation of wastewater treatment**

According to the information collected from large-scale tannery factories in Zabadani area, Damascus, Tannery factories are concentrated in this area, and there is one large-scale factory and more than 200 small scale factories. The large-scale factory has wastewater treatment facilities, and at present, operation has stopped due to breakage and superannuation of facilities. Therefore, wastewater from the large-scale factory and almost all of the small-scale factories is discharged into the branch of Barada River without any treatment. The wastewater of tannery contains high concentration of organic pollutant and chromium as tanning agent, and relocation of tannery to industrial zone with tannery zone is required immediately.

➢ **Recommended treatment process**

As pre-treatment process for tannery wastewater to be discharged into sewer networks, screening, pH control, sedimentation, coagulation and filtration process are recommended. On the other hand, the treatment process for tannery effluent to be discharged into public water bodies, biological treatment process with nitrification and denitrogenation is added to above-mentioned processes for removal of BOD, COD and ammonia nitrogen.

However, the following points should be taken into consideration:

- Since wastewater quality has a remarkable time jitter, equalization of wastewater quality is required.
- TDS of wastewater may exceed the criteria significantly; however, installation of removal process for TDS is costly. Therefore, its reduction should be considered by selection of raw material and chemicals required in production process.
- If necessary, filtration process should be added to the above treatment processes.
- Consideration is required for disposal of the sludge containing chromium.

The following items can be considered as an urgent countermeasure for reduction of organic pollutant and hazardous substance:

- Re-construction of the treatment facilities for large-scale factory (Public sector)
- Wastewater with high concentration should be collected in storage tank, and it should be treated by coagulation method (batch operation). The disposal of generated sludge should be entrusted to a disposal contractor.
- Reduction of wastewater should be aimed by the improvement of production process. (Introduction of Cleaner production: For example, reduction of wastewater by improvement of the washing method from single stage washing to multi stage washing and dewatering process)
- For small-scale factory, it is desirable to transfer these small factories to industrial zone for tannery with treatment system. Therefore, the plan of an industrial zone for tannery needs to be promoted.

Electroplating Factory Wastewater

There is no data about number of this kind of factory, and regional distribution of electroplating factory is unknown. However, it is learnt that Damascus, Zabadani area has many

electroplating factories.
Characteristics of wastewater from electroplating factory are as follows:

- In the same electroplating type of industry, wastewater quality is changed by used raw material or contents of work.
- Wastewater contains hazardous substances such as Copper, Nickel, Chromium, Zinc, Cyanide, etc. however, wastewater does not have high concentration of organic matters.
- Usually, amount of wastewater is not much, and from results of wastewater quality analysis it is observed that objective factories have 1 m^3/day – 15 m^3/day of water consumption.
- For each process wastewater is discharged intermittently, and wastewater quality has a remarkable variation with time.

From the results of Water Quality Survey for Industrial Wastewater, pH value of 6.3 is observed as the lowest value among three samples, and the abnormal value of pH is not detected. However, high concentration values of Boron, Nickel, Zinc, Chromium, and Copper are detected. Wastewater quality of Electroplating factory is shown in **Table 8.5.15**.

Table 8.5.15 Results of Wastewater Quality Analysis (Electroplating)

Items	Maximum	Minimum	Average (n=3 samples)
pH	7.3	6.3	6.8
TSS (mg/l)	129	31.0	88.0
Sulfide (S) (mg/l)	1.8	1.4	1.6
NH_4-N (mg/l)	70.0	1.0	24.5
PO_4 (mg/l)	5.0	0.2	3.1
BOD (mg/l)	200	40	123
COD (mg/l)	8,640	784	4,710
TDS (mg/l)	1,100	887	995
B (mg/l)	25.0	0.70	11.3
Cr (mg/l)	7.4	0.02	2.54
Cu (mg/l)	6.0	0.3	2.2
Ni (mg/l)	253	3.77	97.7
Zn (mg/l)	83.0	0.17	28.0

Source) Water Quality Survey for Industrial Wastewater (JICA, 2007)

There are no data concerning the situation of wastewater treatment and water pollution and contamination by wastewater from electroplating factory. Three objective factories of wastewater quality analysis have no treatment facilities, and discharge into sewer networks and public water bodies.

- **Recommended treatment process**

As treatment process for electroplating wastewater is expected to discharge into sewer networks and public water bodies, pH control - coagulation process are recommended. If necessary, filtration process should be added to the above process. (refer to **Figure 8.5.6**)

However, the following points should be taken into consideration:

- Wastewater collection system is classified into Cyanide, Chromium (Hexavalent) and acidic/alkaline wastewater.
- The disposal of Waste liquid from production process should be entrusted to a disposal contractor.
- Consideration is required for disposal of the sludge containing chromium.
- The reduction of raw material and chemicals are required in production process.

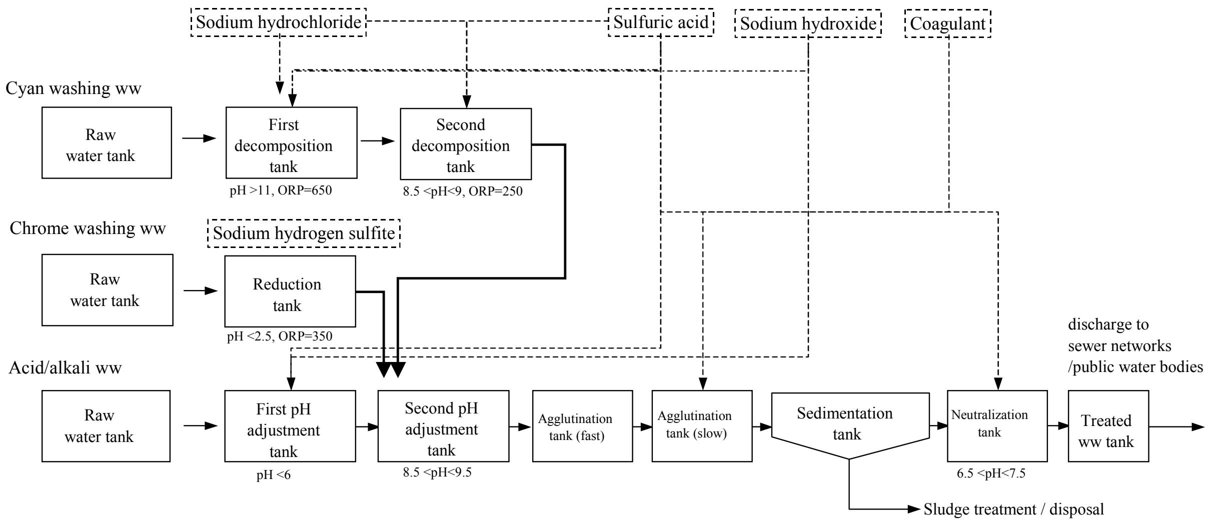


Figure 8.5.6 An Example of Treatment Process for Electroplating Wastewater

The following items can be considered as an urgent countermeasure for reduction of organic pollutant and hazardous substance:

- Wastewater with high concentration should be collected in storage tank, and its disposal should be entrusted to a disposal contractor.
- Reduction of wastewater is aimed by the improvement of production process. (Introduction of Cleaner production)

For small-scale factory, it is desirable to relocate to industrial zone for electroplating industries with treatment system. Therefore, the plan of industrial zone for electroplating factory needs to be promoted.

<u>Textile Factory Wastewater</u>

Textile factory is categorized into the public sector (25 factories) and the private sector (7,613 factories), and textile industry is one of the major industries in Syria. Of private sector factories, 89% are small-scale factory with less than 5 employees, and 25 factories have more than 100 employees. In terms of regional distribution, nearly half of the private sector and quarter of public sector factories are concentrated in Aleppo. Following Aleppo, the large number of factories are located in Damascus and Rural Damascus, and three Governorates contribute about 72 % of all factories as shown in **Table 8.5.16.**

Table 8.5.16 Number of Textile Factories in Governorate (Private Sector)

Governorate	Number of Factory Classified by Number of Employee					
	1 - 5	6 - 9	10-50	51-100	More than 100	Total
Lattakia	164	5	2	0	0	171
Tartous	103	0	0	0	0	103
Deir-Ez-zor	40	0	0	0	0	40
Hassakeh	44	0	0	0	0	44
Raqqa	59	2	0	0	0	61
Dar'aa	83	0	0	0	0	83
Rural Damascus	916	82	71	3	7	1,079
Aleppo	2,730	585	369	24	15	3,723
Hama	198	2	1	0	1	202
Homs	407	9	12	0	2	430
Idleb	173	5	0	1	0	179
Sweida	73	1	0	1	0	75
Qunetra	2	0	0	0	0	2
Damascus	1,330	68	23	0	0	1,421
Total	6,322	759	478	29	25	7,613

Source) Ministry of Industry (2006)

In textile industry, the maximum quantity of production is shared by cotton yarn and cotton fabrics. Next is synthetic fiber fabric and wool yarn textiles. There are very few silk fabrics as shown in **Table 8.5.17**.

Table 8.5.17 Amount of Textile Industry in Syria (2004)

Production	Amount of production
Cotton Yarns	135,725 ton/year
Textile yarns	11,138 ton/year
Cotton Textiles	39,576 ton/year
Woolen Textiles	10,061 ton/year
Synthetic Textiles	31,186 ton/year
Silk Textiles	40 ton/year
Total	227,726 ton/year

Source) Statistical Abstract 2006, Central Bureau of Statistics

Characteristics of wastewater from textile factory are as follows:

- Effluent from Textile factories can be classified into two. One is wastewater from fiber spinning process, and another is wastewater from a dyeing process.
- In wastewater from fiber spinning process, the wastewater from scouring wool process (BOD 6,000-10,000 mg/l) and silk reeling wastewater have high level of organic

pollution. Wastewater from cotton yarn process does not have high level of pollution.

- Therefore, equalization of amount of wastewater and its water quality are required.
- Wastewater from a dyeing process changes with raw material or contents of work. And in the same factory, wastewater changes with a season or time. Therefore, detailed investigation and consideration are required for at each factory.
- Dyeing wastewater may be acidic or alkaline, and may contain hazardous substances such as Copper, Nickel, Chromium, Zinc and etc.
- Dyeing wastewater may have a high COD/BOD ratio because of the detergent, dye, reducing agent, etc.
- Wastewater quality of Textile factory (three analysis samples) is shown in **Table 8.5.18**.

Table 8.5.18 Results of Wastewater Quality Analysis (Textile Factory)

Items	Maximum	Minimum	Average (n=3 samples)
pH	8.6	4.4	6.7
SS (mg/l)	4,300	258	1,790
Sulfide (S) (mg/l)	1.6	0.8	1.2
NH_4-N (mg/l)	125.0	7.5	49.2
PO_4 (mg/l)	17.5	0.2	6.7
BOD (mg/l)	460	40	280
COD (mg/l)	7,300	1,570	3,600
TDS (mg/l)	4,381	1,488	2,671

Source) Water Quality Survey for Industrial Wastewater (JICA, 2007)

The item in the above-mentioned characteristics of wastewater is confirmed as follows:

- The color of the influent of the Adraa STP changes rapidly. This is because dyeing process of textile factory is without adequate equalization of wastewater.
- From results of Wastewater quality analysis, COD/BOD ratio of textile wastewater is estimated to be ranging from 4.2 to 21.

➢ **Recommended treatment process**

As treatment process for textile wastewater is expected to discharge into sewer networks, pH control - coagulation process (or pressurized floatation with coagulant) are recommended. And if necessary, filtration process should be added to the above process.

Also when treatment process for textile wastewater is expected to discharge into public water bodies, biological treatment process with nitrification and denitrogenation should be added to above-mentioned processes are recommended. And if necessary, filtration process should also be added to the above process.

If necessity, ozonation and an activated-carbon-adsorption treatment process for decolorization should be added, and if necessity, treatment process (mentioned later) for heavy metals should be provided.

b) Industrial Wastewater Treatment of Factory in Sewerage Developed Area

Usually, installation of wastewater treatment and operation and maintenance in case of the medium and small-scale factory are not easy considering factors such as costs and operation and maintenance technology. Therefore, it is recommended that wastewater from factory in sewerage developed area or adjacent area be discharged into sewer networks. However, wastewater must satisfy the following conditions:

- Wastewater should satisfy the criteria of "the maximum limits of industrial pollutant load permitted to be discharged to the sewer networks".
- If wastewater does not satisfy the above criteria, it must be treated by pre-treatment facilities.
- It is necessary to discuss with Sewerage Company in case if factory has a large amount of wastewater or high fluctuation with time.

Effects to Environment by discharge into Sewer Networks are as follows:

- From environmental viewpoint, reliability of wastewater management is high.
- It is possible to implement the efforts towards reduction of wastewater amount and improved water quality through charge collection.

The difference between the wastewater treatment method aiming to achieve effluent quality level to discharge to a public water bodies and the treatment method of the pre-treatment facilities aiming to achieve effluent quality to discharge into sewer networks is different only in terms of setting up of target treated effluent quality. For example, when discharging to a river, the level of BOD in treated effluent is required to be 40 mg/l and below, but when discharging into sewer networks, it should be less than or equal to 800 mg/l. In case of the former, the treatment method equivalent to the biological treatment method in sewerage treatment plant is required. While, in case of the latter, wastewater treatment may be possible by simple treatment processes such as sedimentation, coagulation process, etc.

The fundamental treatment method for industrial wastewater according to objective water quality item is shown below. (refer to **Table 8.5.19**)

Table 8.5.19 The Fundamental Treatment Method for Industrial Wastewater

Element Name or Items	Treatment method
Temperature	Water and air cooling
pH	Neutralization
Percipitable solid materials	Gravity sedimentation
Total Suspended Solids	Gravity sedimentation, Coagulation sedimentation, filtration and floatation
Sulfide	Chemical oxidation, air oxidation
Ammonia / ammonium	Biological and physico-chemical nitrogen removal
Phosphate	Physico-chemical nitrogen removal, biological treatment

Table 8.5.19 The Fundamental Treatment Method for Industrial Wastewater

Element Name or Items	Treatment method
Saponifiable oils and grease and resinous materials, Metallic oil and grease	Normal floatation, pressurized floatation
Boron	Coagulation sedimentation, Chelating resin
Cadmium, Barium, Nickel, Silver, Zinc	Coagulation sedimentation, Chelating resin, ion exchange resin
Calcic chromium, Cr^{6+}	Chemical reduction, electrolytic reduction, ion exchange resin
Copper, Lead	Metal hydroxide co-sedimentation, ferrous powder, ferrite, Chelating resin, ion exchange resin
Mercury	Coagulation sedimentation, sulfide coagulation, activated carbon adsorption, Chelating resin
Selenium	Chemical reduction, co-precipitation, ion exchange resin
Cyanide	Alkaline chlorine, electrolytic oxidation, ion exchange resin, chelating resin
Arsenic	Metal hydroxide co-sedimentation, ferrous powder, ferrite
Phenol compounds	Chemical oxidation, biological treatment, activated carbon adsorption
BOD	Biological treatment , physico-chemical treatment
COD	
T.DS, Chloride, Sulfate	Ion exchange resin, reverse osmosis film method
Fluoride	Calcium hydroxide co-sedimentation, activated alumna adsorption, ion exchange resin
Pesticides	activated carbon adsorption
Detergents	activated carbon adsorption
Algonac organic compounds	activated carbon adsorption

Source) Business Establishment Wastewater Guidance Manual (2002) Japan Sewage Works Association

Outline of treatment method for main items from **Table 8.5.19** are described as below:

- **pH**

The occurrence of pH value not satisfying standards for discharging into sewer networks in case of industrial wastewater is common and easy, and abnormal values of pH influences the corrosion of a sewer facilities.

Usually, pH adjustment is carried out through the neutralization method by acid solution and alkali solution. In case of strong acidic (pH 3 or less) and strong alkaline (pH 10 or more) wastewater, installation of two neutralization tanks in series and two-stage neutralization processes are required for safety. Moreover, the simple neutralization method-using limestone, as shown in **Figure 8.5.7,** is possible in case of weak acidic wastewater.

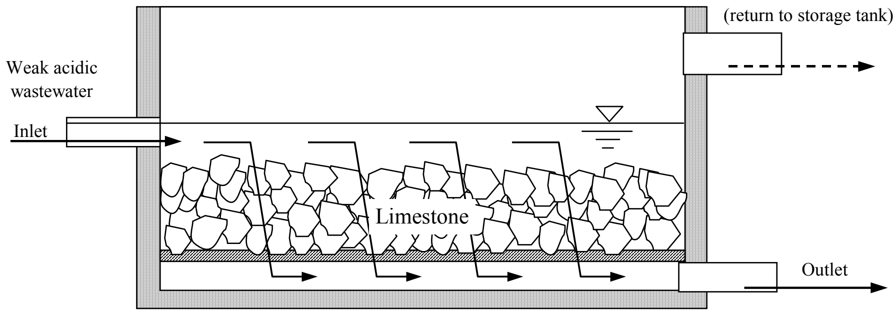


Figure 8.5.7 The Simple Neutralization Method of Slightly Acidic Wastewater

- **Suspended Solids (SS)**

The suspended Solids present in wastewater settles in a sewer pipe, and reduces flow capability due to deposition. It influences the frequency of sewer pipe cleaning which normally increases for sewer carrying wastewater having high SS.

According to the analysis result, in 25 cases the discharge into sewer networks were detected to contain SS exceeding the defined criteria, and in particular, the high values of SS were detected in effluents from the olive mill, paper, tannery, textile, aluminum and detergent factories.

Various treatment methods for removing suspended solids are gravity sedimentation method, coagulation sedimentation method, air floatation method, and filtration method. Usually, gravity sedimentation method is employed. In case when particles are small and in a colloidal dispersion state, it is difficult to settle and separate using the gravity sedimentation method. In such cases, the SS are coagulated through addition of coagulating agent into flocks of large particle size for sedimentation separation. Air floatation method is also a promising SS treatment method. This method is suitable for SS which is lower or equivalent in density to water and difficult to separate by gravity sedimentation. The filtration method is used for removal of low-concentration SS, extremely small and fine heavy-metallic hydroxides left in the water after sedimentation treatment.

- **Organic Pollutant (BOD, COD)**

The organic pollutant, measured in terms of BOD and COD, is roughly divided into soluble organic matter and insoluble organic matter as suspended solids. The treatment of insoluble organic matter as suspended solids is mentioned above. On the other hand, high concentration of soluble organic matter influences the biological process of sewage treatment plant, and thereby deterioration in treatment efficiency and treated water quality are expected.

Usually, the factories which have a high concentration of organic pollutant as BOD and COD, are food factory including beer, yeast, sugar, starch, cooking oil and pulp mill. In the results of wastewater quality analysis, high BOD value is detected in wastewater from olive mill, beer, yeast and paper factory.

Although treatment method changes with characteristics of organic pollutant, sedimentation method is adopted for removal of insoluble organic pollutant roughly and biological treatment process as activated sludge method is used for removal of soluble organic pollutant and insoluble one which is in form of small particles and in colloidal dispersion state. However, if wastewater has a high ratio of insoluble BOD/ total BOD, it may be possible to treat to satisfactory water quality level for discharging into sewer networks by gravity sedimentation, coagulant sedimentation method and air flotation method.

In wastewater with high concentration of soluble BOD, as in case of effluent of beer factory, anaerobic biological treatment method or combined anaerobic and aerobic biological treatment method may be adopted. Many beer breweries in Japan adopt anaerobic treatment method (UASB) as pre-treatment process, and advantages from viewpoint of require facilities area and costs comparison with aerobic biological treatment method are evaluated.

➢ **Oil**

Oil can roughly be classified into animals & plants oil and mineral oil. In order that the latter may deteriorate the function of activated sludge process compared with the former, the maximum limits of industrial polluters permitted to be discharged to the sewer networks is set up severely. (The maximum limits of industrial polluters permitted to be discharged to the sewer networks are 100 mg/l as saponifiable oils and grease and resinous materials (as animal and vegetable oil) and 10 mg/l as metallic oil and grease)

Usually, the factories, which have the wastewater containing oil are oil refining, petrochemical, iron manufacture, car production/maintenance shop, food manufacturing industry, the oil and fats industry, etc. In the results of wastewater quality analysis, high oil content, which is exceeding the maximum limits of the sewer networks, is detected in wastewater from dairy, painting, olive oil, aluminum and pharmaceutical factory.

There are four methods shown in **Table 8.5.20** that could be used as a method of treating the oil in wastewater. The method is selected according to not the classification of animals & plants oils and mineral oils but the state of the oil contained.

Table 8.5.20 Treatment Method of Oil Contained Wastewater

Oil condition	Treatment Method of Oil Contained Wastewater			
	Oil trap (gravity) type separation	Floating separation	Chemical precipitation	Adsorption
Floating	○	○	○	○
Emulsified	×	○	○	Δ
Solid	○	○	○	×
Features	Used as a pre-treatment	Treatment possible regardless of the oil condition	Effective for treatment of the oil content which coexists with SS or the heavy oil content.	Appropriate for treatment of low-concentration oil
Drawbacks	Limited in the concentration to be treated	Complicated maintenance	Pre-treatment to remove of the oil necessary beforehand because of large quantity of sludge produced	Periodical replacement of adsorbent and checking for clogging necessary

Source) Business Establishment Wastewater Guidance Manual (2002) Japan Sewage Works Association

In case of animal and vegetable oil, it shall be removed by pre-treatment facility such as oil trap. While, mineral oil shall be removed at treatment facility in each factory without connecting to sewerage system.

➢ **Nitrogen (NH_4-N) and Phosphorous (PO_4)**

Usually, factories that have wastewater containing ammonia nitrogen and Phosphorous are food manufacturing industry, dyeing factory, chemical industry, metal industry with metal surface treatment and fertilizer factory. In the results of wastewater quality analysis, concentration of ammonia nitrogen exceeding the limits for discharging into sewer networks is detected in wastewater from olive mill factory, tannery, yeast factory, refinery for olive oil factory and aluminum factory. High levels of ammonia nitrogen observed in surveyed cases are 2,250 mg/l in olive mill factory being the maximum, 600 mg/l in tannery and 300 mg/l in yeast factory.

Similarly, exceeding concentration of phosphate is detected in olive mill factory, paper factory, tannery, meat processing & slaughterhouse, refinery for olive oil and detergent factory.

Usually, nitrification process in biological treatment process is treatment method for removal of ammonia. The physico-chemical ammonia nitrogen removal process includes adsorption removal by ion-exchange resin, ammonia stripping method and discontinuous point chlorine treatment method. However, application is difficult for wastewater containing many organic matters or other substances.

On the other hand, as the processing method of phosphate, there are coagulation sedimentation method and the biological treatment method, and usually, coagulation sedimentation method is applicable.

➢ **Hazardous Substance**

Usually, factories that have the wastewater containing hazardous substance are tannery, electroplating/ metal surface treatment factory, chemical industry producing agricultural chemicals, dyeing factory (that uses dye and dyeing agents with hazardous substance), printing works of photograph/ publishing, etc.

The treatment method of hazardous substance was shown in **Table 8.5.19**, and outline of main treatment methods are described below:

- **Metal hydroxide co-sedimentation method (Chemical precipitation method)**
  Generally, alkaline agents (such as sodium hydroxide, etc) are added to make heavy metals insoluble for their precipitation. In most cases, these insoluble hydroxides are left suspended as small particles in wastewater and its removal is difficult in the gravity sedimentation process. The problem is overcome by adding a coagulant to combine small particles into large flocks (a process called "flocculation"). These particles have high settling speed, which is favorable for sedimentation and removal. This method is called chemical precipitation method.
- **Ion exchange resin method**
  Anion or cation dissolved in a solution is taken into a specific substance (ion exchange resin) on contacting with such substance, with ions in this substance dissolved into the solution. This phenomenon is called ion exchange. The ion exchange resin method utilizes this phenomenon to remove specific substances in wastewater. Ion exchange resin is classified into an anion exchange resin to take into anion and a cation exchange resin to take into cation.

- **Adsorption method**

  The adsorption method consists of allowing wastewater to contact a solid adsorbent, thereby causing soluble substances in wastewater to adsorb to the solid adsorbent. Solid adsorbents include activated carbon synthetic zeolite, activated alumina, silica gel, and formed fibers used for adsorption of oil.
- **Chelating resin method**

  The chelating resin method has been developed to adsorb selectively the extremely small amount of heavy metals. This method uses a resin that performs an ion exchange phenomenon by producing chelate with ion in the wastewater. The selectivity of metallic ions by the chelating resin varies greatly depending on the pH value of wastewater. The pH value allowing the best collection is unique to each metal ion.

An example of the processing flow of heavy metal wastewater is shown in **Figure 8.5.8**.

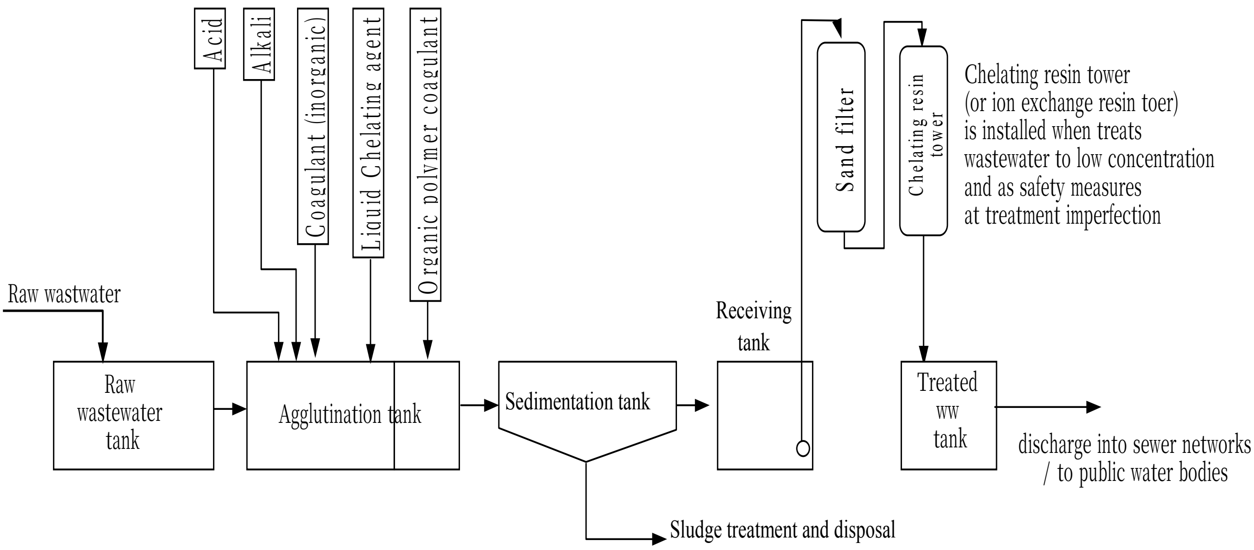


Figure 8.5.8 An Example of Treatment Process for Heavy Metal Wastewater

From the results of wastewater quality analysis, factory (type of industry) exceeding criteria for discharging into sewer networks is shown in **Table 8.5.21**. According to the results of wastewater quality analysis survey, recommended pre-treatment process for industrial wastewater is considered and shown in **Table 8.5.22**. (This table also shows the recommended treatment process for discharging into public water bodies.)

Table 8.5.21 The Water Quality Item which Exceeded the Criteria for Discharging into Sewer Networks

Type of Factory \ Wastewater Quality Parameters	Temperature	pH	Suspended Solids (TSS)	Sulfide (S)	TDS, Sulfate (SO_4), Chloride (Cl^-)	Nitrogen (NH_4-N)	Phosphate (PO_4)	Oil and grease	Hazardous substance	BOD, COD
Oil Pressing		○	○	○	○	○	○			○
Food Fac. (Canning for Agriculral Products)		○	○							○
Food factory (Canning Factory for Meat)		○	○	○			○			○
Food factory (Dairy & cheese products)		○	○							○
Food factory (Slaughterhouse)			○	○			○			
Food factory (Yeast Factory)			○	○	○	○				○
Food factory (Beer /Alcohol)	○		○							○
Paper factory		○	○		○		○		○	○
Tannairy		○	○	○	○	○	○		○	○
Textile factory		○	○		○	○			○	○
Painting factory			○				○	○	○	○
Electroplating		○	○						○	○
Oil refinery factory		○	○		○	○	○	○	○	○
Pharmaceutical		○	○					○	○	○
Aluminum factory			○		○	○		○	○	
Battery		○						○	○	○
Fertilizer & Agricultural Chemicals factory		○	○						○	○
Detergent		○	○	○	○		○		○	○

Table 8.5.22 Recommended Treatment Process of Pre-treatment and Wastewater Treatment Facilities

Type of Industry	Wastewater Treatment Process
Olive mill factory	Olive mill wastewater (OMW) is not suitable to be discharged to sewer networks for the reason that it has seasonal operation and high organic concentration. Treatment Process: Lagoon with drying bed as OMW treatment facilities is recommended. OMW is carried by tank lorry to the treatment plant. It is recommended that separate collection system, classified into washing wastewater and olive juice wastewater after oil separation, be established. Washing wastewater is treated by sedimentation, oxidation pond process or septic tank. Only olive juice wastewater is conveyed to the treatment plant. An environmental measure is fully considered including monitoring for air and groundwater contamination.
Sugar factory	Sugar factory wastewater is not suitable to be discharged to sewer networks for the reason that it has seasonal operation and high organic concentration. Wastewater collection system is divided into flume wastewater and Steffen wastewater. Flume wastewater is treated by sedimentation and oxidation pond process. The treatment methods for Steffen wastewater adopt a lagoon system with drying bed same as treatment method of olive mill wastewater.
Food factory. (Canning for Agricultural Products)	Pre-treatment process: pH control and Sedimentation process Treatment process: pH control and Sedimentation process or Biological treatment process (oxidation pond, etc) According to the field survey, it found that groundwater was used abundantly. Consideration concerning reduction of water use is desired.

Table 8.5.22 Recommended Treatment Process of Pre-treatment and Wastewater Treatment Facilities

Type of Industry	Wastewater Treatment Process
Food factory (Canning Factory for Meat)	Pre-treatment process: screen, sedimentation, pH control and coagulation process. If necessary, Biological treatment process is added. Treatment process: screen, sedimentation, pH control and Biological treatment process (for reduction of sulfide, NH_4-N, BOD, COD), coagulation (for reduction of COD, PO_4), if necessary, filtration process is added. The pollution load reduction in a production process is expected. (For example, recovery of blood)
Food factory (Dairy & cheese products)	Pre-treatment process: pressurized floatation with coagulant process. Treatment process: oil separation, Biological treatment process (for reduction of sulfide, NH_4-N, BOD, COD), Coagulation (for reduction of COD and PO_4), if necessary, filtration process is added. Objective factory for Wastewater quality analysis has oil separation process, and treated wastewater discharge into river. However, it cannot be satisfied with criteria by this treatment process. The above process is required.
Food factory (Yeast Factory)	Pre-treatment process: sedimentation and Biological treatment process (anaerobic process such as UASB) Treatment process: sedimentation, and Biological treatment process (for reduction of sulfide, NH_4-N, BOD and COD) Since BOD is very high, anaerobic + aerobic process, two stage activated sludge process, oxidation pond are available.
Food factory (Beer /Alcohol)	Pre-treatment process: sedimentation and biological treatment process (anaerobic process as UASB) Beer factory has treatment facilities, and the processes are pH control, floatation, biological treatment process, coagulation, filtration and oxidation pond. Moreover, there is RO for reuse of wastewater. This is good example of reference for same type of industry. Beer factories in Japan adopt anaerobic process such as UASB in many, and anaerobic process is suitable for high concentration of organic wastewater.
Paper factory	Pre-treatment process: pH control, sedimentation and coagulation process Paper factory (Deir-Ez-zor) has treatment facilities, and the processes are pH control, sedimentation, and oxidation pond. Other factory (Aleppo) has construction plan of treatment facilities, and planned process are pH control, sedimentation, aerated lagoon and filtration process for reuse of treated water. The latter factory is considering reuse of treated effluent, and this is good example as reference for same type of industry.
Tannery factory	Pre-treatment process: screen, pH control, sedimentation, and coagulation process. It is necessary to aerate in storage tank. Treatment process: screen, pH control, sedimentation, Biological treatment process (for reduction of sulfide, NH_4-N, BOD and COD) and coagulation (for reduction of COD and PO_4). If necessary, filtration process is added. From results of wastewater quality analysis, difference of maximum and the minimum value is large about PO_4, NH_4-N and COD, ratio of max/min reached about 100 times. Equalization of amount of wastewater and its water quality are required. Consideration is

Table 8.5.22 Recommended Treatment Process of Pre-treatment and Wastewater Treatment Facilities

Type of Industry	Wastewater Treatment Process
	required for disposal of the sludge containing chromium.
Textile factory	Pre-treatment process: pH control, sedimentation, biological treatment process and coagulation process. If necessity, treatment process will be added for heavy metals. Treatment process: pH control, sedimentation (depending on wastewater change to floatation), Biological treatment process (for reduction of sulfide, NH_4-N, BOD and COD) and coagulation (for reduction of COD and PO_4). If necessity, ozonation and an activated-carbon-adsorption treatment process aiming at decolorization will be added, and if necessity, treatment process will be added for heavy metals.
Painting factory	Pre-treatment process: pH control, floatation and coagulation process. (Depending on wastewater change to pressurized floatation with coagulant) Treatment process: pH control, floatation, coagulation process (depending on wastewater change to pressurized floatation with coagulant), Biological treatment process (for reduction of sulfide, NH_4-N, BOD and COD) and coagulation (for reduction of COD and PO_4). If necessity, filtration process will be added. Objective factory for Wastewater quality analysis has pH control, sedimentation and filtration process. However, it cannot be satisfied with criteria by this treatment process for BOD, COD, NH_4-N and PO_4.
Electroplating	Pre-treatment process: coagulation (aiming at removal of heavy metals) and filtration process. If necessity, chelating resin or ion exchange resin adsorption process will be added. Treatment process: same as above process It is necessary to classify electroplating wastewater for every kind of plating and process.
Oil refinery factory	The oil refinery factory already has a detailed investigation report, and applies to the plan. "Pre-investment Study for Banias Wastewater Project and rehabilitation of Banias Refinery Industrial wastewater Treatment Plant" May 2005, Syr-BPS 6-01 (E), Ministry of Housing and Construction, Syrian Arab Republic. Other oil refining factories are using olive oil as materials, and consider it to be the same thing as refining of cooking oil. Pre-treatment process: pH control, floatation, biological treatment and coagulation process. Treatment process: pH control, floatation, biological treatment, coagulation and filtration process. Anaerobic + aerobic process and two stage activated sludge process are available as biological treatment process.
Pharmaceutical factory	Pre-treatment process: pH control, floatation or pressurized floatation with coagulant process. Treatment process: pH control, oil separation, Biological treatment process (for reduction of sulfide, NH_4-N, BOD and COD) and coagulation (for reduction of COD and PO_4). If necessary, filtration process is added.
Aluminum factory	Usually, the wastewater from the surface treatment process of aluminum material shows acidity or alkalinity. Furthermore, aluminum and phosphoric acid are contained and oil is contained from a painting process. In this analysis, neither strong acidity and alkalinity nor high values of phosphoric acid have been detected. However, high value of ammonia nitrogen is detected.

Table 8.5.22 Recommended Treatment Process of Pre-treatment and Wastewater Treatment Facilities

Type of Industry	Wastewater Treatment Process
	Pre-treatment process: pH control, floatation or pressurized floatation with coagulant process, Physico-chemical nitrogen removal process (air stripping, ion exchange process, etc) Treatment process: same as above process. If necessary, filtration process is added. Objective factory for Wastewater quality analysis has pH control, sedimentation, biological treatment process, coagulation and oxidation pond process. This is good example as reference for same type of industry.
Battery factory	The object factory of wastewater quality analysis was not the production plant of a lead storage battery and an alkali storage battery but a factory of manganese dry cell manufacturer. There was no wastewater from production process, and it was only from floor washing and domestic wastewater of employee. It is possible to avoid wastewater generation by change of the floor washing method. Examination of the washing method is priority from wastewater treatment facilities.
Agricultural Chemicals factory	Pre-treatment process: sedimentation or coagulation process. Treatment process: sedimentation, biological treatment process and coagulation process. If necessary, filtration process is added. However, if wastewater contains agricultural chemicals, it is necessary to treat by activated carbon adsorption method.
Fertilizer factory	This fertilizer factory is only one factory in Syria. The subject items of wastewater treatment are nitrogen, phosphorus and TSS. The factory already has pH control and sedimentation process. Wastewater discharge into the Qattinah lake and sufficient treatment is required for prevention of eutrophication. As the strategy of the future wastewater treatment of this factory, it is desired to reduce and reuse wastewater, and to reuse nitrogen and phosphorus in wastewater as raw material. Physico-chemical removal process, ion-exchange resin method, reverse osmosis film method can be considered as treatment method. However, concentration of TDS, chloride and sulfate are high, and consideration of applicability including cost comparison is required.
Detergent factory	Pre-treatment process: pH control and coagulation process. If necessary, aeration process in storage tank is added for removal of sulfate. Treatment process: pH control, sedimentation, biological treatment process and coagulation process. If necessary, filtration process is added. Three objective factories for Wastewater quality analysis have treatment facilities. One factory has pH control, floatation, biological treatment process, coagulation, filtration and oxidation pond. This is good example as reference for same type of industry.

c) Industrial Wastewater Treatment of Factory which is located in the no sewerage system area

Industrial wastewater, which discharges into public water bodies is regulated by water quality criteria “Industrial polluters permitted to be discharged to the external environment”. As shown in Chapter 3, it is specified more severely than criteria for discharge into sewer networks, therefore, more advanced treatment method can be required.

Based on the results of wastewater quality analysis, factory (type of industry) exceeding criteria for discharge into the public water bodies is shown in **Table 8.5.23.**

Table 8.5.23 Water Quality Item which Require Treatment for Discharging into River

Wastewater Quality Parameters / Type of Industry	Temperature	pH	TSS	Sulfide (S)	TDS	NH_4-N	PO_4	Oil & grease	Hazardous s.	BOD	COD
Olive mill		○	○	○	○	○	○			○	
Food (canning for agricultural pro)		○	○								○
Food (canning for meat)		○	○	○			○			○	
Food (dairy & cheese products)		○	○							○	
Food factory (slaughterhouse)			○	○			○				
Food (yeast factory)			○	○	○	○				○	
Food (beer /alcohol)	○		○							○	
Paper production			○	○	○		○		○	○	○
Tannery		○	○	○	○	○	○		○	○	○
Textile factory		○	○	○	○	○	○		○	○	○
Paint factory			○	○		○	○	○	○	○	○
Electroplating			○	○		○			○	○	○
Oil refinery factory		○	○	○	○	○	○	○	○	○	○
Pharmaceutical factory			○		○	○		○	○	○	○
Aluminum factory			○		○	○		○	○	○	○
Battery			○	○	○	○		○	○		○
Pesticide factory			○			○	○		○	○	○
Fertilizer factory			○		○	○	○		○		
Detergent factory		○	○	○	○	○	○		○	○	○

Wastewater treatment processes in the objective factory of wastewater quality analysis are shown in **Table 8.5.24**. There are some factories in which the advanced treatment processes are installed by company efforts. Moreover, there are six oxidation pond system, it seems that factory in which land acquisition is possible has adopted the processing method considering cheap method. The factory in which land acquisition is possible has adopted the processing method from viewpoint of stable treatment efficiency and moderate cost of operation and maintenance.

Table 8.5.24 Wastewater Treatment Process of the Existing Factory
(Objective Factory for Water Quality Survey for Industrial Wastewater)

Category of Industry	Name of Governorate	Discharge Place	Wastewater Treatment Processes							Note
			Sedimentation	Neutralization	Floatation	Biological tr.	Coagulation	Oxidation pond	Filtration	
Olive mill	Dar'aa	Irrigation	○							
Food (Beer)	Rural Damascus	River	○	○	○	○	○	○	○	RO
Food (Meat)	Damascus	Sewage	○							
Food (Milk)	Damascus	River				○				Oil separation
Food (Yeast)	Damascus	No data				○				
Paper Production	Deir-Ez-zor	River	○	○			○			
Tannery	Damascus	Canal	○	○			○			
Tannery	Damascus	River	○							
Tannery	Rural Damascus	River	○							
Textile	Rural Damascus	River	○	○	○		○		○	
Paint	Rural Damascus	Canal	○	○					○	
Fertilizer	Homs	Lake	○	○						
Pesticide	Rural Damascus	Irrigation	○	○			○			
Detergent	Rural Damascus	Canal	○	○	○	○	○	○	○	
Detergent	Rural Damascus	Sewage		○			○			
Detergent	Rural Damascus	Lake	○							
Aluminum	Rural Damascus	Irrigation	○	○	○		○	○	○	
Aluminum	Rural Damascus	Canal	○	○		○	○	○		
Aluminum	Lattakia	Sewage	○	○						
Oil refinery	Rural Damascus	River	○	○	○		○	○	○	Oil separation
Oil refinery	Tartous	Sea	○	○	○	○	○	○		

Source) Water quality survey for industrial wastewater, JICA 2007

According to the results of wastewater quality analysis survey, recommended industrial wastewater treatment process is considered and has been presented in **Table 8.5.22.** However, this table is a fundamental description, and it is necessary to select a treatment process in consideration of the negative flow sheet (after-mentioned) of each factory, water quality data, discharge conditions, and also the installation requirements of treatment facilities.

(3) Cleaner Production (Reduction of Industrial Wastewater Pollution Load)

It was thought that all the wastewater from production process in factory should just be treated before discharge to any water body, or untreated effluent was discharged without thinking about it. It was called “End of Pipe Technology” because they disposed of wastewater at an outlet.
Promotion of "cleaner production" which unified the management technique (soft technology) on the conventional measure technology for each measure (hard Technology), was taken up in Agenda 21 adopted by “United Nations Conference on Environment and Development (Global Summit)” in 1992, with which this cleaner production was adopted at the ring Earth Summit in 1992.

The contents of “Cleaner Production” in industrial wastewater treatment are to check the whole production process in factory once again, and to consider reduction of water use, amount of wastewater and pollution load.

Usually, large expense and high technology are required for reduction of discharged pollution load by expansion of wastewater treatment facilities. There a possibility to reduce generated pollution load from sources by introduction and practice of "cleaner production" without large expense and high technology.

The contents and the example of "cleaner production" are explained below. (See **Table 8.5.25**)

Table 8.5.25 Outline of Cleaner Production

Creation of Negative flow sheet	Amount of wastewater and pollution load from each process are illustrated according to the flow of manufacturing process. The ratio of the amount of pollutant and contribution ratio in each process could be calculated from this figure. The process, which has the highest contribution ratio, is a considerable production process in treatment system, and this process has high priority.
Change of raw materials	Reduction of wastewater and simplified treatment facilities by change of raw materials - Change to low impurities - Change to low hazardous materials - Change to high biodegradation - Change to low organic pollution /low pollutant
Management, improvement, and change of equipment and instrument	- Dividing drain system according to concentration/ pollutant - Improvement of washing method (wiping, spray-washing, steam-washing, multistage washing) - Prevention of liquid dropping onto the floor
Change of production process	Based on the negative flow sheet, production process is improved with the viewpoint of reduction of wastewater.
Recycle	Examination of re-use of low concentration wastewater and recovery of raw material and valuables from concentrated wastewater
Other treatment method without effluent	Application of the following processing methods is considered. - Drying - Incineration of thick wastewater - Wet-oxidation

a) Negative Flow Sheet

In past, factory might mix all wastewater and might be carrying out treatment facilities. However, since the water quality characteristic (substance contained in wastewater) and amount of wastewater changes with production processes, treatment of mixed wastewater has a possibility of causing increase in treatment cost, and decline in removal efficiency. In order to perform suitable treatment of industrial wastewater, it is necessary to grasp the amount of wastewater and the wastewater quality characteristic that are generated from each production process. For that purpose, a negative flow sheet serves as a very effective means.

An example as reference is illustrated in **Figure 8.5.9** and below.

Upper Figure: Since, information about the wastewater of each process is not analyzed and separated, entire mixed wastewater is treated.

Lower Figure: It is expected that the treatment result improves if the decision on treatment procedure is made based on the negative flow sheet.

For example:

- Depending on the characteristics of wastewater in each production process, wastewater is collected separately.
- Thick waste liquid is entrusted to a contractor, and valuables are recovered from waste liquid.
- Low concentrated wastewater from washings is reused and thus reduces total amount of generated wastewater. Thereby, the scale of treatment facilities gets smaller.
- Since the substances contained in wastewater are different, treatment facilities are established to include two treatment processes and perform suitable removal.

Although this is not an actual example, through preparation of the negative flow sheet such an effect could be expected.

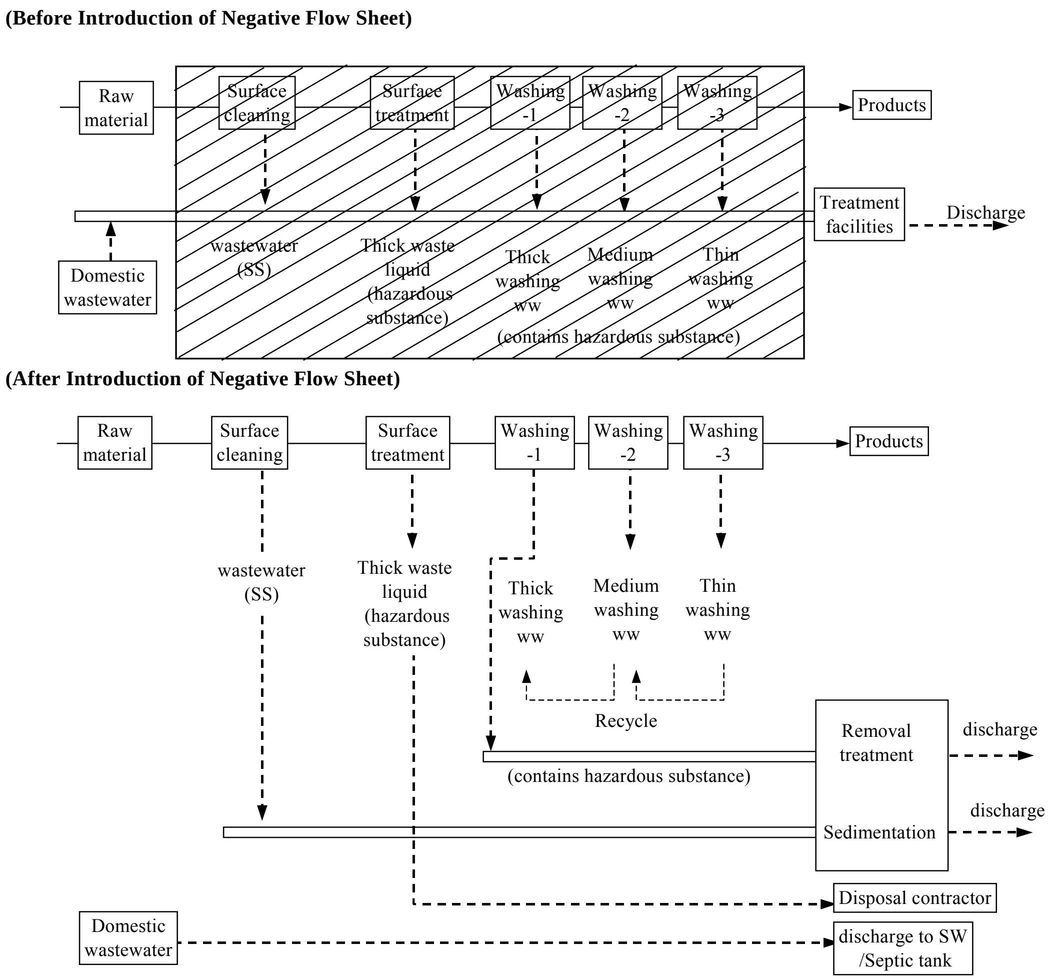


Figure 8.5.9 The Improvement Effect Image by the Negative Flow Sheet

b) Separation of Thin and Thick Wastewater / Separation for Contained Substance

The effect of wastewater separation brings a remarkable result in case of treatment of electroplating industrial wastewater. The following three kinds of wastewater are generated in electroplating industries:

- Wastewater containing cyanide
- Wastewater containing hexavalent chromium
- Acidic and alkaline wastewater

Since the treatment method for three kinds of wastewater differ, these wastewater need to be collected separately.

When the treatment is carried out for mixture of these three kinds of effluents, increase of chemicals for treatment and deterioration of removal efficiency are expected.

In other type of industry, if wastewater from one particular process contains hazardous substance or high concentration pollutant, it should be sent separately to treatment facilities capable of treating particular hazardous substance or high concentration of pollutant.

At a plating factory, the deteriorated liquid with very high concentration of pollution is discharged. If the deteriorated liquid and low-concentration wastewater from washing process is mixed, suitable treatment will become difficult. Therefore, it is appropriate that the treatment of this deteriorated waste liquid be entrusted to a processing contractor. As a result of entrusting this processing, the following benefits could be obtained.

- Treatment facilities do not get overloaded.
- A contractor collects valuables from waste liquid that could be reused, and consequently leads to resource preservation.
- A suitable treatment method for the low-concentration wastewater from washing process can be selected.

c) Devised Washing Methods

The example of multi-stage and counter current washing is described.

➢ **Case –1 (Single stage washing)**

Sponge is washed using the large tank (For example, it is assumed that 1kg mercury is included). In one washing, even if amount of water is large, the mercury of 200 mg remains in sponge. (refer to **Figure 8.5.10**)

(Condition of calculation: after washing, Sponge contains water of 1 /l)

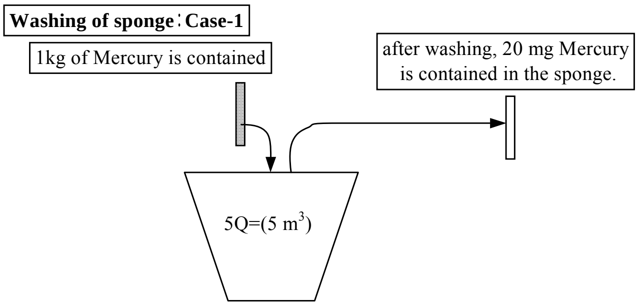


Figure 8.5.10 Effect by the Different Washing Method (Case-1)

➢ **Case –2 (Multi stage washing)**

The washing effect is large when five tanks (whole capacity is the same as case-1) wash. The mercury that remains to sponge is very slight, and the quantity is $1x10^{-9}$ mg. (refer to **Figure 8.5.11**)

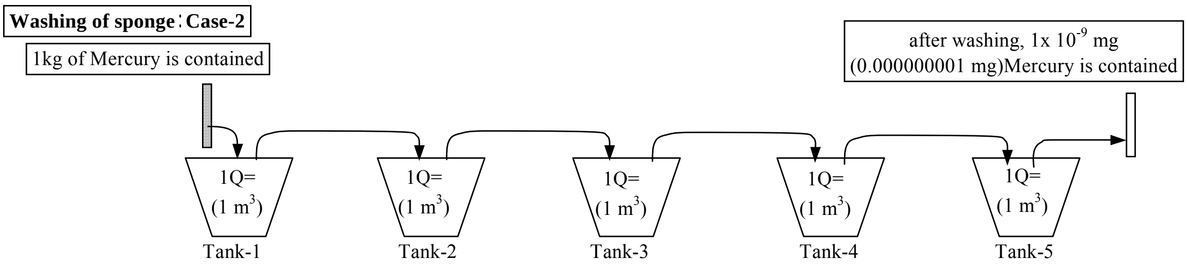


Figure 8.5.11 Effect by the Different Washing Method (Case-2)

➢ **Case –3 (Multi stage washing + dewatering)**

Although it is the same conditions as Case-2, but if dewatering is carried out between each tank, the washing effect will be higher. (refer to **Figure 8.5.12**)

(Condition of calculation: after washing, Sponge contains water of 0.1 /ls)

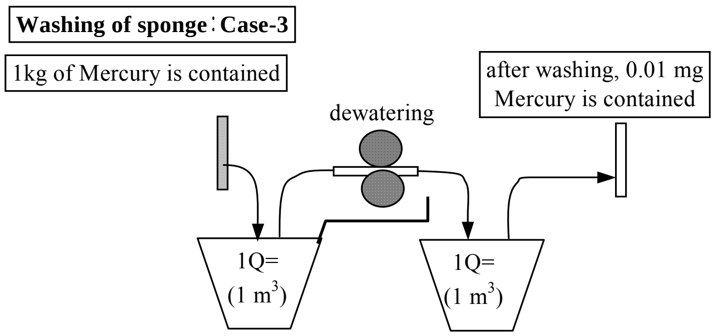


Figure 8.5.12 Effect by the Different Washing Method (Case-3)

➢ **Case –4 (Multi stage washing + dewatering + counter current)**

As is clear from figure, repeated washing is carried out. After washing in 1st tub, the concentration of pollutant in tub increases and therefore water is drained. In the second washing, the 2nd tub becomes the 1st tub which has less pollution concentration and the washing continues. If this method is adopted, little water could be used for effective washing. (refer to **Figure 8.5.13**)

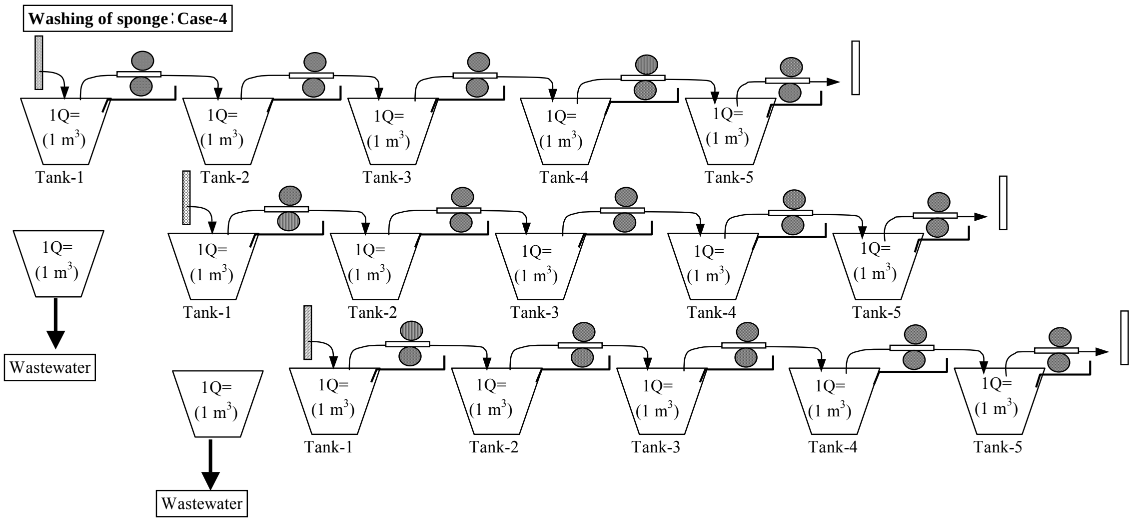


Figure 8.5.13 Effect by the Different Washing Method (Case-4)

The above is an introductory explanation of the cleaner production in this section. In the above-mentioned explanation, much information has been acquired from "The measure against reduction of the industrial wastewater which is possible at the minimum cost" Copyright(C) Atsuhiro Honda and Global Environment Centre Foundation. It is expected that the discussion/ examination and meeting in administration-sponsored seminar and the factory site will be held based on this data.