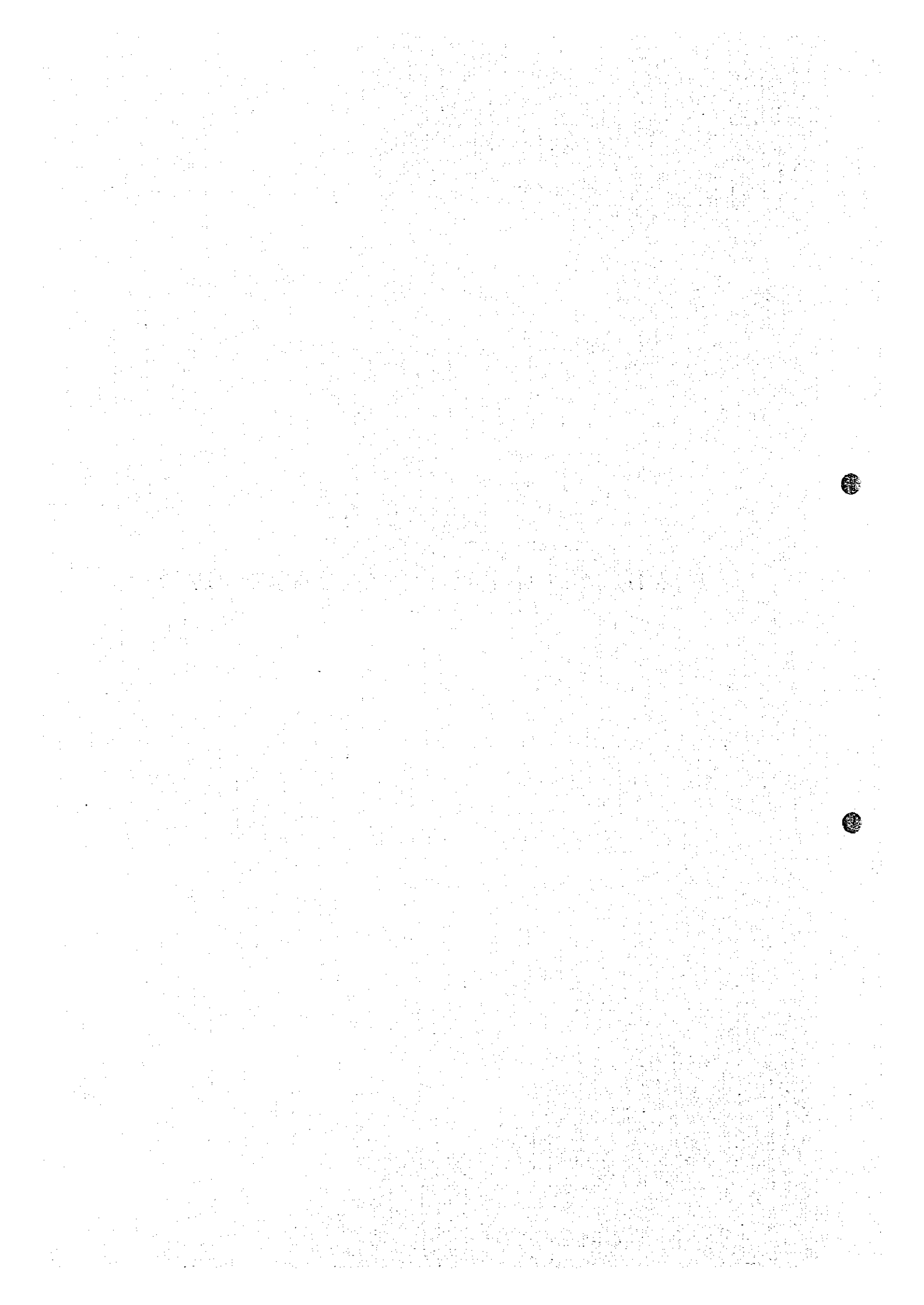


CHAPTER 14

ENVIRONMENTAL IMPACT ASSESSMENT



14 ENVIRONMENTAL IMPACT ASSESSMENT

14.1 INTRODUCTION

Fig. 14-1 shows the steps in environmental assessment for this Study. Since, this Study consists of the formulation of Wastewater Management Master Plan for the Guatemala Metropolitan Area and the Feasibility Study on the First Stage Project, the environmental assessment is carried out in three steps. They are;

- Step 1 Initial Environmental Examination (IEE) and Preparation of Terms of Reference (TOR) for Environmental Impact Assessment (EIA) for the Master Plan and Priority Regions,
- Step 2 Execution of Environment Surveys on Alternatives (Central Region and South 3 Region) for the First Stage Project, and
- Step 3 EIA on the First Stage Project (i. e. the selected alternative, South 3 Region).

This Chapter summarizes the EIA on the First Stage Project, that is Step 3. Results of Step 1, Step 2 and Step 3 are reported in Supporting Report S, Volume V.

14.1.1 Legal Framework

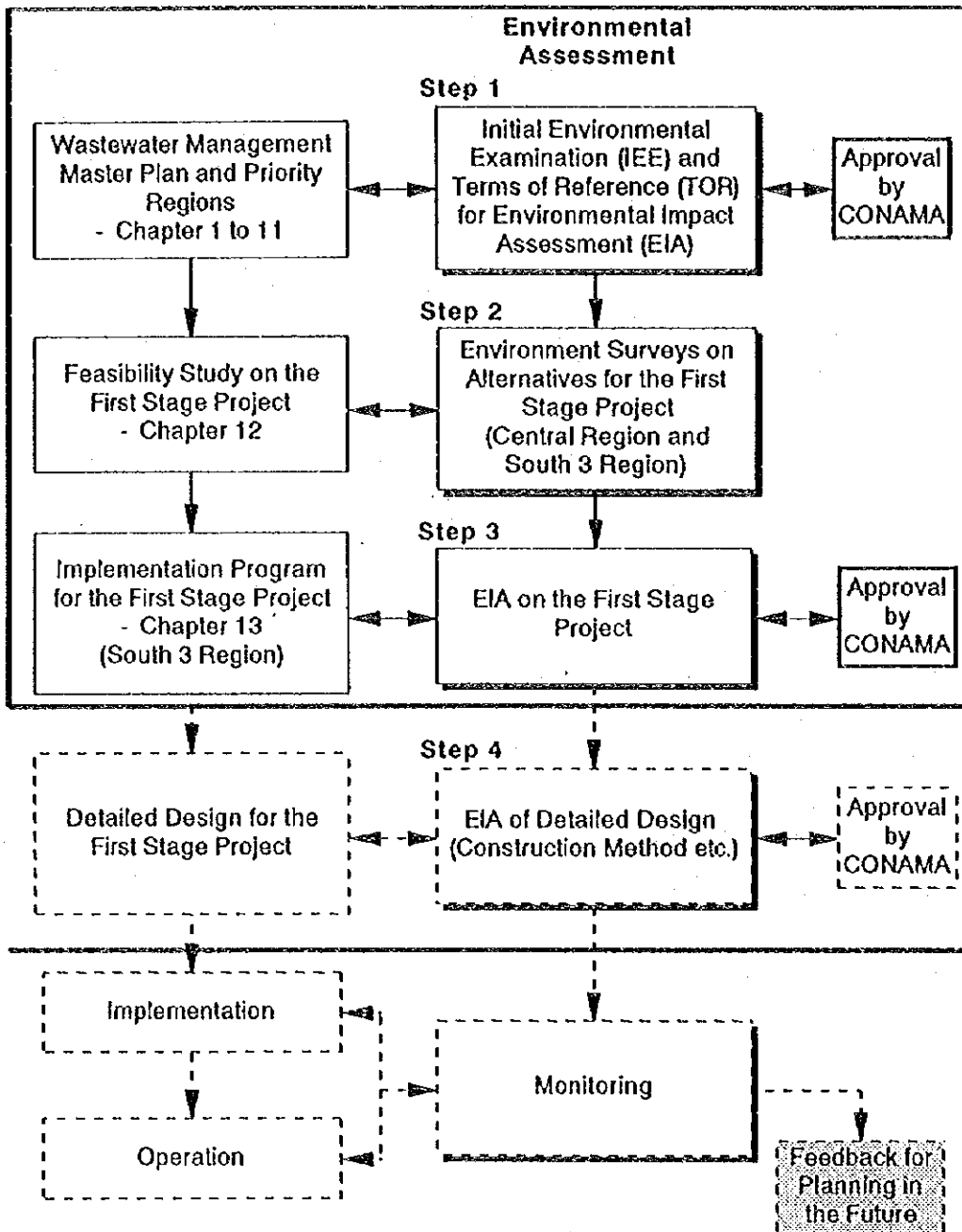
The Law for the Protection and Improvement of the Environment ("Ley 68-86") enacted by the Congress of Guatemala requires that an environmental assessment be carried out for development projects in the planning stage. If significant or potential impacts are envisaged, an environmental impact assessment (EIA) is necessary and the EIA must be approved prior to project implementation. National Environment Commission (CONAMA) is entrusted with the authority to approve EIA.

The current regulation for conducting an environmental impact assessment is "Instructivo de Procedimientos para las Evaluaciones de Impacto Ambiental" of 1990 issued by CONAMA.

Due to the scale of the proposed Wastewater Management Master Plan and the First Stage Project, an EIA is necessary.

At the Master Plan stage, an IEE was carried out and the TOR for EIA was approved by CONAMA.

The Study on the Improvement of Wastewater Management in the Guatemala Metropolitan Area



<p>THE REPUBLIC OF GUATEMALA</p> <p>GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)</p>	<p>THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA</p> <p>JAPAN INTERNATIONAL COOPERATION AGENCY</p>	<p>TITLE</p> <p>STEPS IN ENVIRONMENTAL ASSESSMENT FOR THE WASTEWATER MANAGEMENT STUDY</p>
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14.1.2 Project Implementing Organization

The Municipal Water Supply Public Corporation (EMPAGUA) will be the implementing organization for the First Stage Project. EMPAGUA is a public enterprise under the Municipality of Guatemala. Its service area is defined as the Guatemala City and its associated urban area. The name of its legal representative and address are as shown below:

Legal Representative	:	Ing. Carlos Quezada Vega General Manager
Address	:	7a Avenue 1-20, Zone 4 Edificio Torre Café Guatemala City

14.1.3 Local Consultant

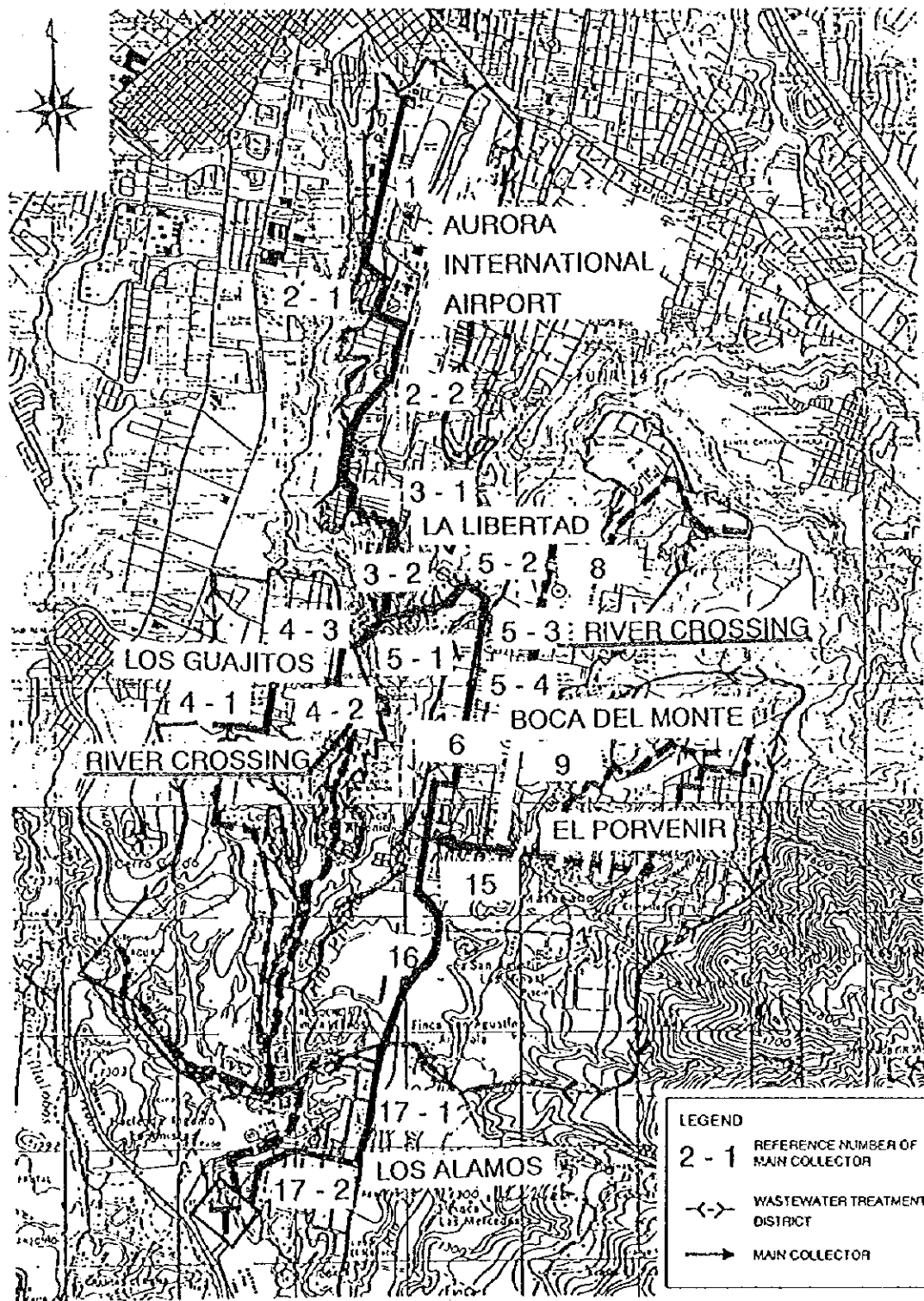
EIA is conducted by the JICA Study Team and the local consultant, namely Ingeniería Ambiental, S. A./AMBIO; registered with CONAMA as an environmental consultant and registered in the National System of Financing the Pre-Investment (SINAFIP), which is a requirement of SEGEPLAN for conducting EIA.

14.2 PROJECT SUMMARY

Table 14-1 shows the project summary. Fig. 14-2 shows the layout of proposed main collector routes and the location of treatment plant for the First Stage Project in South 3 Region. Table 14-2 shows the summary of collectors for construction. Fig. 14-3 shows the Layout Plan of WWTP.

Table 14-1 Project Summary

Item	Content
Name of Project	First Stage Project on the Improvement of Wastewater Management in the Guatemala Metropolitan Area
Background	Most of the wastewater from Guatemala Metropolitan Area is being discharged without treatment to valleys/streams and Lake Amatitlan, thus polluting water supply sources (surface water and groundwater) and living environment. To improve the wastewater management a Master Plan has been prepared to the year 2015. Feasibility Study is conducted to select the First Stage Project.
Objective	To construct and operate a) sewage collection facilities (main collectors and manholes), and b) wastewater treatment plant for the South 3 Region with a treatment capacity sufficient until the year 2008
Location	Areas in the Municipalities of Guatemala, Santa Catarina Pinula, Villa Canales and San Miguel Petapa (see Fig. 14-2)
Implementing Organization	Guatemala Water Supply Public Corporation (EMPAGUA)
Beneficial Population	Direct beneficiaries are 53,200 people who will be connected to the WWTP at the commencement of WWTP (2002). Improvement of living environment and reduction of water-borne diseases in the sewer served area is expected. Indirect beneficiaries are ; a) population depending on the groundwater resources of Ojo de Agua and surrounding area ; b) population using Pinula River water for washing and irrigation c) population downstream of Michatoya River
Planning Conditions	
Type of Plan	Feasibility Study
Target Area	a) Collectors - 1,500mm x 10.0km (tunnel in soft) - 1,200mm x 1.2km (open-cut in soft) - 300~700mm x 6.0km (open-cut in soft) - 400~700mm x 0.12km (pipe-bridge, 2 locations) Total length - 17.32km (refer Table 14-2 and Fig. 14-2) b) Area of WWTP about 30ha c) Served Population year 2002 -53,200 persons, commercial establishments and industries year 2008 - 133,300 persons, commercial establishments and industries d) Area of treatment district year 2001 - 896ha e) Quantity of Wastewater year 2002 - 14,890m ³ /d (daily maximum) year 2008 - 34,750m ³ /d (daily maximum)
Sewage Collection Method	Separate-sewer System
Wastewater Treatment Plant (WWTP)	a) Treatment Process High-rate trickling filter with intermediate clarifier (see Fig. 14-3) b) Treatment Capacity 36,000m ³ /d (daily maximum)
Wastewater Sludge Treatment and Disposal Method	a) Treatment Process Drying-bed b) Disposal Method Sanitary landfill of the Municipality of Guatemala
Receiving Water	Treated effluent will be discharged to Pinula River which confluence with Villalobos River about 1 km downstream. Villalobos River discharges to Lake Amatitlan at about 7.7 km downstream. Michatoya River, which is the only exit of Lake Amatitlan, confluences with many rivers and finally discharges to Pacific Ocean 81 km downstream. Effluent quality : BOD - 56 mg/L and SS - 56 mg/L



<p>THE REPUBLIC OF GUATEMALA</p>	<p>THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA</p>	<p>TITLE LOCATION MAP OF COLLECTOR AND WASTEWATER TREATMENT PLANT</p>
<p>GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)</p>	<p>JAPAN INTERNATIONAL COOPERATION AGENCY</p>	

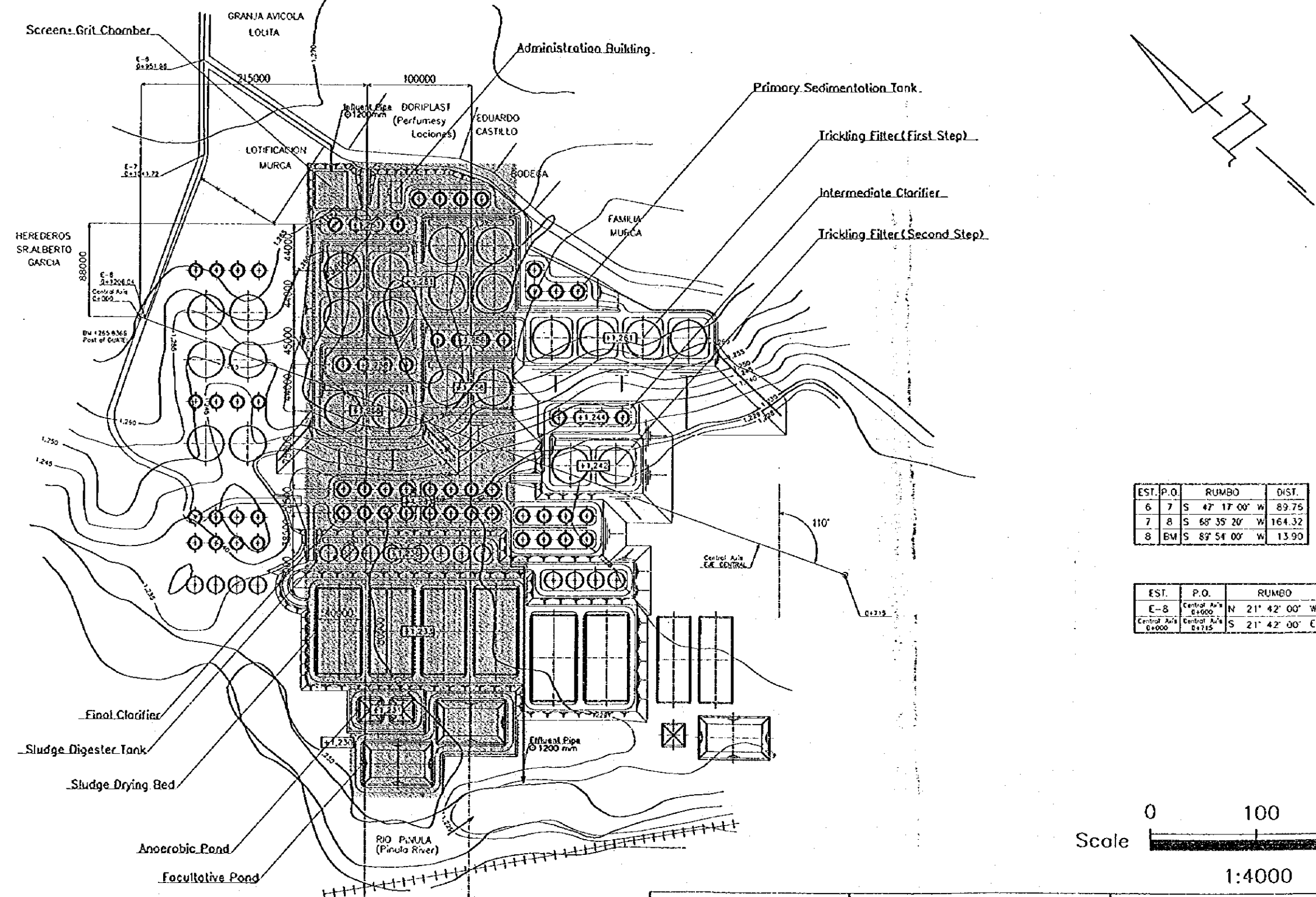
Table 14-2 Summary of Main Collectors for First Stage Project

Ref. No.	Diameter, mm	Length, m	Construction Method	Remarks
1	300	1,730	Open-cut	
2-1	500	230	Open-cut	
2-2	1,500	1,490	Tunnel	Soft
3-1	1,500	260	Tunnel	Soft
3-2	600	610	Open-cut	
3-3	1,500	630	Tunnel	
3-4	600	440	Open-cut	
5-1	1,500	630	Tunnel	Soft
5-2	700	200	Open-cut	
5-3	700	70	Pipe bridge	
5-4	1,500	760	Tunnel	Soft
15	1,500	660	Tunnel	Soft
16	1,500	2,010	Tunnel	Soft
17-1	1,500	1,060	Tunnel	Soft
17-2	1,200	1,150	Open-cut	
4-1	400	1,510	Open-cut	
4-2	1,500	760	Tunnel	Soft
4-3	400	50	Pipe-Bridge	
4-4	1,500	130	Tunnel	Soft
7	400	500	Open cut	
8	500	810	Open-cut	
9	1,500	1,630	Tunnel	Soft
Total		17,320		

Note : Total length of main collectors are based on the results of longitudinal surveys conducted in this Study, Note that the lengths reported in Table 9-1 and 9-2 are based on topographical map of scale 1 : 15,000 and enlarged map of scale 1 : 50,000. Therefore, the lengths are different.

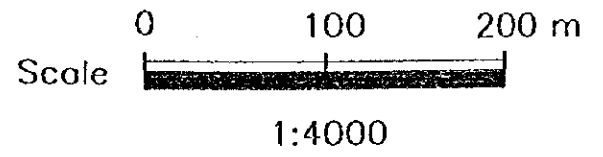
Source : Study Team

Layout Plan of Wastewater Treatment Plant (Alternative 2: South3 WWTP)



EST.	P.O.	RUMBO	DIST.
6	7	S 47° 17' 00" W	89.75
7	8	S 68° 35' 20" W	164.32
8	EW	S 87° 54' 00" W	13.90

EST.	P.O.	RUMBO	DIST.
E-8	Central A/s 0+000	N 21° 42' 00" W	5.94
	Central A/s 0+000	S 21° 42' 00" E	715.00



: FIRST STAGE

<p>THE REPUBLIC OF GUATEMALA</p> <p>GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)</p>	<p style="text-align: center;">THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA</p> <p style="text-align: center;">JAPAN INTERNATIONAL COOPERATION AGENCY</p>	<p>TITLE</p> <p style="text-align: center;">LAYOUT PLAN FOR FIRST STAGE PROJECT (ALTERNATIVE 2: SOUTH3 WWTP)</p>
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14.3 SIGNIFICANT ENVIRONMENTAL IMPACT ASSESSMENT

14.3.1 Evaluation of Significant Impacts and Mitigation Measures

The proposed Project will result in protection of water supply sources, improvement of living environment, public health benefits and abatement of pollution to rivers and groundwater. In the meantime, there are possibility of some negative impacts unless adequate safeguards are taken during project implementation and operation. Potential and significant environmental impacts, both positive and negative, are identified and assessed for

- a) the pre-construction stage,
- b) the construction stage, and
- c) operation stage.

Fig. 14-4 shows the major environmental aspects of the Proposed Project. Table 14-3 shows the impact matrix for significant impacts. The following section describes those impacts and necessary mitigation/compensation measures..

a) Pre-construction Stage

Project activities causing significant impacts in this stage are as follows:

- 1-1 Land Procurement for WWTP
- 1-2 Publicity of the Project

Activities in this stage cause immediate impacts on the project implementation.

1-1 Land Procurement for WWTP

Impact(1-1.1): Procurement of land from private land owners will be essential for WWTP construction. Failure to procure land will have serious impact, because alternative locations for WWTP site are very limited.

1-1.1 Mitigation / Compensation Measures

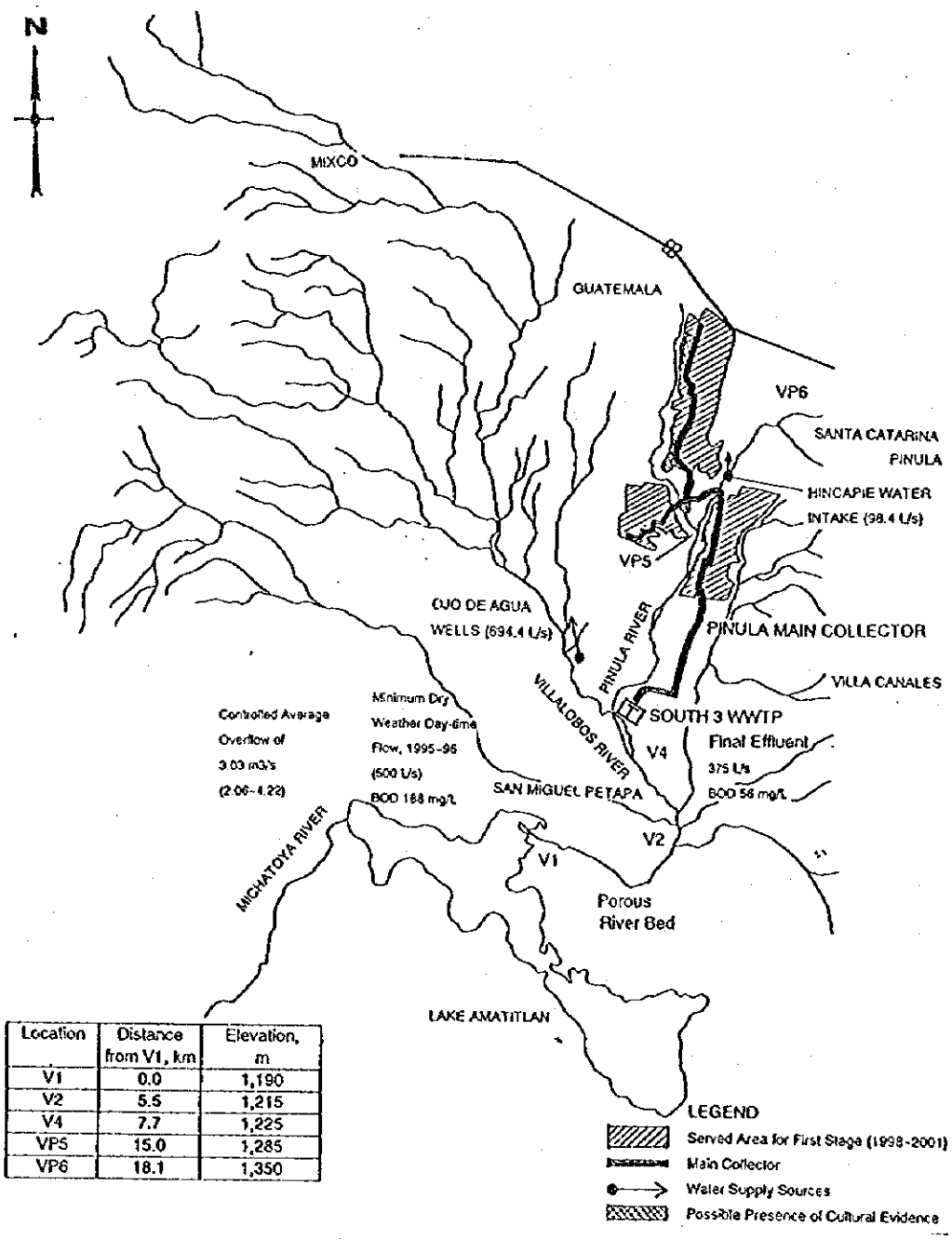
EMPAGUA should make definite arrangements to ensure the procurement of land for WWTP site at the earliest.

1-2 Publicity of the Project

Impact(1-2.1): Information about the Project to the public is necessary for successful implementation and operation. Due to badly operated small-scale facilities in the study area, public perception of sewerage facilities is not very favorable. Opposition or indifference to the project may occur.

1-2.1 Mitigation / Compensation Measures

Therefore, role of sewerage be explained to the public. Public should be informed of the project's progress. Proper operation should be pledged.



Location	Distance from V1, km	Elevation, m
V1	0.0	1,190
V2	5.5	1,215
V4	7.7	1,225
VP5	15.0	1,285
VP6	18.1	1,350

THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA	TITLE MAJOR ENVIRONMENTAL CHANGES DUE TO THE PROPOSED PROJECT
	JAPAN INTERNATIONAL COOPERATION AGENCY	

Table 14-3 Impact Matrix for the Significant Impacts

Project Activity	Social Environment						Natural Environment												
	Living Environment (Health)		Infrastructure		Social Opinion		Cultural Heritage		Disaster Risk		Aesthetic View		Flora and Fauna		Surface Water		Ground Water		
	Central	South 3	Central	South 3	Central	South 3	Central	South 3	Central	South 3	Central	South 3	Central	South 3	Central	South 3	Central	South 3	
a) Pre-construction Stage																			
1-1 Land Procurement for WWTP																			
1-2 Public Relations					B	B													
b) Construction Stage																			
2-1 Excavation of Tunnels			C	C			P	P									B	B	
2-2 Out and Fill Operation for WWTP Construction			C	C									C	C					
2-3 Construction Activity				B	B														
c) Operation Stage																			
3-1 Elimination of Raw Wastewater Discharges (connection to sewerage system)	A	A															A	A	A
3-2 WWTP Discharge																			
3-3 WWTP Operation				A	A							B	B				B	B	C
3-4 Disposal of sludge																	A	A	A
3-5 Stability of Slopes																	A	A	
3-6 Ability to withstand earthquake																	A	A	
3-7 Public Relations																	A	A	

Note: P- Positive Impact

A - Serious Negative Impact

B - Moderate Negative Impact

C - Minor Negative Impact

Source : Study Team

b) Construction Stage

Project activities causing significant impacts in this stage are as follows:

- 2-1 Excavation of Tunnels
- 2-2 Cut and Fill Operation for WWTP Construction
- 2-3 Construction Activity

Activities in this stage cause short-term impacts which generally cease at the end of construction activity.

2-1 Excavation of Tunnels

Impact(2-1.1): Excavation of tunnels will result in surplus soil of about 35,000 m³. Disposal of surplus soil at Guatemala Municipal Landfill or at an alternative location (South 3 WWTP) might result in wash-away of material, unless precautions are taken.

2-1.1 Mitigation / Compensation Measures

Proper drainage during stockpiling and disposal should be made to avoid wash-away of material. If necessary, retention ponds for settling wash-away material be constructed.

Impact(2-1.2): Vicinity of Aurora Zoological Park and the south-west of Aurora International Airport are known for the possible presence of prehispanic or colonial cultural evidences (Fig. 14-4), which were believed to be destroyed or lost during urban development activities. Manual excavation of tunnel for main collector may unearth some of the lost evidences.

2-1.2 Mitigation / Compensation Measures

Excavation in these areas should be undertaken with care. Department of Monuments shall be informed of the excavation work and if necessary, periodic inspection could be made. If any objects are found, Department of Monuments should be notified so that the competent persons can rescue the items. Route changes would be necessary only if any evidence are to be left in place.

Impact(2-1.3): Transportation of excess soil will cause noise, dust and possibly accidents.

2-1.3 Mitigation / Compensation Measures

Proper construction procedures must be followed to reduce noise, dust and accidents. Public must be informed for understanding with short-term disturbances.

2-2 Cut and Fill Operation for WWTP Construction

Impact(2-2.1): Construction of WWTP will involve cut and fill operation with an earthwork volume of 350,000 m³, each. Silting or muddy water in Pinula River due to wash-away material may occur, unless precautions are taken.

2-2.1 Mitigation / Compensation Measures

Take proper construction procedures to avoid wash-away of material. If necessary, drainage retention pond should be constructed to remove silt escaping to river.

Impact(2-2.2): Cut and fill operation will disturb the vegetation within the WWTP site.

2-2.2 Mitigation / Compensation Measures

Improve aesthetic environment of WWTP by landscaping with indigenous trees and plants.

2-3 Construction Activity

Impact(2-3.1): Due to large-scale construction activity, movement of construction labor to the project area is expected.

2-3.1 Mitigation / Compensation Measures

Temporary shelters for construction laborers shall be provided with adequate facilities for waste disposal.

c) Operation Stage

Project activities causing significant impacts in this stage are as follows:

- 3-1 Elimination of Raw Wastewater Discharges
- 3-2 WWTP Discharge to Receiving Water
- 3-3 WWTP Operation
- 3-4 Disposal of Sludge
- 3-5 Stability of Cut and Fill Slopes
- 3-6 Public Relations

Activities in this stage cause long-term impacts.

3-1 Elimination of Raw Wastewater Discharges (Connection to Sewerage System)

Impact(3-1.1): Failure to get households, commercial establishments and industries to connect to the sewerage system will reduce project benefits, as EMPAGUA lacks the legal authority.

3-1.1 Mitigation / Compensation Measures

Improvement of water quality in Pinula River for about 3.1 km and improvement of living environment for 53,200 persons are expected. However, this benefit depends on ensuring that the households, commercial establishments and industries in the served area are connected to the sewerage system which requires revisions/additions to the legal authority of EMPAGUA for providing sewerage service in the project area.

3-2 WWTP Discharge to Receiving Water

Impact(3-2.1): Average effluent discharge of 375 L/s from WWTP will become a new point source to Pinula River just upstream of the confluence with Villalobos River, with both BOD and SS concentration of 56 mg/L (see Fig. 14-4).

3-2.1 Mitigation / Compensation Measures

Existing dry weather flow (day-time) of Villalobos River near the downstream of the confluence with Pinula River is about 500 L/s. Conservative estimate of flowrate in Villalobos River after the commissioning of South 3 WWTP will be 875 L/s (375+500), even though construction of sewerage will eliminate the existing discharges to Pinula River thus reducing its flow. Inlet of Villalobos River to Lake Amatitlan is 7.7 km through a porous river bed from the confluence of Pinula River. Under these conditions, no significant increase in surface flow to Lake Amatitlan is expected. However, monitoring is required during operation for planning subsequent stages.

Reduction of pollutant load is expected in the Pinula and Villalobos Rivers, because the existing BOD and SS concentrations of Villalobos River are 188 and 130 mg/L respectively while the WWTP effluent is 56 mg/L in terms of both BOD and SS.

Impact(3-2.2): Failure to build and maintain suitable WWTP effluent outfall will cause river bed / river bank erosion.

3-2.2 Mitigation / Compensation Measures

To avoid erosion on river beds, and an increase on sediment transport downstream during the final design stage, a structural protection should be designed to protect the streambank beds. Erosion of river borders can be prevented by vegetation.

3-3 WWTP Operation

Impact(3-3.1): Failure to follow good housekeeping procedures will result in odor and fly problems. Odor and fly problems are highly detrimental to the public perception of WWTP and will have serious impact to the sustainable operation of WWTP.

3-3.1 Mitigation / Compensation Measures

Operating personnel should be educated thoroughly on the treatment principles and operating procedures. Responsible person shall ensure that the procedures are strictly adhered to. Growing of trees around the treatment facilities and WWTP site will reduce odor problems. However, elimination of odor require covering of facilities, extraction of odorous air and its treatment . These require huge investment. At this

stage of planning, these are considered to be unnecessary. However, will there a situation arise, it is possible to augment the proposed facilities for odor control.

3-4 Disposal of sludge

Impact(3-4.1): Sludge will be disposed at landfill of Guatemala Municipality. If heavy metals are present, groundwater contamination may result.

3-4.1 Mitigation / Compensation Measures

Acceptance of industrial wastewater should be under the condition that EMPAGUA shall have full authority to monitor wastewater. Monitoring of industrial wastewater and wastewater sludge is necessary.

3-5 Stability of Cut and Fill Slopes

Impact(3-5.1): Large amount of cut and fill is necessary in the WWTP(approximately 350,000 m³, each) for maintaining gravity flow throughout the treatment facilities. Failure of slopes will seriously affect the facilities.

3-5.1 Mitigation / Compensation Measures

Provide slopes considering the local experience and soil characteristics and provide adequate drainage. Regular maintenance shall be made to ensure their stability.

3-6 Ability to withstand earthquake

Impact (3-6.1): Failure of sewerage system due to earthquake

3-6.1 Mitigation / Compensation Measures

Sewerage structures shall be designed to withstand earthquakes. Magnitude of the earthquake to which the structures are to be designed shall be based considering other public utilities.

3-7 Public Relations

Impact(3-7.1): Information on the role of sewerage facilities to the public is necessary for successful operation.

3-7.1 Mitigation / Compensation Measures

Public relations shall be conducted on a continuous basis, during project implementation and during operation. Education to children/public including visits to the WWTP is recommended.

Summary of the above discussion on significant environmental impacts and action/countermeasures are shown in Table 14-4.

Table 14-4 Summary of Significant Environmental Impacts (1/2)

Project Activity	Description of Impact	Category	Impact	Action
a) Pre-construction Stage (immediate impacts)				
1-1 Land Procurement for WWIP	1-1.1 Failure in procurement	Social	Serious	Ensure procurement.
1-2 Public Relations	1-1.2 Public opposition	Social	Moderate	Implement public education on the role of sewerage
b) Construction Stage (immediate or short-term impacts)				
2-1 Excavation of Tunnels	2-1.1 Wash-away of excavated soil	Physical	Moderate	Provide adequate drainage and retention pond for soil stock-piles.
	2-1.2 Possibility of finding historical evidences underground	Social	Positive	Inform Department of Monuments for rescue of those items
	2-1.3 Noise, dust and accidents during transportation	Social	Moderate	Take proper construction procedures to reduce them. Request public understanding with short-term disturbances.
2-2 Cut and Fill Operation for WWIP Construction	2-2.1 Muddy water and silting of Pinula River	Physical	Moderate	Take proper construction procedures to avoid wash-away of material.
	2-2.2 Disturbance to vegetation	Physical	Minor	Landscape WWIP site.
2-3 Construction Activity	2-3.1 Strain on infrastructure due to labor influx.	Physical	Minor	Provide waste disposal facilities for temporary shelters for labor.

Note : Impact are classified as Serious, Moderate and Minor of which only serious impact will endanger the Project implementation or its sustainability.

Source : Study Team

Table 14-4 Summary of Significant Environmental Impacts (2/2)

Project Activity	Description of Impact	Category	Impact	Action
c) Operation Stage (long-term impact)				
3-1 Elimination of Raw Wastewater Discharges (connection to sewerage system)	3-1.1 Legal authority is necessary for implementation	Physical	Serious	Revise laws and regulations
3-2 WWTP Discharge to Receiving Water	3-2.1 New point source from WWTP	Physical	Minor	Implement monitoring
	3-2.2 Erosion of river bed	Physical	Moderate	Build suitable outfall
3-3 WWTP Operation	3-3.1 Fly and odor problem	Social	Moderate	Plant trees and plants. Follow good house-keeping
3-4 Disposal of sludge	3-4.1 Contamination of soil and water.	Physical	Serious	Accept only non-toxic wastewater. Monitor wastewater and sludge.
3-5 Stability of Cut and Fill Slopes	3-5.1 Failure of slopes	Physical	Serious	Provide stable slope and maintain.
3-6 Ability to withstand earthquake	3-6.1 Failure of sewerage system due to earthquake	Physical	Serious	Design structures to withstand earthquakes
3-7 Public Relations	3-7.1 Public opposition or indifference to sewerage	Social	Serious	Public education and conduct public /children visits to WWTP

Note : Impact are classified as Serious, Moderate and Minor of which only serious impact will endanger the Project implementation or its sustainability.

Source : Study Team

14.3.2 Proposed Project Versus No Action

From the discussion on significant environmental impacts, it is understood that countermeasures/actions can reduce the negative impacts of the Proposed Project. It is necessary to keep in mind that the existing conditions are worsening and action on systematic management of wastewater disposal is long overdue. The Proposed Project is part of the sustainable solution to the worsening problems due to indiscriminate disposal of wastewater in the Guatemala Metropolitan Area. Table 14-5 shows the comparison of the benefits of the Proposed Project versus if no action is taken. From the table, it is clear that the advantages outweigh the disadvantages.

Table 14-5 Comparison of Proposed Project Versus No Action

Item	With Project	No Action
1. Sewerage service with treatment	<ul style="list-style-type: none"> - Improvement of living environment of 896 ha and for 53,200 persons, commercial establishments and industries - Reductions of water-borne diseases - Pollutant load reduction to rivers and groundwater of 3,010 kg BOD/d and 3,010 kg SS/d. 	<ul style="list-style-type: none"> - Indiscriminate disposal of wastewater without treatment and worsening living environment - Increase in water-borne diseases - Additional pollutant load to rivers and groundwater, thus accelerating the pollution of existing water supply sources.
2. Construction of Collector and WWTP	<ul style="list-style-type: none"> - Employment opportunities in construction sector 	<ul style="list-style-type: none"> - No opportunity. - Strain on existing infrastructure.
3. Operation and Management of WWTP	<ul style="list-style-type: none"> - New employment opportunities and acquiring of WWTP operation skills, which are essential for sewerage development in Guatemala - Slight impairment of living environment around WWTP 	<ul style="list-style-type: none"> - No opportunity and no skills. - No impairment.

Source : Study Team

14.4 MITIGATION MANAGEMENT

Mitigation measures are discussed in section 14.3.1. As shown in Fig. 14-1, the Proposed Project is in the Feasibility Study stage and Detailed Design stage will follow before Implementation. Some of the mitigation measures should be taken during detailed design (pre-construction stage) even though the impact occurs at later stages. Table 14-6 shows the mitigation measures to be taken at each stage showing the organization responsible for it.

Table 14-6 Mitigation Management

Mitigation Measure	Responsible Organization(s)
a) Before Detailed Design - Arrangements for land procurement - Publicity and public education campaigns - Revision of laws and regulations for EMPAGUA to provide sewerage service	EMPAGUA EMPAGUA and INFOM Government of Guatemala (INFOM / EMPAGUA)
b) During Detailed Design - Construction methods - Design criteria for structures - Design criteria for slopes (cut/fill) - WWTP O/M Manual - Landscape Design	EMPAGUA (approved by CONAMA)
c) During Construction - Construction method - Provision of shelters/facilities	EMPAGUA (supervision) EMPAGUA/Municipalities
d) During Operation - WWTP Operation - Public liaison/children Education - Monitoring	EMPAGUA EMPAGUA, Municipalities and Ministry of Education CONAMA

Source : Study Team

14.5 MONITORING PLAN

In addition to the water and sludge quality monitoring of WWTP to be conducted by EMPAGUA for operation of WWTP, monitoring the effects of the Project is necessary for planning in the future. They are :

- a) South 3 wastewater treatment plant effluent

- b) Dried sludge from South 3 WWTP
- c) Pinula River and Villalobos River near the confluence of those rivers.
- d) Lake Amatitlan and Michatoya River

It is desirable that these kind of monitoring be conducted by CONAMA. Frequency of monitoring may be three to four times a year. Analytical and measurement parameters shall include flowrate, organic matter, nutrients and heavy metals.

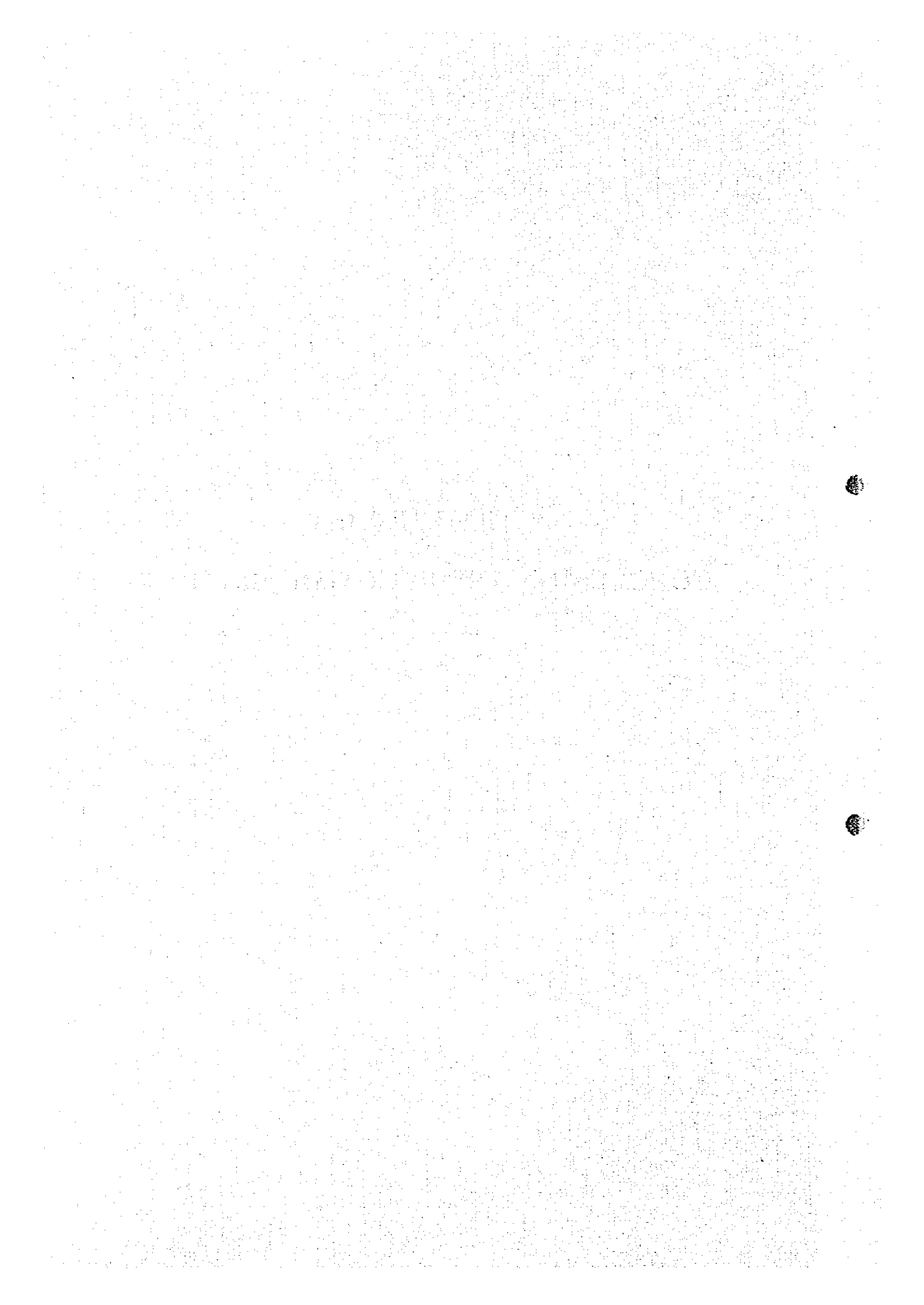
14.6 CONTINGENCY PLANS

At this stage, it is not convenient, nor necessary, to prepare detailed contingency plans. These have to be done during the final design stage and can be focused in the following aspects:

- 1) Plan in case of accidents during tunneling.
- 2) Plan in case the tunnels fail / during maintenance
- 3) Plan in case the wastewater treatment plant stops operation.

CHAPTER 15

CONCLUSION AND RECOMMENDATIONS



15 CONCLUSION AND RECOMMENDATIONS

15.1 CONCLUSION

Discussion in the preceding sections showed that the First Stage Project in the South 3 Region is financially feasible provided that a working fund is established to cover the local portion required for implementation. Generally, sewerage projects are implemented with subsidies from the Central Government or local government because initial investment required is high. However, in this case the possibility of obtaining subsidy is rather limited and the only way of generating capital for investment will be to obtain foreign loan and to establish a working fund from the mark-up of sewerage service charges in the existing sewer-served areas.

It is concluded that the proposed First Stage Project in South 3 Region is the most feasible alternative in the process of improving the wastewater management in the Guatemala Metropolitan Area.

15.2 RECOMMENDATIONS

To implement the proposed First Stage Project and Wastewater Management Master Plan smoothly the following measures are recommended.

a) **First Stage Project**

1) **Establishment of Wastewater Management Fund**

- Take necessary actions to establish Wastewater Management Fund for implementation of First Stage Project, such as to obtain approval from municipalities for increasing sewerage service charge.
- A suitable tariff structure shall be introduced and the billing and collection system shall be improved to ensure the accumulation of Wastewater Management Fund

2) **Procurement of Land for WWTP**

- Take necessary actions to procure land for the proposed South 3 WWTP site. Alternative sites for WWTP are very limited due to mountainous topography and utmost importance should be given for this.

3) **Strengthening of Legal Powers of EMPAGUA**

- Entrust EMPAGUA with wastewater management in the First Stage Project Area and in the long-term to the entire Study Area (not only within the municipality of Guatemala),
- Set standards for accepting or refusing industrial wastewater
- Require that all desludging be controlled by EMPAGUA. Private desludging operators shall report to EMPAGUA and the sludge shall be brought to the wastewater treatment plants.

b) Wastewater Management Master Plan

1) Sanitation Facility Management

- New facilities to be constructed by EMPAGUA will be managed by it,
- Bring the management of existing small-scale sewerage treatment plants under EMPAGUA's management as a prerequisite for their rehabilitation,
- Disposal of septage from private desludging shall be at the wastewater treatment plants and shall be applied over the entire Area in order to appeal to the public.

2) Sewerage Facility Management

- Information and Records of the existing sewer network are in disorder. Confirmation and arrangement of this data is urgently required. Systematic record keeping for all sewerage facilities should be established.

3) Effluent Standards

- Current effluent standards shall be improved and enforced. In the long-term effluent standards shall be set based on water quality standards for public water bodies.

4) Ground Water Protection

- Currently there are no laws governing the disposal of wastewater underground. Underground disposal of wastewater is practiced extensively including the disposal of industrial wastewater. Regulations concerning the underground disposal of wastewater shall be prepared and implemented to protect ground water sources.







JICA