S5.2 EVALUATION OF SIGNIFICANT IMPACTS

Evaluation of the significant impacts identified in the previous section are described in this section for both Central Region and South 3 Region.

S5.2.1 Planning Stage

1-1 Land Procurement for WWTP

Impact(1-1.1): Procurement of land from private land owners will be essential for WWTP construction. Land requirement for Central Region WWTP facilities and for South 3 Region WWTP facilities are 90 ha and 30 ha, respectively for ultimate stage. Failure to procure land will have serious impact, because alternative locations for WWTP site are very limited.

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.

S5.2.2 Construction Stage

2-1 Excavation of Tunnels

Impact (2-1.1): Excavation of tunnels will result in surplus soil of about 35,000 m^3 in South 3 Region and about 152,000 m^3 in South 3 Region. Disposal of surplus soil at Guatemala Municipal Landfill or at an alternative location (e.g. South 3 WWTP for soil from South 3 Region) might result in wash-away of material, unless precautions are taken.

Impact(2-1.2): Cultural evidences may be found in the areas identified below.
Central Region: The archeological site named as "Montículo de la Culebra" presents colonial age archeological evidence with a defined location. Construction activity near this location will have high possibility to find some evidence. The area near Kaminal Juyu is also a similar category.

Chinautla is another site which was used by pre-hispanic population, because of its inherent self-defense characteristics. Up to date, the agricultural activity developed in this site has caused considerable damage. It is considered as a potential loss for the cultural heritage during the construction works.

Other archeological sites with Grade 2 and 3 (Appendix SB4)) can be object of minor importance.

South 3 Region: Vicinity of Aurora Zoological Park and the south-west of Aurora International Airport are known for the possible presence of pre-hispanic or colonial cultural evidences, 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.

Impact(2-1.3): Transportation of excess soil will cause noise, dust and possibly accidents. The normal activities during construction, such as machinery mobilization, soil excavation and construction of different structures can impact the workers' health, due to possible accidents, and other health related problems caused by dust and noise generation.

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 m^3 (each) in South 3 Region WWTP and 1,500,000 m^3 (each) Central Region WWTP. Silting or muddy water in Pinula River or Las Vacas River due to wash-away material may occur, respectively, unless precautions are taken.

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

Central Region: Loss of Vegetation Cover: The loss of vegetation cover is estimated at about 50 ha., because of the clearing works and land leveling at the Wastewater Treatment Plant area and access roads. Under the actual conditions of deforestation (approximately 80 %), this vegetation loss will generate a low-negative, irreversible impact. Most of the site is covered by corn and grass, which is associated with fauna, can spread out and adapt easily to the surrounding wild zones of the WWTP site.

South 3 Region: The major part of the project infrastructure is located in an area that is 100 % deforested, being principally dedicated for agricultural and cattle activities, undertaking an approximately area of 9 ha.

Under these considerations, the impact generated on the vegetation is low, negative, reversible, temporal and non-significant. Also, the impact of wildlife populations is not significant, because the actual existing fauna in the region could easily moved to the surrounding wild areas close to the Wastewater Treatment Plant.

2-3 Construction Activity

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

S5.2.3 Operation Stage

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, especially in the South 3 Region. In Central Region, existing small discharges need to be connected to the main collectors.

3-2 WWTP Discharge to Receiving Water

Impact(3-2.1): New point pollution sources by WWTP discharge

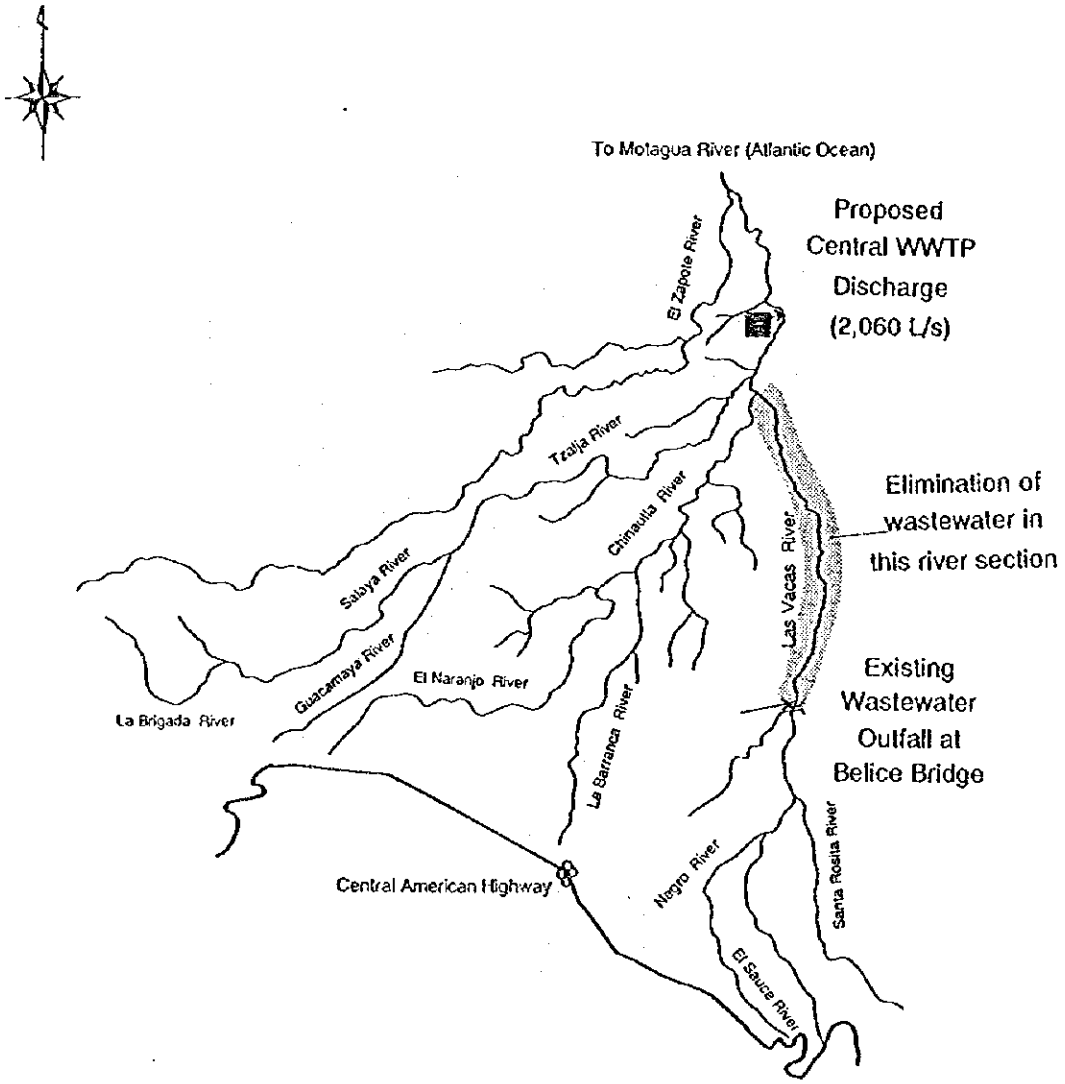
Central Region: Existing raw wastewater discharge at Belice Bridge (Gran Colector North) will be transferred to downstream location of Las Vacs River (Fig. S-15). Water quality of Las Vacas River between Belice Bridge and confluence of Chinautla River will be improved significantly due to elimination of raw wastewater discharge at Belice Bridge. Average WWTP effluent discharge will be 2,060 L/s with BOD concentration of 182 mg/L and SS concentration of 126 mg/L. Average BOD of Las Vacas River near the proposed WWTP discharge is 178 mg/L (Dec. '95~Feb. '96). Therefore, there will be no significant improvement in the water quality downstream of WWTP discharge as a result of First Stage Project.

Flowrate downstream of WWTP discharge will remain similar to the existing conditions while that between Belice Bridge and confluence with Chinautla River to the levels prior to the construction of Gran Colector North, in the beginning of eighties.

South 3 Region: 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 (Fig. S-16).

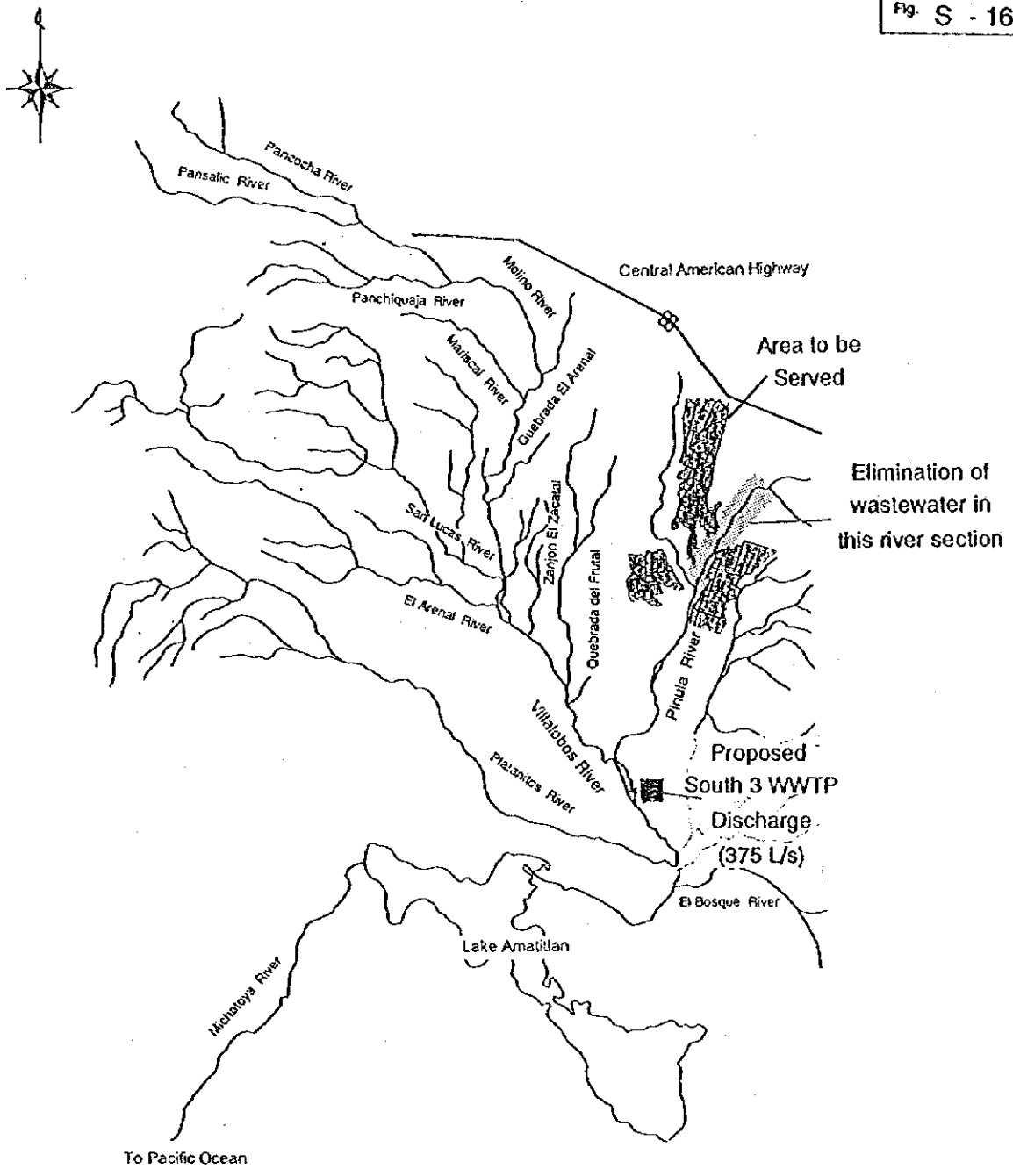
Existing dry weather flow (day-time) of Villalobos River near the downstream of the confluence with Pinula River is about 500 L/s. Conservative estimate of flowrate in

Fig. S - 15



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE CHANGE IN WASTEWATER DISCHARGE : CENTRAL REGION

Fig. S - 16



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE CHANGE IN WASTE WATER DISCHARGE : SOUTH 3 REGION

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 is7.7 km through a porous river bed. 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 will be 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.

3-3 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.

3-4 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.

3-5 Stability of Cut and Fill Slopes

Impact(3-5.1): Large amount of cut and fill is necessary in the WWTP (approximately 350,000 m^3(each cut and fill) for South 3 WWTP and 550,000 m^3 (each cut and fill) for Central WWTP) for maintaining gravity flow throughout the treatment facilities. Failure of slopes will seriously affect the facilities.

3-6 Ability to withstand earthquake

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

3-7 Public Relations

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

S5.3 ENVIRONMENTAL RISK IDENTIFICATION

S5.3.1 Construction Stage

a) Seismic Characteristics

During this stage, the risk can be described as follows:

As previously described, the Valley of Guatemala City presents a well defined pattern of faults oriented mostly North-South. Most of these faults are normal. There are also some inverse faults.

Collectors: Basically, the possibility exists that the collectors will be built parallel or perpendicular to the known faults.

Tunnel excavation labors have the risk of cutting through a fault. The areas with these characteristics can be weak zones that may become unstable during construction. There are also zones with high contents of humidity and clay.

The fault location is shown in Annex SB1). It must be taken into account that these are surface expressions, and its projection to the collector depth depends on the inclination of the fault. In some consulted works, a width of 15 m to both sides of the fault trace is considered as fault zone.

WWTP Sites: Although evidence of fault was not observed that could affect the proposed construction area of the treatment plants, the possibility that the prolongation of some faults through the sites exists. In the WWTP area in Central Region, North Chinautla, there is a fault system oriented North-South. In South 3WWTP, a geomorphological expression of fault is located less than about 500 m which is associated to El Frutal Fault. In any case, these events will impact a very limited area, and the impact itself will be non-significant, because the environmental consequences are negligible.

b) Landslides

Many landslides can be observed at the City Valley. Most of these landslides were generated by the 1976 earthquake and had less relation with landslides occurred previously. A favorable aspect is the presence of horizontal to subhorizontal stratification of the lythological sequence. This disposal is the most known stratification form. In general, it is observed that the risk of occurrence of a landslide is minor at the South Valley. The North

could be affected by this phenomena too.

Main Collectors: The risk during the construction stage is represented by a landslide possibility, which can occur at collector sites located in high risk areas. Relating the trace with the distance to the slope zones which are closer, and the reported landslides of the Guatemala Valley, it is considered that there exists an acceptable distance, that, together with the free surface above the collectors, that will minimize the risk. The impacts of landslides during construction of collectors have a high human cost. Only proper emergency plans can help minimize the negative impacts.

WWTP Sites: Nearby areas of the proposed sites (for the construction of two plants) were observed with a likeness to moderate landslides. Near these sites, the side slopes are unpronunciated and show a minor dip of side slopes, where landslides occurs. The major risk exists in the plant located at the Central Region. The impact will be temporal but significant, if landslides do occur and damage the construction of the plant.

c) Groundwater

Main Collectors: According to the depth of collectors, there is a risk to go through a ground water saturated zone, with the corresponding problems that it would generate during the construction phase. The depth of freatic levels exclude the possibility that the collectors may pass through the saturated zones.

WWTP Sites: It is estimated that the freatic levels in the area of the plants are approximately within 10 m below the existing ground level.

S5.3.2 Operation Stage

a) Seismic Characteristics

The Valley of Guatemala City is a zone frequently affected by earthquakes. According to this, the major activation risk occurs North-South, direction that present the majority of failure traces was obtained.

The risk can represent a high level of environmental impact by the operation of the collectors, because a failure in collectors could represent groundwater pollution. Special attention require the operation of collectors located near deep wells (Location of deep wells are shown in Annex SB1).

b) Landslides

A phenomenon like this can occur in the WWTP sites, especially if, during the construction, natural slope of the surrounding hills are affected by cut and fill operation. The major risk is in the Central Region WWTP. The impact will be temporal and significant, if a plant stops operations.

S5.4 IMPACT PREDICTION

S5.4.1 Pollutant Load

Table S-9 shows the pollutant load generated and reduced at the WWTP for the year 2002. Major positive impacts of the project will be improvement of living environment in the sewer served area and elimination of raw wastewater discharges to rivers. Since, rivers replenish groundwater, pollution of groundwater will be reduced.

Table S-9 Estimated Pollutant Load Generation and Reduction (year 2002)

Item	Central Region	South 3 Region
Pollutant load generated, kg BOD/d	55,200	11,600
Pollutant Load to WWTP and Sanitation Facility, kg BOD/d	47,230	3,760
Served Area, ha	4,605	896
Pollutant load removed, kg BOD/d	30,700	3010

Note: Pollutant loads are estimated for the year 2002 and are approximated to the nearest tenth.

Source : Study Team

Improvement of water quality in the river sections where raw wastewater discharges will be eliminated are difficult to express quantitatively as neither river flow records nor sufficient water quality data are available. Water quality surveys conducted in this Study can be used with future monitoring for evaluating the impacts.

S5.4.2 Water Balance

a) Lake Amatitlan

The balance estimated herein must be taken as a general idea, and not as an accurate value, because the available data is limited, and it does not cover all the different aspects involved to prepare the balance inside the project area.

The methodology used was as follows: From the data collected, an average water discharge rate in the entrance to the lake and in its exit were calculated, during a year, on a monthly basis.

The same method was used to estimate the rainfall, using the data collected. Rainfall, in mm, was transformed in cubic meters, using the area of the lake (15.35 km^2).

The evaporation (70% of the rainfall) and infiltration rates are also assumed.

The inflows are summed up. They are:

- surface water inflow (Villalobos River, Data of 1976 measured at El Cementario)
- precipitation (annual average, 1951 ~ 1980)
- groundwater (assumed to be 24% of Storage Volume)

Similarly, the outflows are also summed up. They are

- controlled overflow (Michatoya River, Data for 1953~1994)
- evaporation (70% of precipitation)

With this data, the deficit or excess of water in the lake was calculated in cubic meters, for the different months, and also as an annual average.

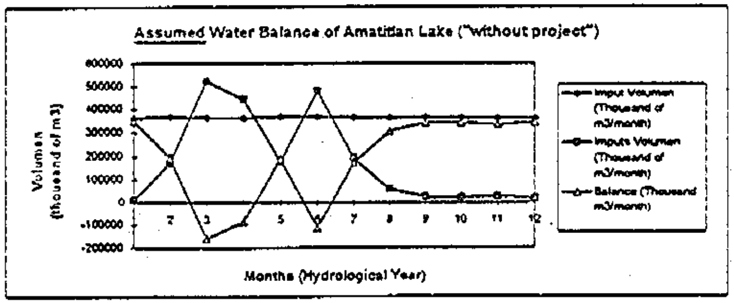
According to the available data, the results from the South 3 Region and Lake Amatitlan are summarized in Fig. S-17.

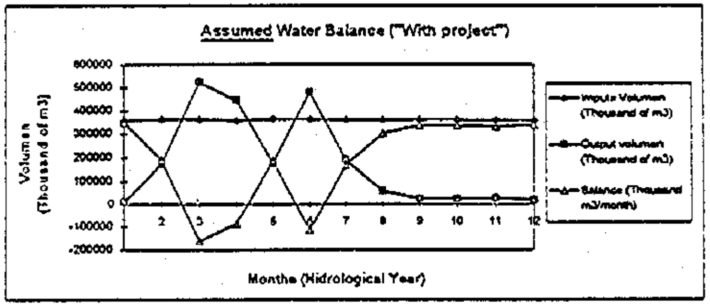
Fig. S - 17

SOUTH 3 REGION

Q=m3/s

Place / Item / Month	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	ANNUAL
Amatitlan out, Estacion Compuertas, Avg. Q (1953-94)	3,39	3,36	2,80	2,84	3,36	3,24	2,59	2,47	2,52	2,81	3,49	3,56	3,03
Getting out Volume by month	9080	172519	522784	444258	175488	478183	188133	54778	20714	20020	25306	16630	
Lake entrance, Villalobos River, Est. Cam. Avg. Q.	0,639	2,299	1,884	0,65	1,829	0,804	0,278	0,099	0,095	0,097	0,059	0,14	0,75
Income Volume by month	1711	118042	348030	101679	96626	132855	20048	2196	781	691	429	664	
Balance (e-s) m3/s	-2,751	-1,061	-0,946	-2,19	-1,531	-2,336	-2,314	-2,371	-2,425	-2,713	-3,431	-3,41	-2,29
days in the month	31	30	31	31	30	31	30	31	31	28	31	30	
precipitation	0,0036	0,0046	0,0059	0,0222	0,1501	0,2572	0,2063	0,1733	0,2419	0,1481	0,0173	0,0048	1,243.30
Storage vol. in thousands of m3 of rain 1080	56	71	91	341	2304	3848	3151	2680	3713	2273	266	75	
Storage vol. in thousands of m3 of flow 65.4	1711	5958	5046	1741	4741	2421	715	265	254	235	158	363	
Storaged base volume.	296000	296000	296000	296000	296000	296000	296000	296000	296000	296000	296000	296000	
Storage volume subtotal	297767	292030	291137	298082	293045	292269	299867	298925	299968	298508	296424	296438	
Assumed Groundwater adds	71942	73007	72784	72020	73261	73092	72467	72231	72492	72127	71606	71610	
Assumed Groundwater adds (24 % stot) with project	69064	70067	69873	69140	70331	70169	69568	69342	69592	69242	68742	68745	
Assumed evaporation (70% month) over the rain	39	49	63	239	1613	2764	2206	1862	2599	1591	186	53	
total inputs without project.	369709	365037	363921	360102	366306	365442	362330	361157	362460	360636	368029	358046	
total inputs with project.	366831	362117	361009	367221	363376	362538	359436	364267	359580	357750	365185	355183	
total outputs with project	9118	172568	522947	444498	177102	478926	190339	56840	23314	21811	25674	16892	
total outputs without project	9118	172568	522947	444498	177102	478926	190339	56840	23314	21811	25674	16892	
Assumed Water balance with project	360590	192469	-158926	-84396	189204	-113465	171996	304517	339146	339024	332466	341166	
Assumed Water balance without project	347712	189648	-161838	-87276	186274	-116388	168934	301626	336246	334128	329681	338341	





THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE WATER BALANCE OF LAKE AMATITLAN

S6 EVALUATION OF ALTERNATIVES

S6.1 PROPOSED PROJECT SUMMARY (SOUTH 3 REGION)

In the preceding sections, both Central Region and South 3 Region are evaluated. First Stage Project is proposed for South 3 Region and the discussion hereafter will be made only for that Region. Table S-10 shows the summary of the First Stage Project (note that the Sanitation Systems are not included in the First Stage Project, compared Table S-1).

S6.2 PROPOSED PROJECT VERSUS NO ACTION

An EIA has to consider an analysis of alternatives as part of the study. According to the Guidelines of World Bank, the alternatives have to be at least the proposed project and the no action alternative.

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 S-11 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 S-10 Summary of First Stage Project

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/rivers 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 the 77,300 people who will be connected to sewerage system at the commencement of WWTP (year 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
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 S-2 and Fig. S-4b)) b) WWTP Area about 30ha WWTP 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)
Collection Method	Separate-sewer System
Wastewater Treatment Plant (WWTP)	a) Treatment Process High-rate trickling filter with intermediate clarifier (see Fig. S-7) 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

Source : Study Team

Table S-11 Comparison of Proposed Project Versus No Action

Item	With Project	No Action
1. Sewerage service with treatment	- 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.	- 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	- Employment opportunities in construction sector	- No opportunity. - Strain on existing infrastructure.
3. Operation and Management of WWTP	- New employment opportunities and acquiring of WWTP operation skills, which are essential for sewerage development in Guatemala - Slight impairment of living environment around WWTP	- No opportunity and no skills. - No impairment.

Source : Study Team

S7 MITIGATION AND COMPENSATION

S7.1 DESCRIPTION OF MITIGATION AND COMPENSATION MEASURES

This chapter gives an evaluation of the proposed project, so one can decide how feasible is the project, from an environmental point of view. Table S-12 shows the significant impacts described in Section S5 and the proposed mitigation and compensation measures. Fig. S-18 shows the major environmental aspects of the proposed project.

Mitigation measures proposed are described below for each stages.

S7.1.1 Pre-construction Stage

1-1.1 Failure in Land Procurement

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

1-2.1 Public Opposition due to Bad Public Relations

Role of sewerage be explained to the public. Proper operation should be pledged. It will be necessary to inform the population of the type of activity and the benefits that this type of project has, and also give the population an incentive to participate in the different stages of the project. This procedure should be done in every place where a sanitation system is going to be implemented. Public should be informed of the project's progress.

S7.1.2 Construction Stage

2-1.1 Wash-away of Excavated Material

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.

The soil surplus should be disposed in a suitable place from the environmental point of view. Two alternatives, namely the Solidwaste Landfill of the Municipality of Guatemala, are proposed to dispose the surplus soil; for each one, suggested procedure is described for consideration :

Table S-12 Summary of Significant Environmental Impacts Mitigation/ Compensation Measures (1/2)

Project Activity	Impact Description	Category	Impact	Action
a) Pre-construction Stage (immediate impacts)				
1-1 Land Procurement for WWTP	1-1.1 Failure in procurement	Social	Serious	Ensure procurement.
1-2 Public Relations	1-2.1 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	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 WWTP 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 WWTP 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.

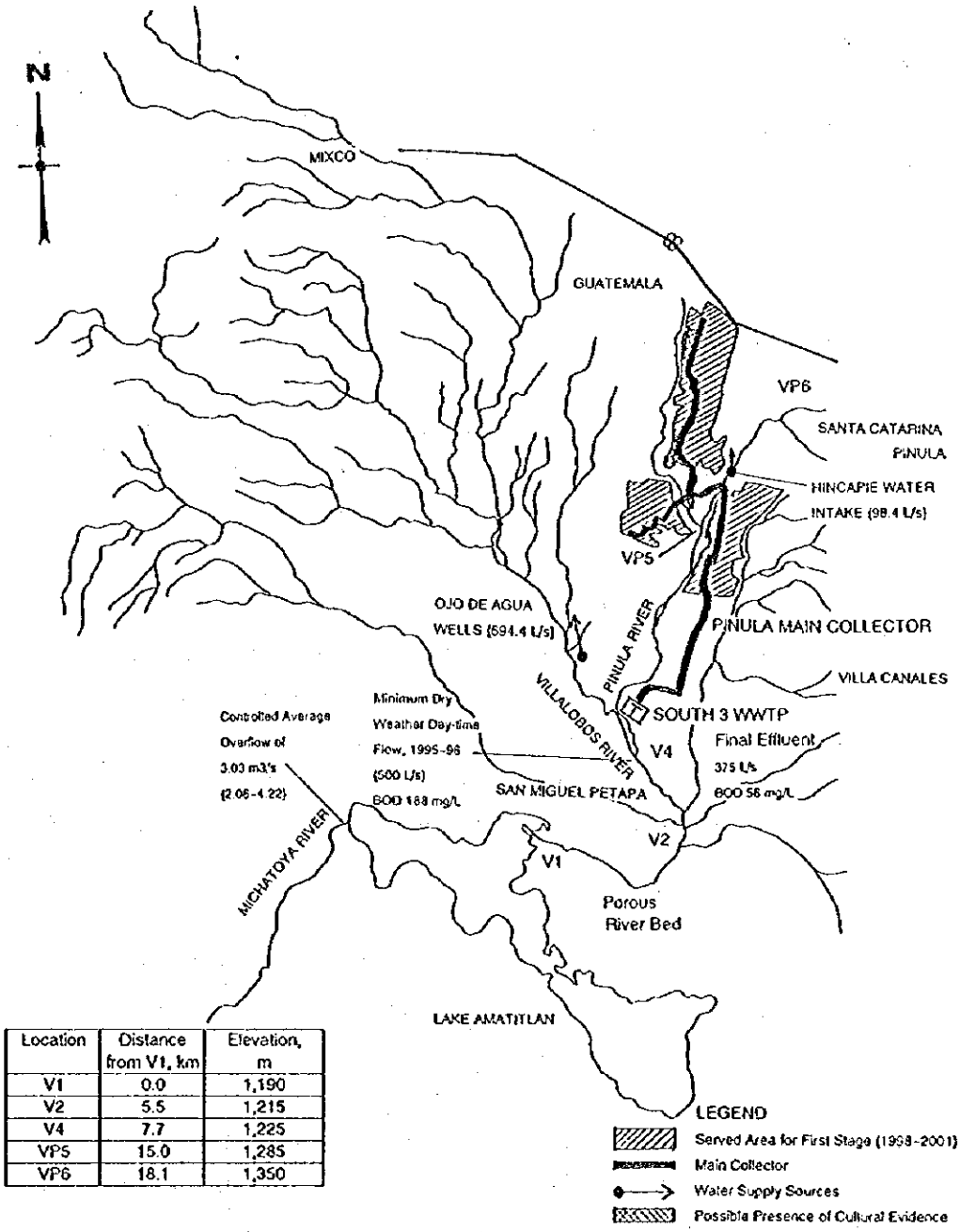
Note : Impact are classified as Serious, Moderate and Minorof which only serious impact will endanger the Project implementation or its sustainability.
Source : Study Team

Table S-12 Summary of Significant Environmental Impacts and Mitigation/Compensation Measures (2/2)

Project Activity	Impact Description	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 lacking for implementation.	Physical	Serious	Revise laws and regulations
3-2 WWTP Discharge to Receiving Water	3-2.1 New point source from WWTP	Physical	Positive	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 sewage works	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

Fig. S - 18



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

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Solidwaste Landfill of the Municipality of Guatemala : If the alternative of the disposal of wastes permanently at the sanitary landfill is feasible, the management of this should be by earth work, as described in the following paragraph. The contribution of these materials will help to minimize substantially the adverse impact of bad management of solid waste disposal in the city.

A base for deposit should be constructed with rocks of 5 cm size to a minimum thickness of 15 cm. Over this, a layer with small rocks of size 2 cm and a minimum thickness of 6 cm should be built. Surplus soil can be disposed on top of a base like this. Operationally, it is recommended that the bank does not exceed 1.5 m height.

The previous recommendations are based on local experience and the local deficiencies that the operation has in such work.

South 3 WWTP : Part of the surplus soil, especially excavation of tunnels near South 3 WWTP, can be disposed within the South 3 WWTP site in the area for future facilities.

2-1.2 Possibility of Finding Historical Evidences

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 / History and Anthropology Institute (IDAEH) 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.

2-1.3 Noise, Dust and Accidents During Transportation

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

An adequate signaling in the construction area and potential areas of danger will be required, and an adequate information system must be implemented in areas where the excavation process needs machinery and use of explosives, to prevent accidents.

2-2.1 Muddy Water and Silting of Pinula River

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

2-2.2 Disturbance to Vegetation in WWTP Site

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

2-3.1 Strain on Infrastructure due to Labor Influx

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

EMPAGUA shall ensure that the contractor must provide their workers with, at least, one portable water closet in every work front. The number of portable water closet should be according to the number of workers, also taking into account the maintenance periods. Solid waste will be generated by workers. In the same way, every work front should have a special place to dispose the wastes.

S7.1.3 Operation Stage

3-1.1 Legal Authority for Eliminating Raw Wastewater Discharges

Major project benefits namely the improvement of living environment and elimination of raw wastewater discharge to the environment is based on the precondition that the household etc. in the served area are connected to the sewerage system. This requires that revisions/additions to the legal authority of EMPAGUA for providing sewerage service in the project area. Necessary laws shall be enacted.

3-2.1 WWTP Discharge (new point source)

Existing dry weather flow (day-time) of Villalobos River near the downstream of the confluence with Pinula River is about 500 L/s (Fig. S-18). 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.

3-2.2 Erosion of River Bed / Bank by WWTP Discharge

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 river bank beds. Erosion of river borders can be prevented by vegetation .

3-3.1 Fly and Odor Problems due to WWTP

Operating personnel should be educated thoroughly on the treatment principles and operating procedures. Responsible person shall ensure that the procedures are strictly adhered to.

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.

To mitigate the possible adverse effect that odors might have, a live barrier of trees and shrubs around the WWTP is recommended. The trees must be able to grow around 5 and 10 m high, and the shrubs at least 1.5 m high. The trees must be planted in two rows with a distance between rows of 5 m, and the shrubs must be planted in the middle. The foliage must be dense, for both.

It is to be noted that from the samplings carried out, it could be seen that the areas nearby the South 3 Region already have a significant insect population, particularly house flies. In some areas, in which chicken farms are located nearby, the fly population increased significantly compared to other areas. The area where the treatment plant may be built does not have fly population. Because of this, in case the insect population is increased due to bad management of the treatment plant, it would not affect significantly the surrounding's situation, particularly because physical barriers exist, which help to stop the proliferation of these insects.

3-4.1 Contamination of Soil and Water by Contaminated Sludge

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.

3-5.1 Failure of Slopes

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

3-6.1 Failure of Sewerage System due to Earthquake

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

3-7.1 Public Opposition

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.

S7.2 MITIGATION MANAGEMENT

As shown in Fig. S-1 in Section S1, 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 S-13 shows the mitigation measures to be taken at each stage showing the organization responsible for it.

Table S-13 Mitigation Management

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

Source : Study Team

S8 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.

S9 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.

ANNEXES

SA PHOTOS

- SA1 - SA9 LOCALIZATION
- SA10-SA13 FLOWMEASURES AND SAMPLES
- SA14-SA18 ENVIRONMENTAL DESCRIPTION
- SA19-SA21 SOCIAL ASPECTS

SB DRAWINGS

- SB1 SEISMIC FAULTS AND LANDSLIDES
- SB2 WATER WELLS AND FREATIC LEVELS
- SB3 ARCHEOLOGICAL SITES

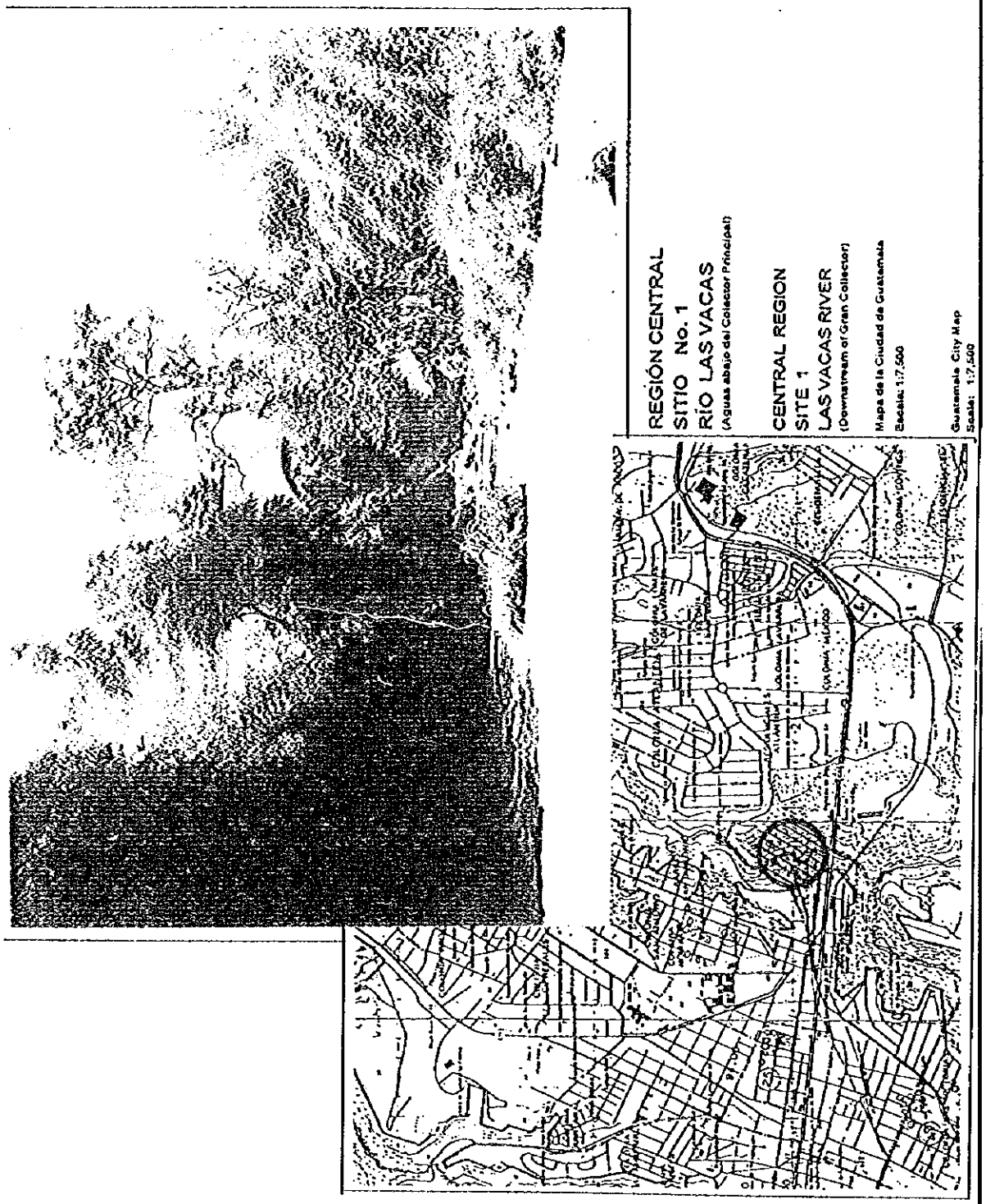
SC RESULTS OF FIELD SURVEYS

- SC1 ODOR TEST ON CENTRAL AND SOUTH 3 REGIONS
- SC2 INSECTS TESTS ON CENTRAL AND SOUTH 3 REGIONS
- SC3 SUMMARY OF SOCIAL QUESTIONNAIRE

SD METHODOLOGY FOR FIELD SURVEYS

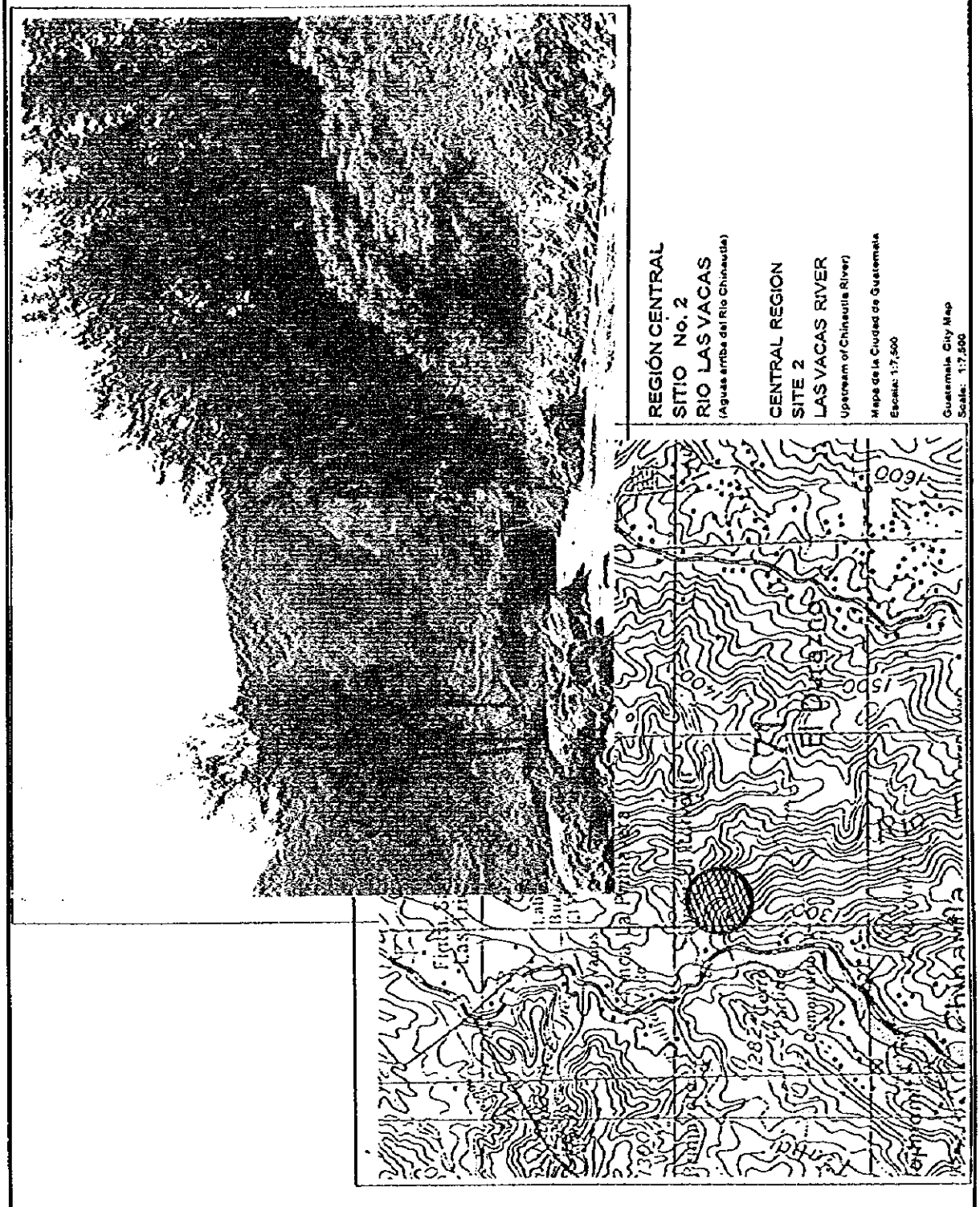
SE TERMS OF REFERENCE FOR EIA

Fig. SA - 1



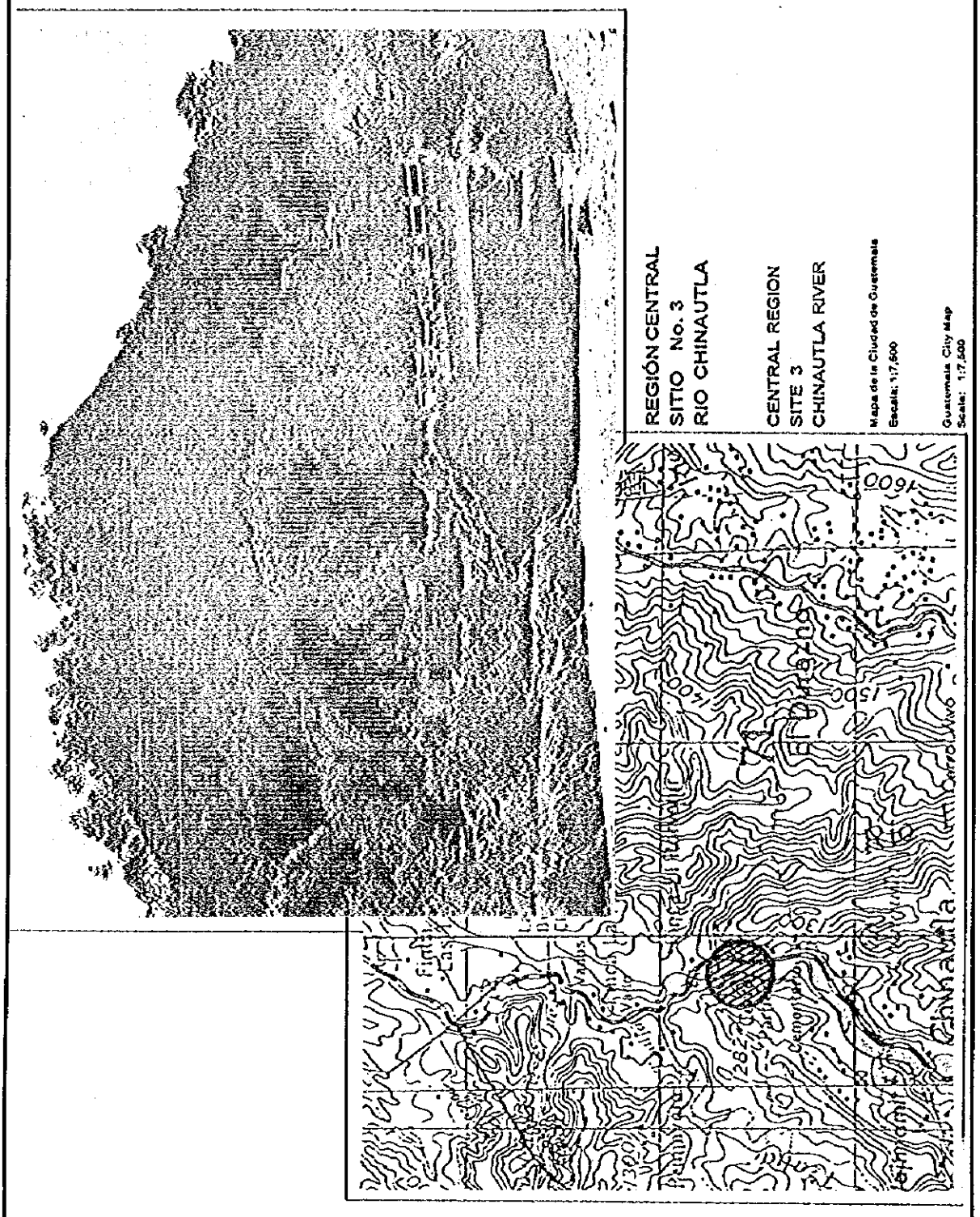
THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LOCATION OF WATER QUALITY SURVEY : LAS VACAS RIVER -DOWNSTREAM OF GRAN COLLECTOR

Fig. SA - 2



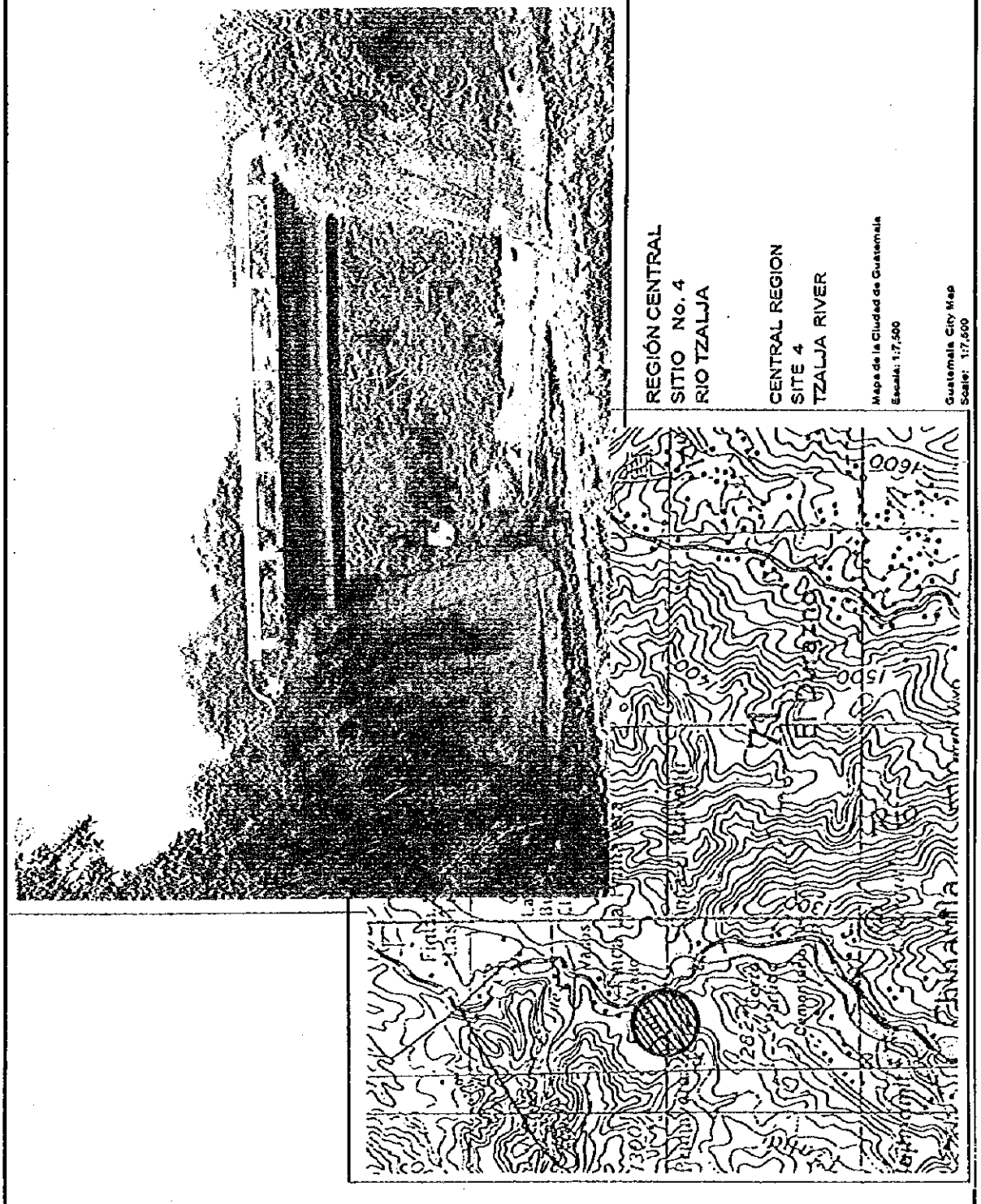
THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LOCATION OF WATER QUALITY SURVEY : LAS VACAS RIVER -UPSTREAM OF CHINAUTLA RIVER CONFLUENCE

Fig. SA - 3



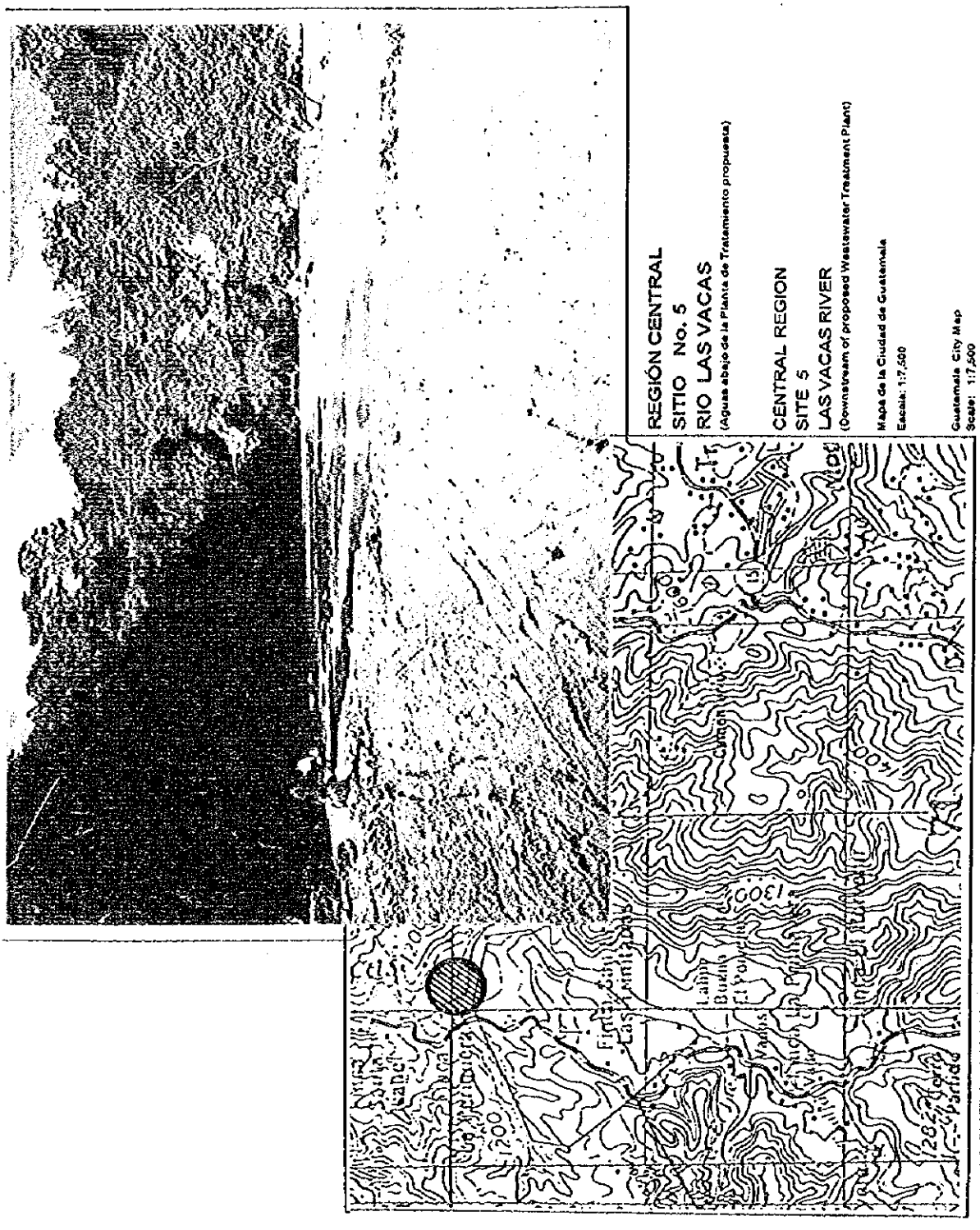
THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LOCATION OF WATER QUALITY SURVEY : CHINAUTLA RIVER

Fig. SA - 4



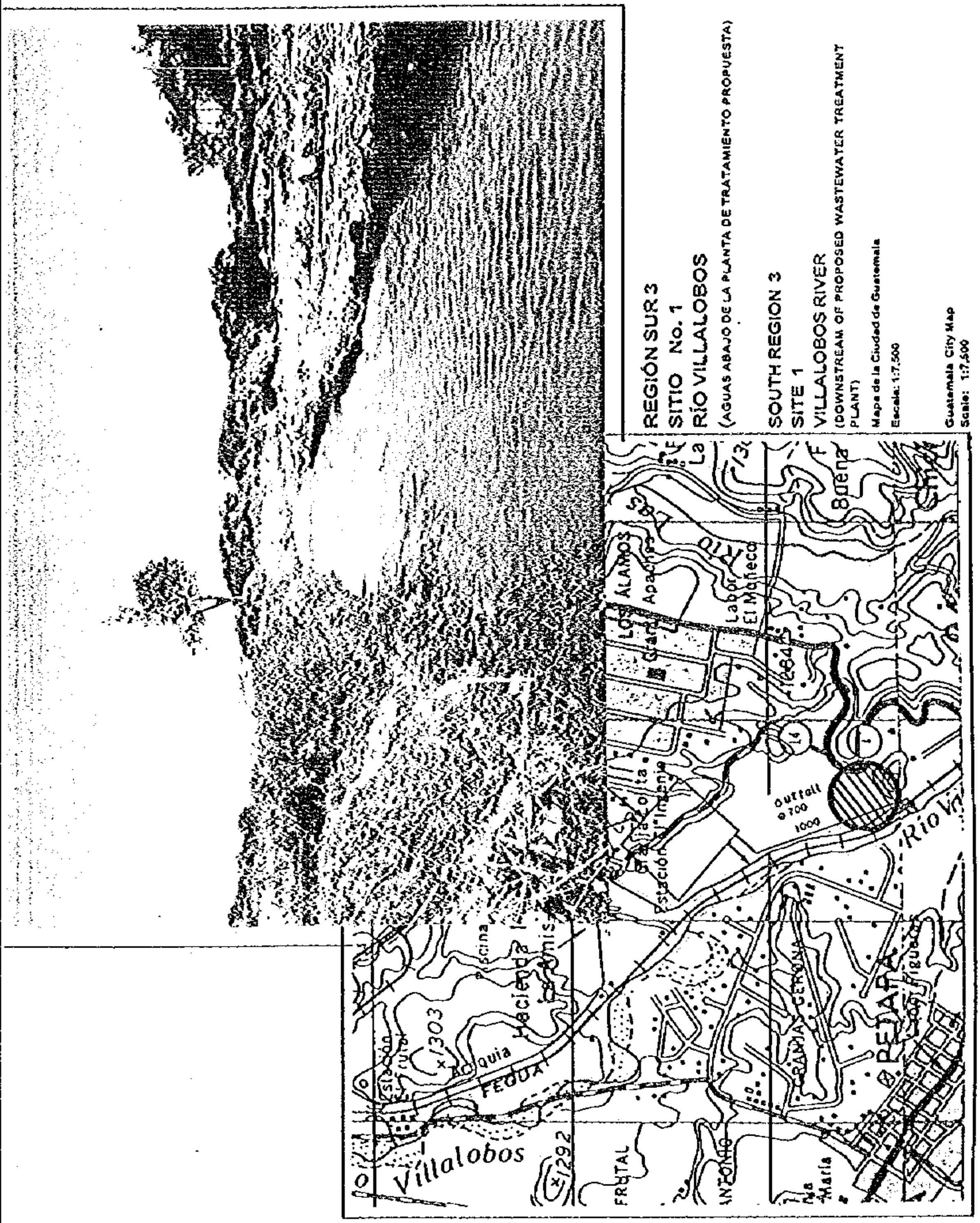
THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LOCATION OF WATER QUALITY SURVEY : TZALJA RIVER

Fig. SA - 5



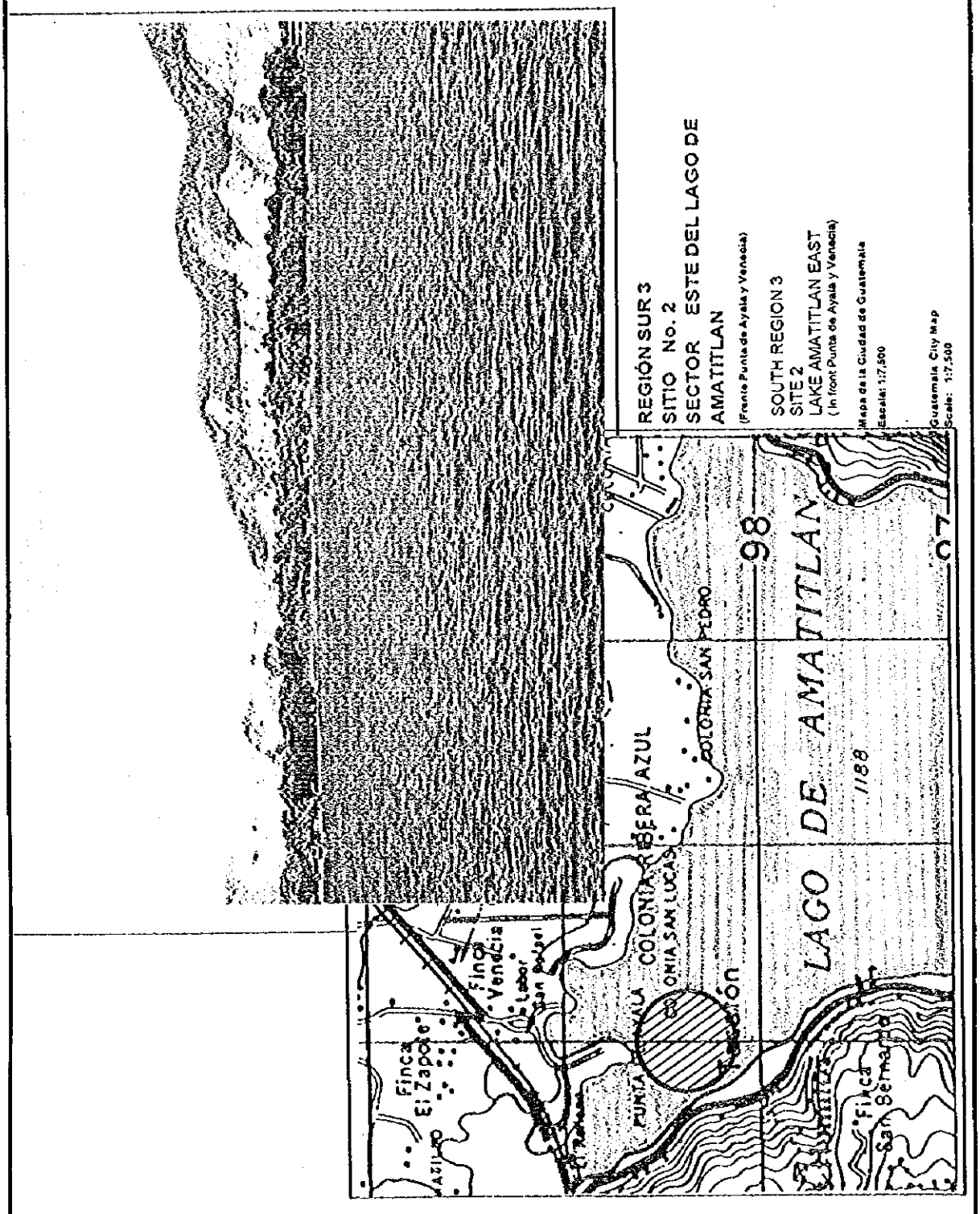
THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LOCATION OF WATER QUALITY SURVEY : LAS VACAS RIVER-DOWNSTREAM OF PROPOSED WWTP

Fig. SA - 6



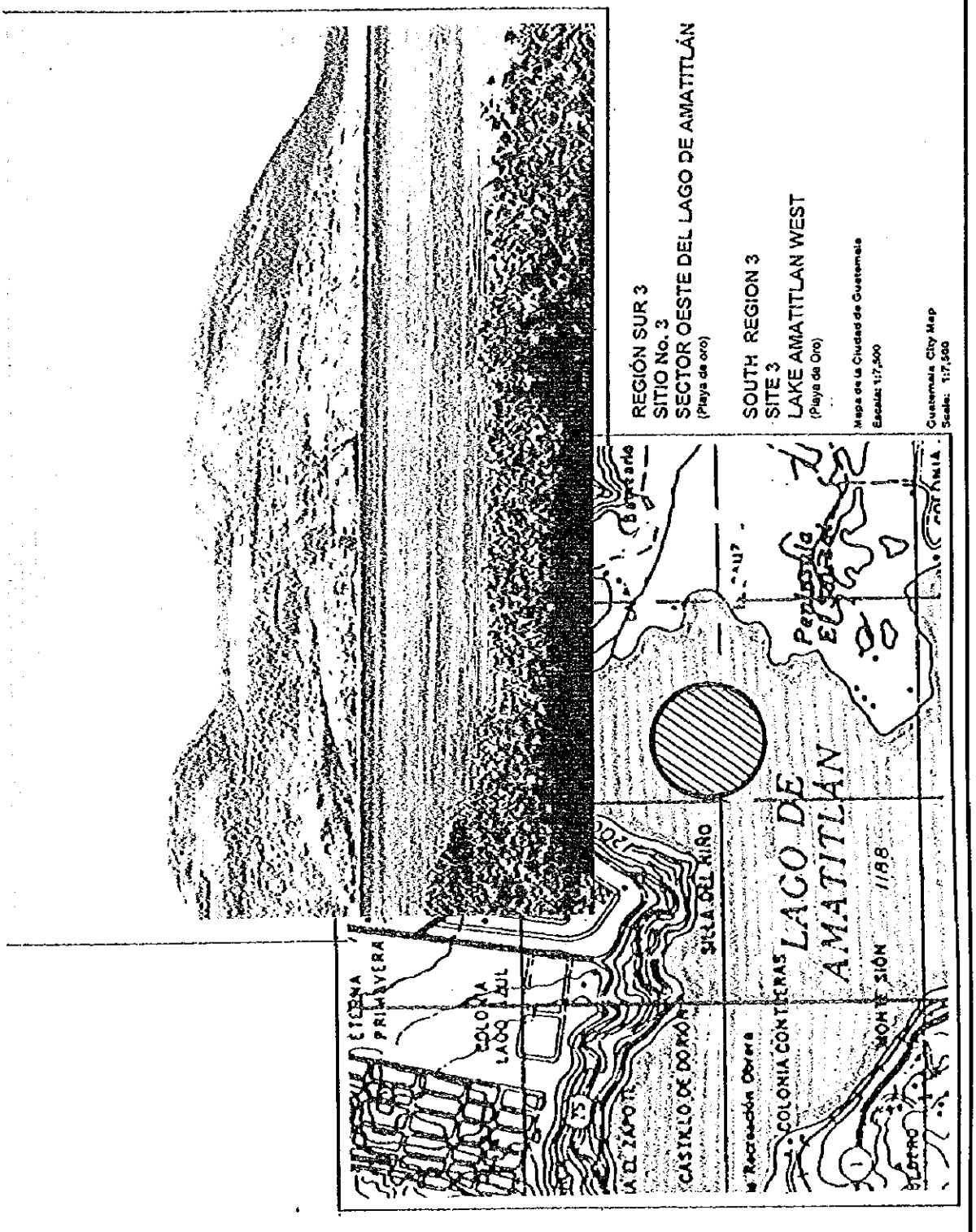
THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LOCATION OF WATER QUALITY SURVEY : VILLALOBOS RIVER DOWNSTREAM OF PROPOSED WWTP

Fig. SA - 7



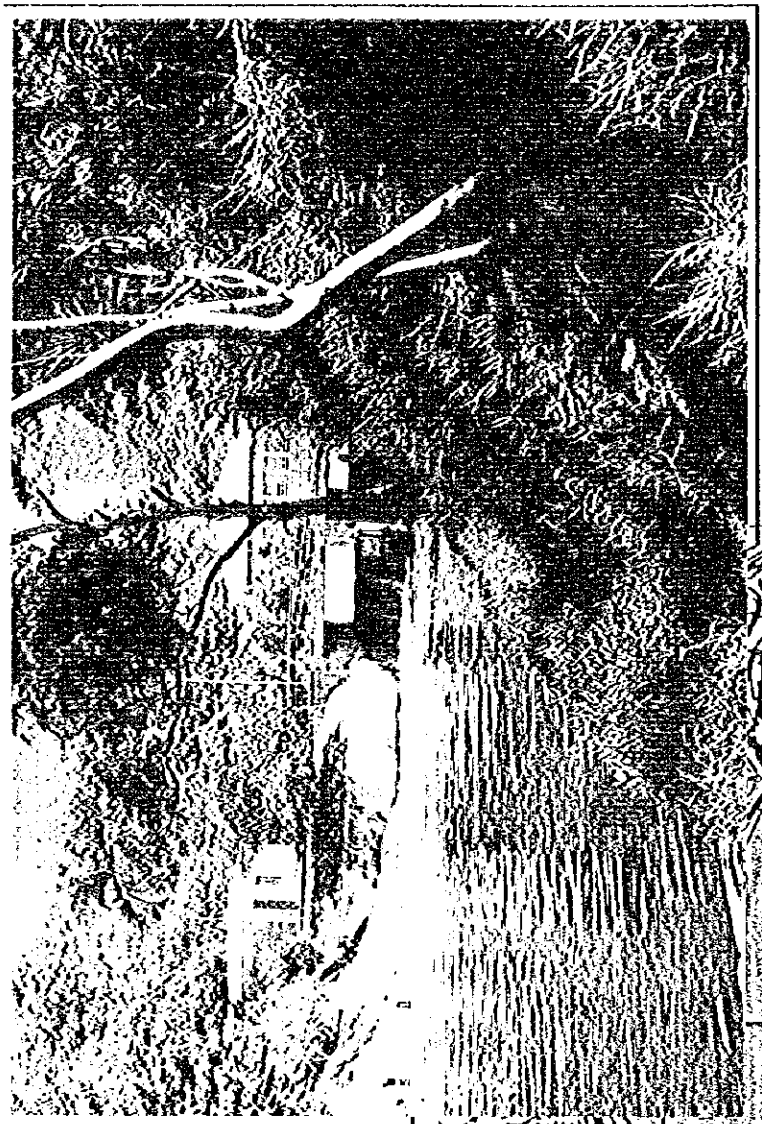
THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LOCATION OF WATER QUALITY SURVEY : LAKE AMATITLAN EAST (FRENTE PUNTA DE AYALA Y VENECIA)

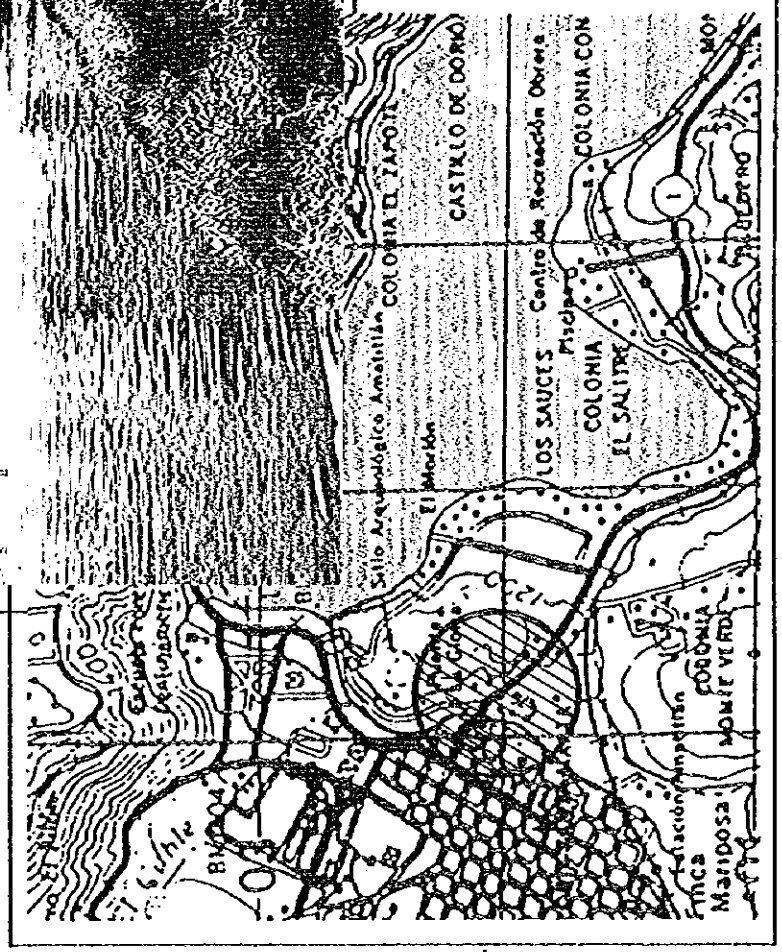
Fig. SA - 8



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LOCATION OF WATER QUALITY SURVEY : LAKE AMATITLAN WEST (PLAYA DE ORO)

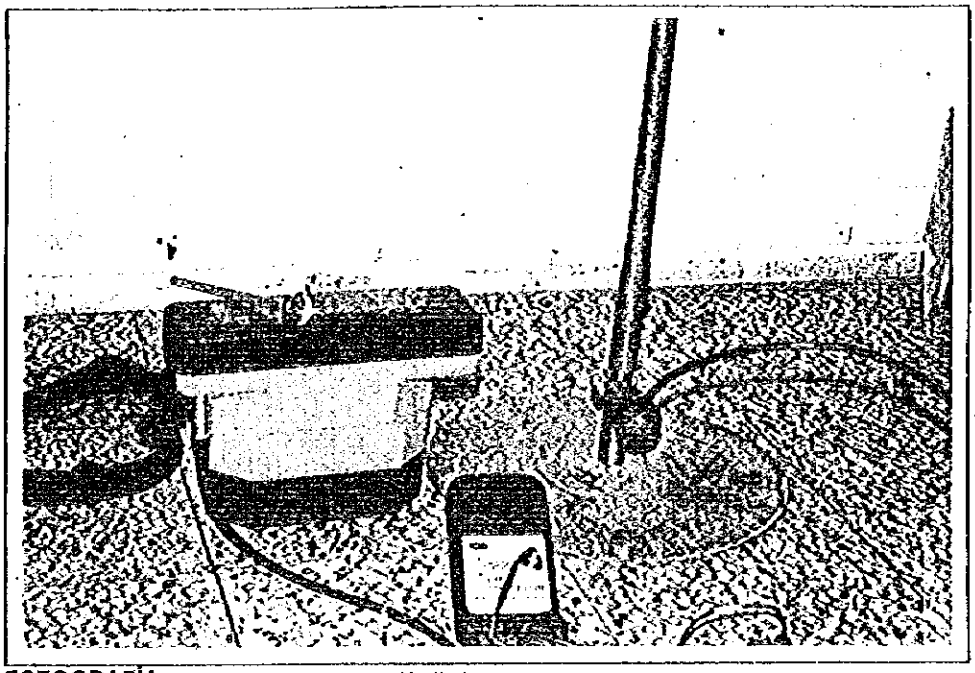
Fig. SA - 9





THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE LOCATION OF WATER QUALITY SURVEY : MICHATOYA RIVER (EXIT OF LAKE AMATITLAN)

Fig. SA - 10



FOTOGRAFÍA (Arriba)

Componentes utilizados para el aforo por vadeo, medición de la temperatura y determinación de Ph in situ.

PHOTO (Above)

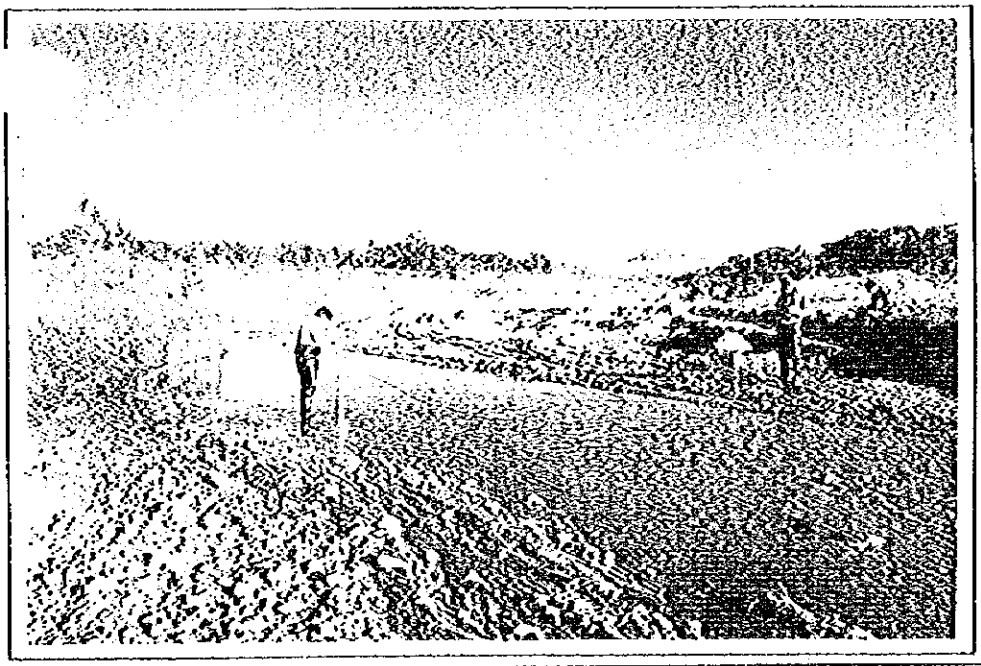
The components used por the wade gauging, temporature measurement and determination of Ph "in situ".

FOTOGRAFÍA (abajo)

Rio Villalobos a pocos metros aguas arriba de la confluencia del Rio Pinula. Aforo por vadeo.

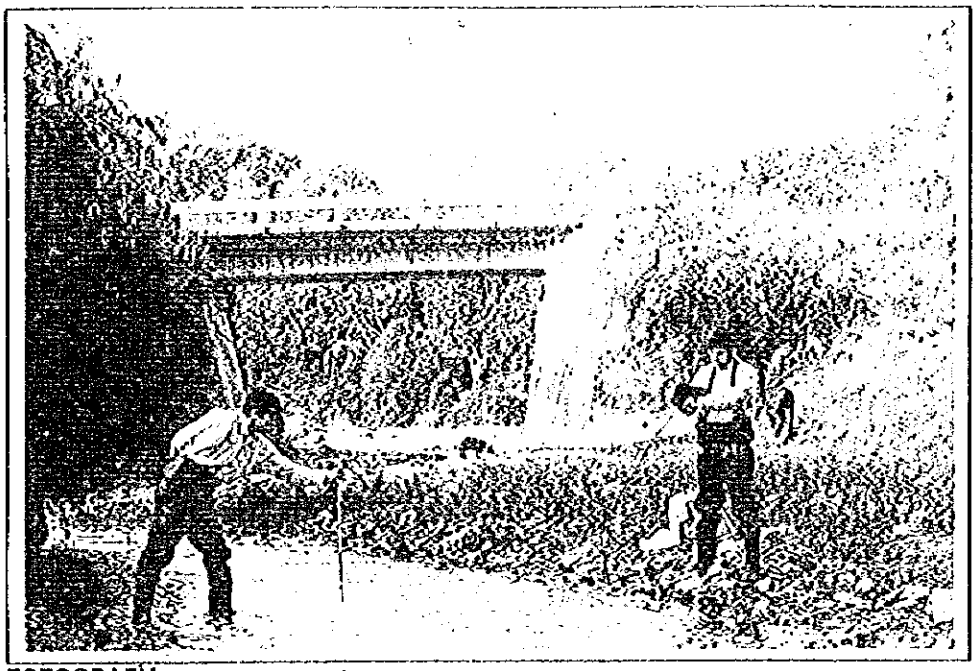
PHOTO (Below)

Villalobos River a few meters upstream of the Pinula River confluent. Wade gauging.



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE WATER QUALITY SURVEY (1/3)

Fig. SA - 11



FOTOGRAFÍA (Arriba)

Río Tzaljá aguas arriba de la confluencia con el río Las Vacas.

Aforo por vadeo.

PHOTO (Above)

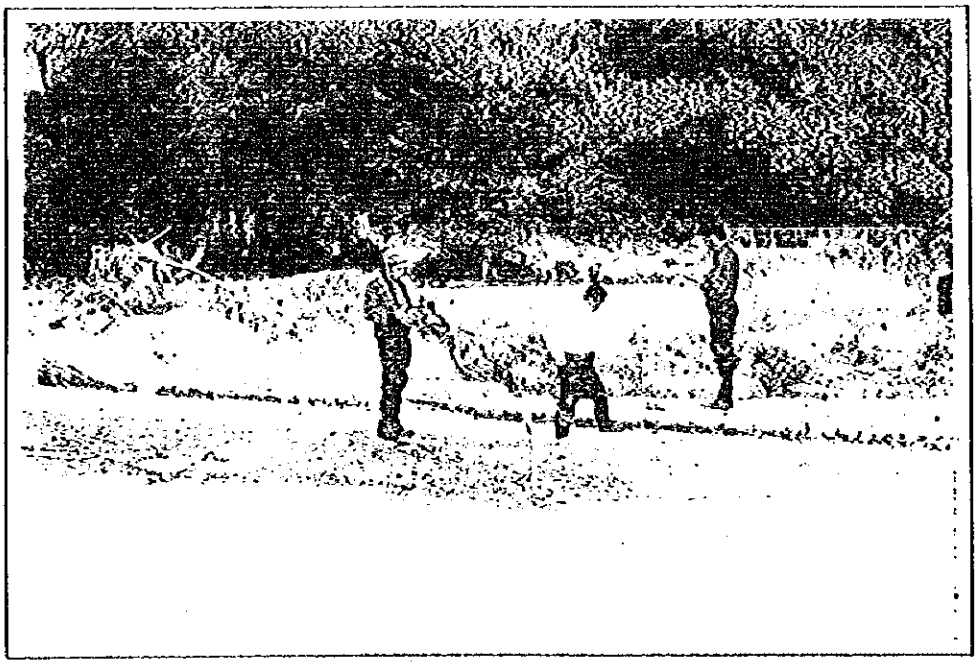
Tzaljá River Downstream with the confluent of Las Vacas River. Wade gauging.

FOTOGRAFÍA (abajo)

Río Las Vacas cerca del área de la futura Planta de Tratamiento de aguas residuales . Aforo por vadeo en uno de sus ramales.

PHOTO (Below)

Las Vacas River close to the area of future Wastewater Management Plant. Gauging in one of its branches.



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE WATER QUALITY SURVEY (2/3)

Fig. SA - 12

FOTOGRAFÍA (Arriba)

Río Las Vacas cerca del área de la futura Planta de Tratamiento de aguas residuales. Toma de muestra para laboratorio.

PHOTO (Above)

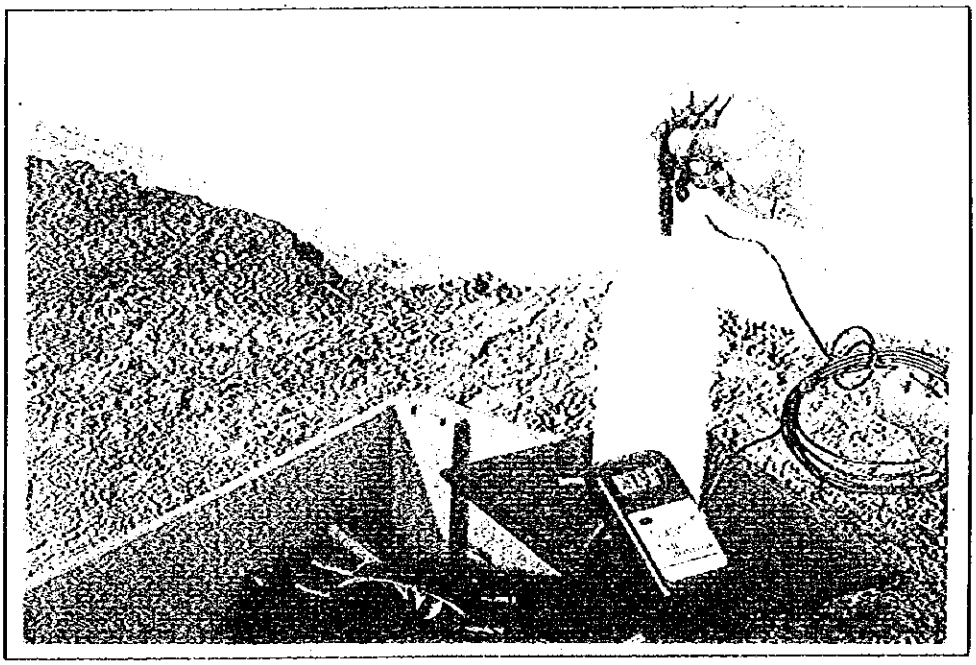
Las Vacas River close to the area of future Wastewater Management Plant. Laboratory sample was taken.

FOTOGRAFÍA (abajo)

Río Las Vacas cerca del área de la futura Planta de Tratamiento de aguas residuales. Determinación del Ph in situ.

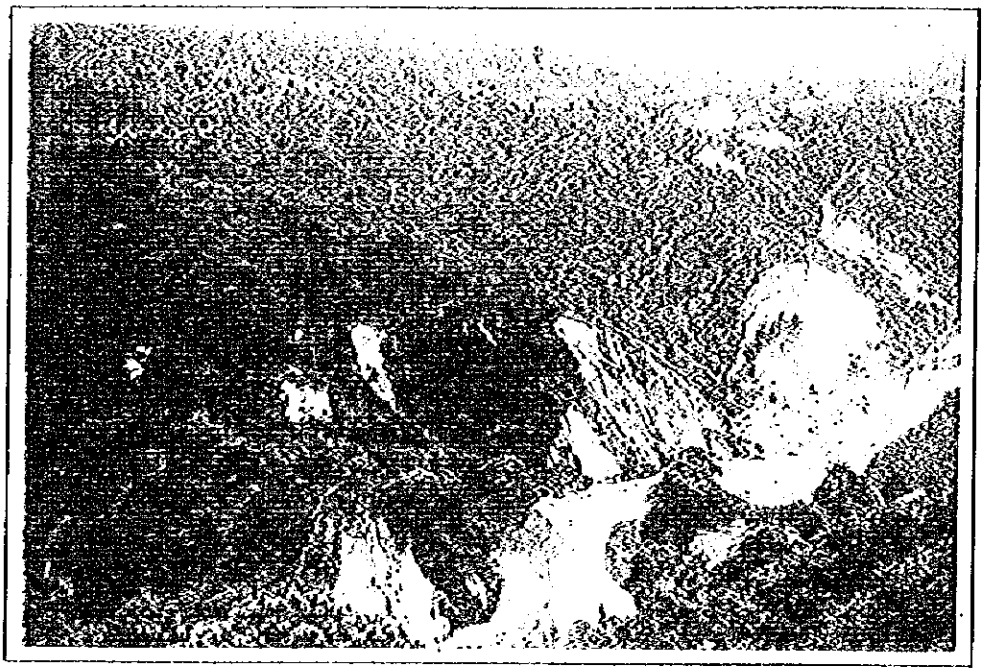
PHOTO (Below)

Las Vacas River close to the area of future Wastewater Management Plant Determintion of Ph "in situ".



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE WATER QUALITY SURVEY (3/3)

Fig. SA - 13



FOTOGRAFÍA (Arriba)

Vista parcial de los deslizamientos presentes en las proximidades del poblado de Chinautla.

PHOTO (Above)

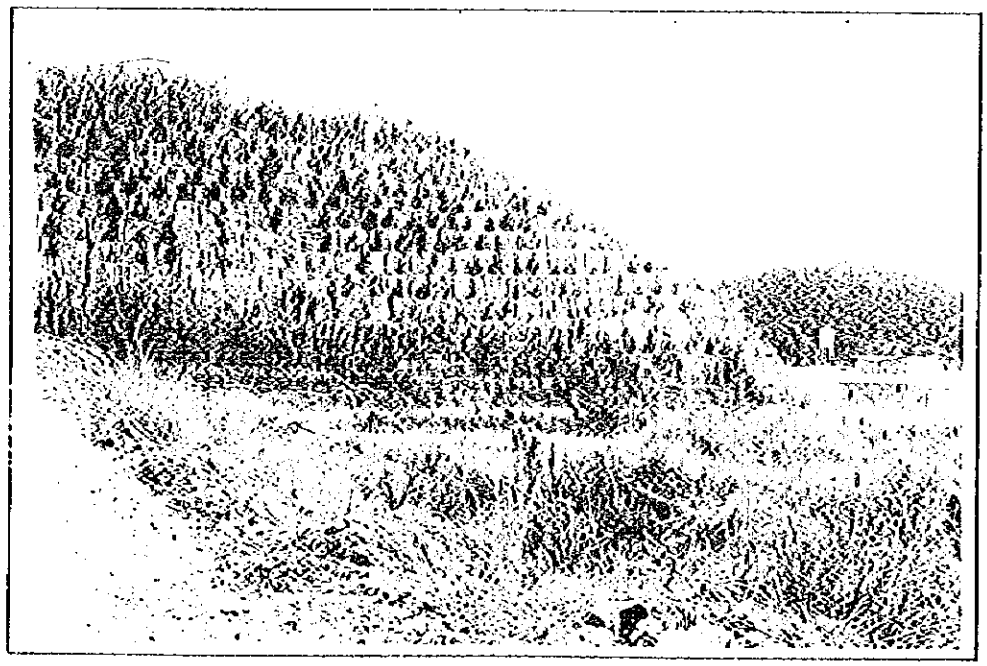
Partial view of landslides in the town of Chinautla

FOTOGRAFÍA (abajo)

Vista de un talud artificial con su tratamiento de terrazas escalonadas con barreras de vegetación. Ubicado en las cercanías del área de la Planta de Tratamiento de la Región Sur 3.
Se observa el tipo de erosión y la estabilidad de los taludes en este sector.

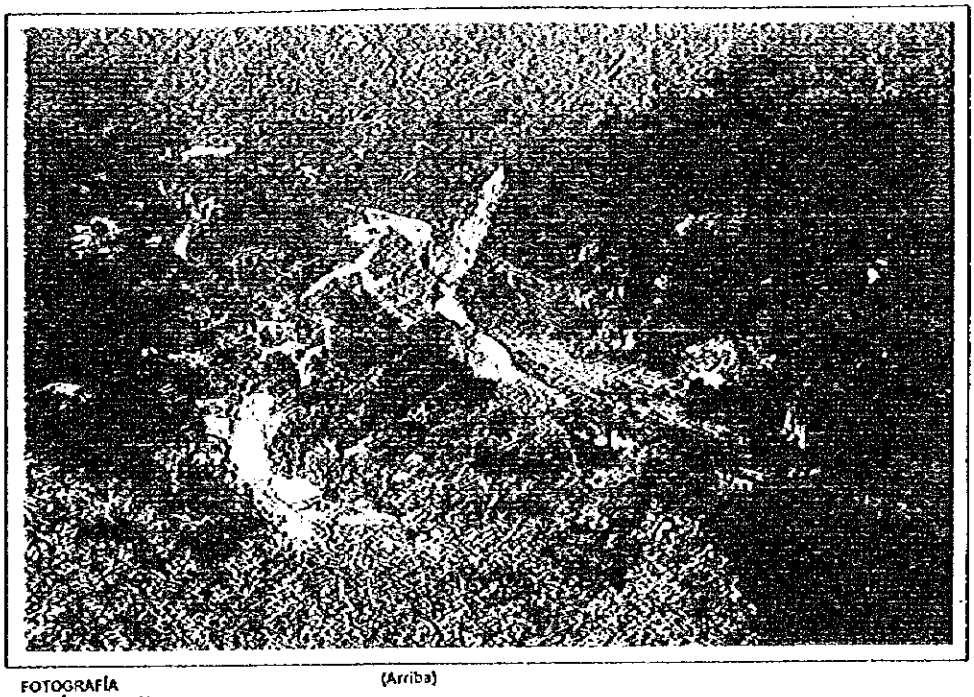
PHOTO (Below)

View of an artificial side slope with its stepped terrace and vegetation barriers. Located in the area close by the Wastewater Treatment Plant South Region 3.
Type and side slope stability is observed.



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE GEOLOGICAL COMPONENT NEAR PROPOSED WWTP SITES

Fig. SA - 14

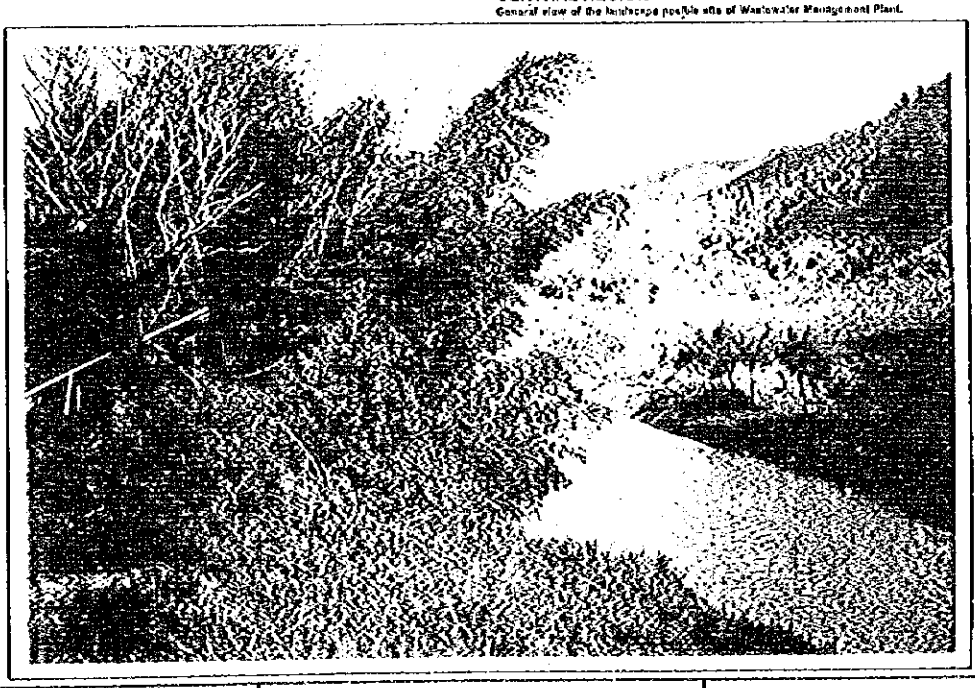


FOTOGRAFÍA (Arriba)
REGIÓN CENTRAL
Río Las Vacas, aguas arriba de la confluencia con el río Chinautla, distribución de viviendas en la región.

PHOTO (Above)
CENTRAL REGION
Las Vacas River, upstream of the Chinautla confluent. Panoramic view.

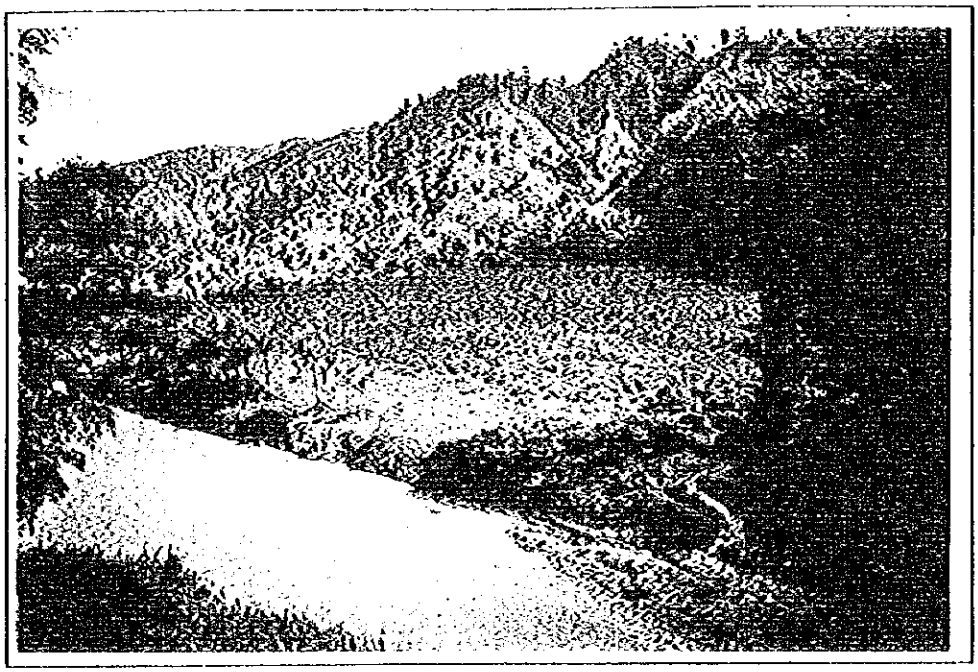
FOTOGRAFÍA (Abajo)
REGIÓN CENTRAL
Aspecto general del paisaje de uno de los posibles sitios de ubicación de la Planta de Tratamiento de aguas residuales.

PHOTO (Below)
CENTRAL REGION
General view of the landscape posible site of Wastewater Management Plant.



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE ENVIRONMENTAL DESCRIPTION NEAR PROPOSED WWTP SITES : CENTRAL REGION (1/3)

Fig. SA - 15



(Arriba)

FOTOGRAFÍA
REGIÓN CENTRAL
Aspecto general del paisaje de unos de los posibles sitios de ubicación de la Planta de Tratamiento de aguas residuales.
Obsérvese el tipo de vegetación y el proceso erosivo de las aguas del río por falta de protección arbórea, obsérvase también el grado de avance del proceso erosivo del suelo en las colinas, por la ausencia del bosque original del lugar.

PHOTO
CENTRAL REGION
General view of the landscape, possible site of Wastewater Management Plant. The type of vegetation and the erosion process caused by lack of vegetation cover at the riverside and hills can be observed.

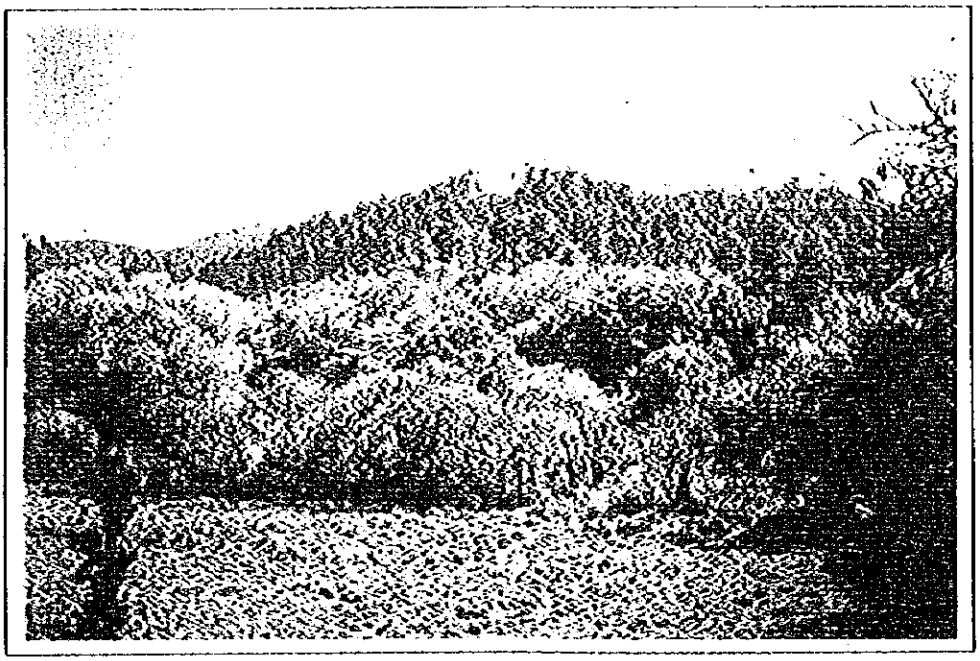
(Above)

FOTOGRAFÍA
REGIÓN CENTRAL
Aspecto general del paisaje de unos de los posibles sitios de ubicación de la Planta de Tratamiento de aguas residuales.

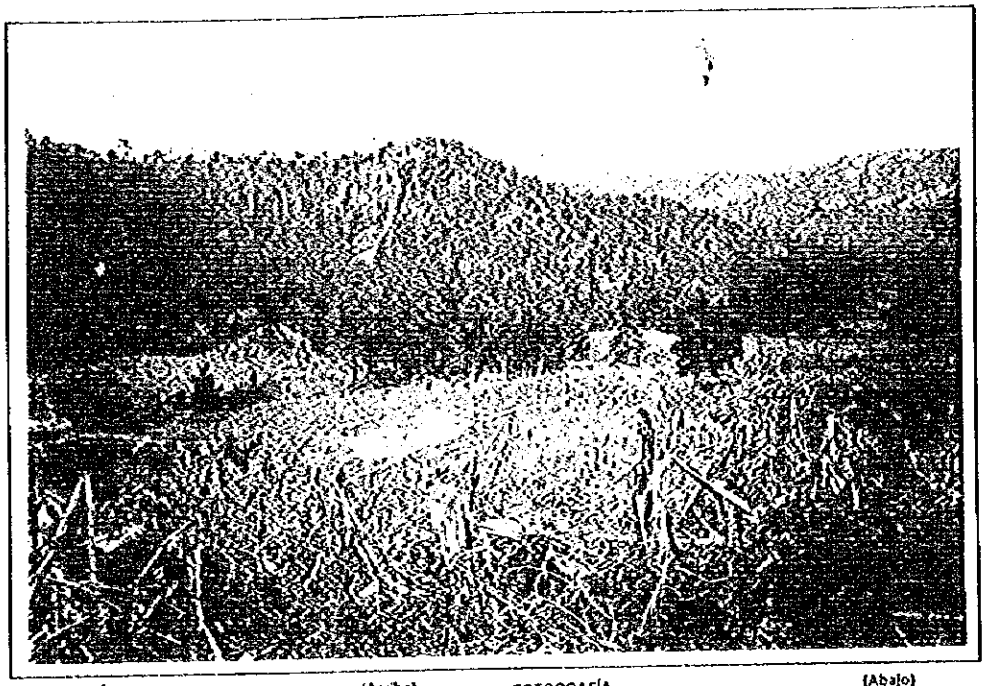
(Abajo)

PHOTO
CENTRAL REGION
General view of the landscape, possible site of Wastewater Management Plant.

(Below)



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE ENVIRONMENTAL DESCRIPTION NEAR PROPOSED WWTP SITES : CENTRAL REGION (2/3)

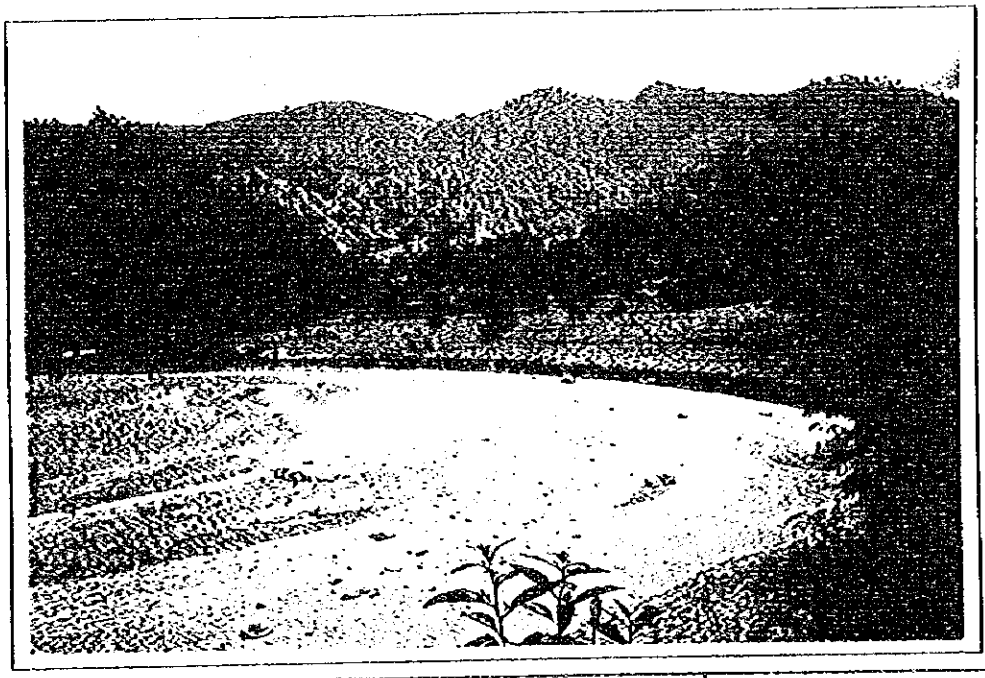


FOTOGRAFÍA (Arriba)
REGIÓN CENTRAL
Aspecto general del paisaje de unos de los posibles sitios de ubicación de la Planta de Tratamiento de aguas residuales.

PHOTO (Below)
CENTRAL REGION
General view of the landscape posible site of Wastewater Management Plant

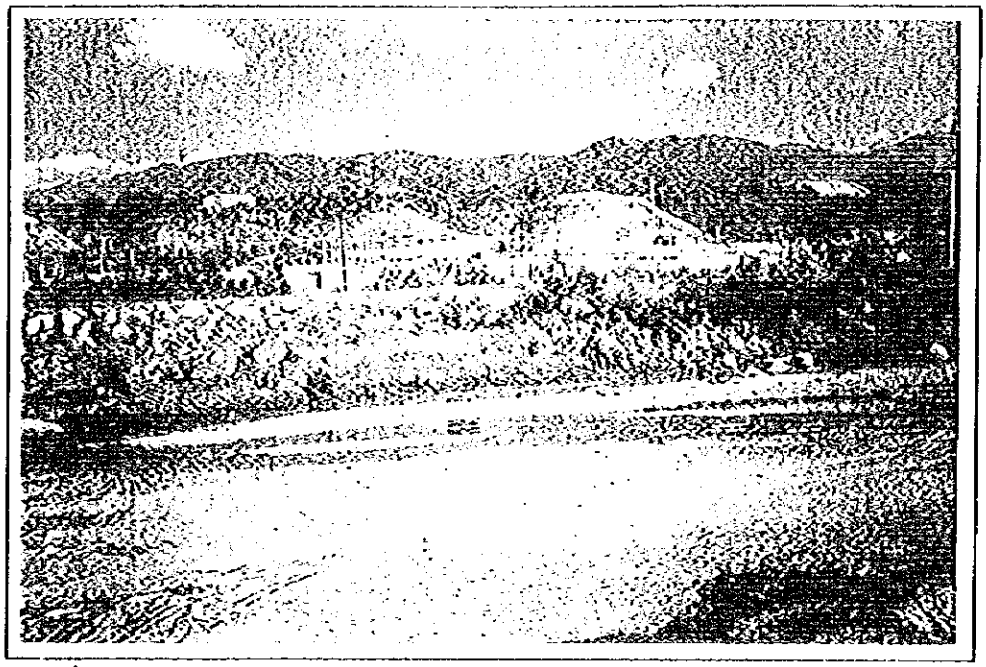
FOTOGRAFÍA (Abajo)
REGIÓN CENTRAL
Aspecto general del paisaje de una de los posibles sitios de ubicación de la Planta de Tratamiento de aguas residuales. Rivera totalmente desprovista de la cubierta forestal. Obsérvese al fondo las colinas cubiertas de bosque secundario de la región.

PHOTO (Below)
CENTRAL REGION
General view of the landscape posible site of Wastewater Management Plant. Without vegetation cover. At the background site covered which secundary forest can be observed.



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE ENVIRONMENTAL DESCRIPTION NEAR PROPOSED WWTP SITES : CENTRAL REGION (3/3)

Fig. SA - 17



FOTOGRAFÍA (Arriba)
REGIÓN SUR 3
Vista general del entorno del sitio de ubicación de la Planta de tratamiento de aguas residuales, obsérvese el proceso de urbanización del área. (Colonia Rivera del Río)

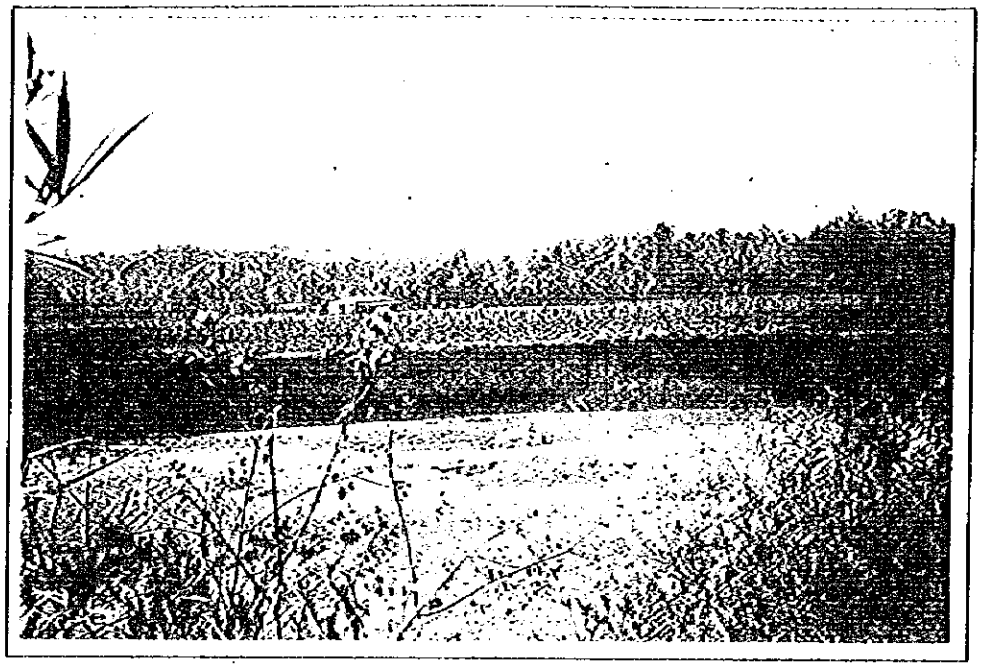
PHOTO (Above)
SOUTH REGION 3
General view, around the site of the future Wastewater Management Plant. Urbanization process can be observed.

FOTOGRAFÍA (Abajo)
REGIÓN SUR 3
Aspecto general del entorno del sitio de ubicación de la Planta de Tratamiento de aguas residuales, obsérvese el grado de contaminación del río, así como la aridez del paisaje causada por la deforestación.

PHOTO (Below)
SOUTH REGION 3
General view, around the site of the future Wastewater Management Plant. Contamination of the river and erosion caused by deforestation.

THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE ENVIRONMENTAL DESCRIPTION NEAR PROPOSED WWTP SITES : SOUTH 3 REGION (1/2)

Fig. SA - 18

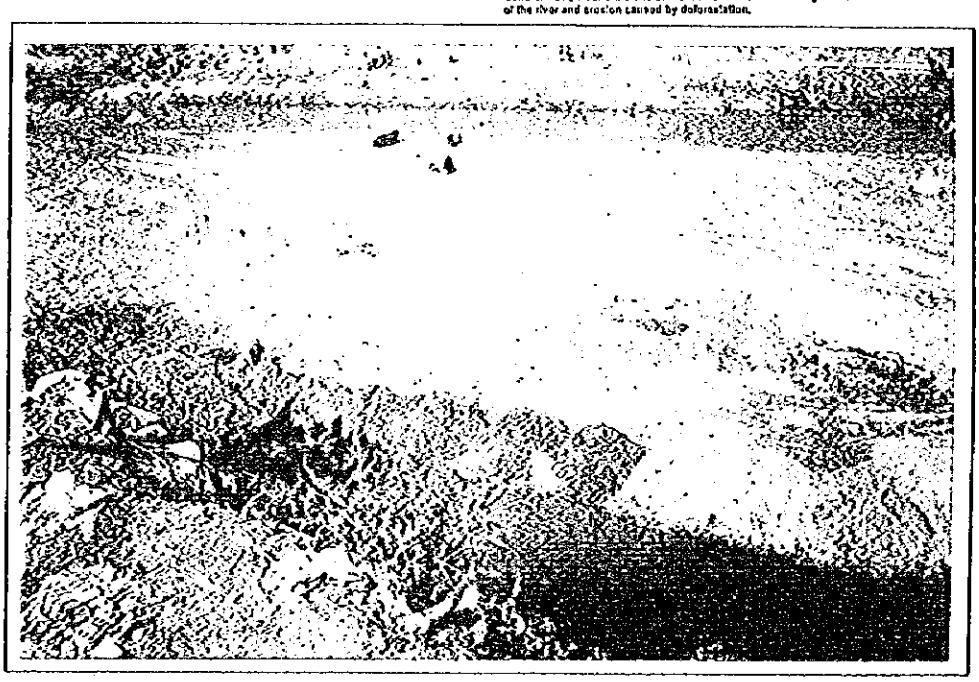


FOTOGRAFÍA (Arriba)
REGIÓN SUR 3
Obsérvese otro aspecto del entorno del sitio descrito como un sector rural en proceso de transición a conformarse en un sector urbano.

PHOTO (Above)
SOUTH REGION 3
Around the site, the rural sector is in transition process to become a urban sector.

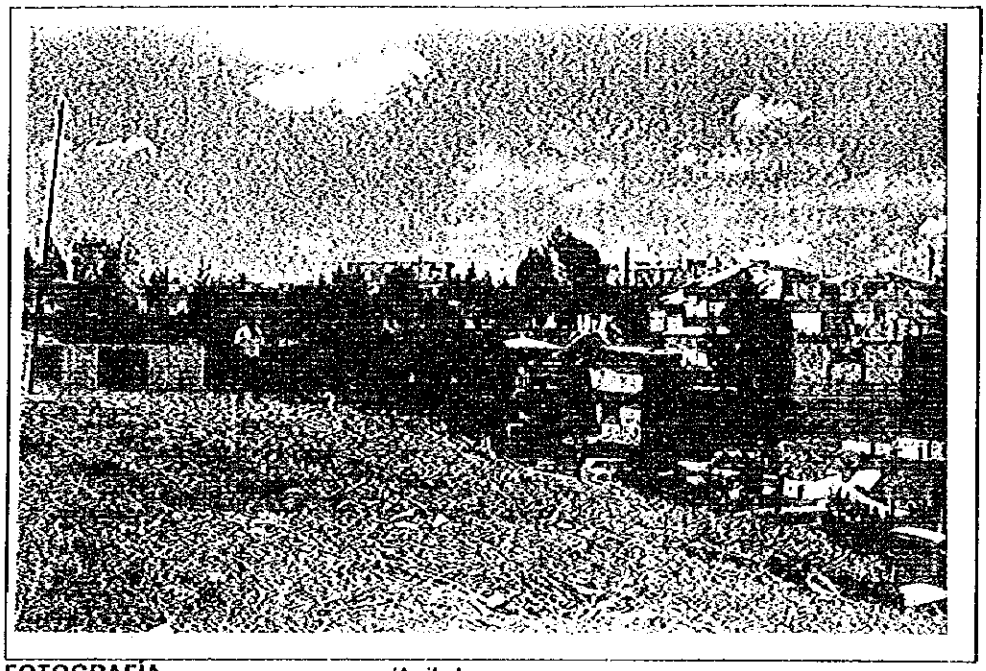
FOTOGRAFÍA (Abajo)
REGIÓN SUR 3
Aspecto general del entorno del sitio de ubicación de la Planta de Tratamiento de aguas residuales, obsérvese el grado de contaminación del río, así como la aridez del paisaje causado por la deforestación.

PHOTO (below)
SOUTH REGION 3
General view, around the site of the future Wastewater Management Plant. Contamination of the river and erosion caused by deforestation.



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE ENVIRONMENTAL DESCRIPTION NEAR PROPOSED WWTP SITES : SOUTH 3 REGION (2/2)

Fig. SA - 19

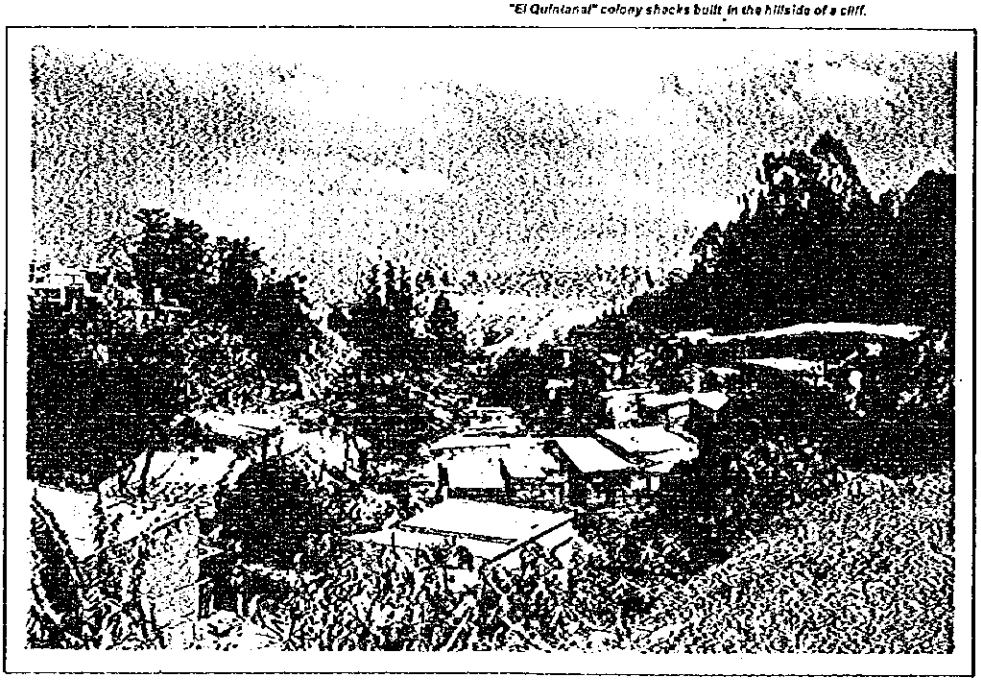


FOTOGRAFÍA (Arriba)
REGIÓN CENTRAL:
Colonia "El Quintanal" construcciones formales y construcciones en ladera de barranco.

PHOTO *(Above)*
CENTRAL REGION:
"El Quintanal Colony", formal construction, built at the hillside of a cliff.

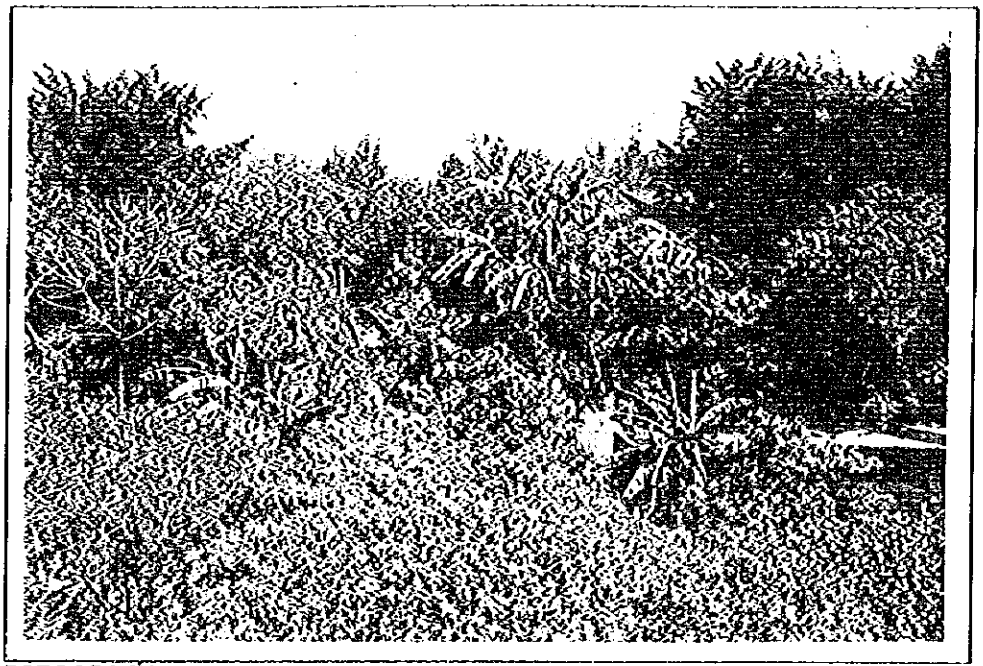
FOTOGRAFÍA (Abajo)
REGIÓN CENTRAL:
Colonia "El Quintanal", viviendas construidas en laderas del barranco, tipo "cobacha

PHOTO *(Below)*
CENTRAL REGION
"El Quintanal" colony shacks built in the hillside of a cliff.



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE SANITATION AREAS : CENTRAL REGION (1/2)

Fig. SA - 20

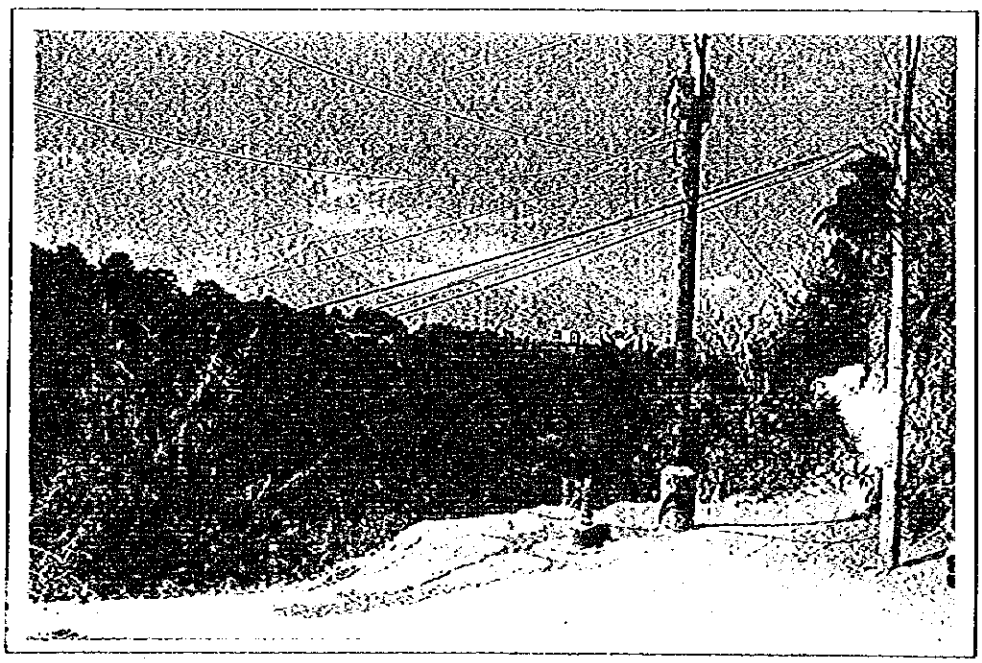


FOTOGRAFÍA (Arriba)
REGIÓN CENTRAL:
Aldea "El pilar", zona 14, Vista de la cobertura vegetal, actividad agrícola y viviendas.

PHOTO *(Above)*
CENTRAL REGION:
"El Pilar" Village, zone 14. Vegetation cover, agricultural activity and houses.

FOTOGRAFÍA (Abajo)
REGIÓN CENTRAL:
Aldea El Aldea "El Pilar", zona 14. Vista General del área, a nivel del paisaje vegetal aún existe actividad de conservación.

PHOTO *(Below)*
"El Pilar" Village zone 14. General View of the area with vegetation conservation



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE SANITATION AREAS : CENTRAL REGION (2/2)

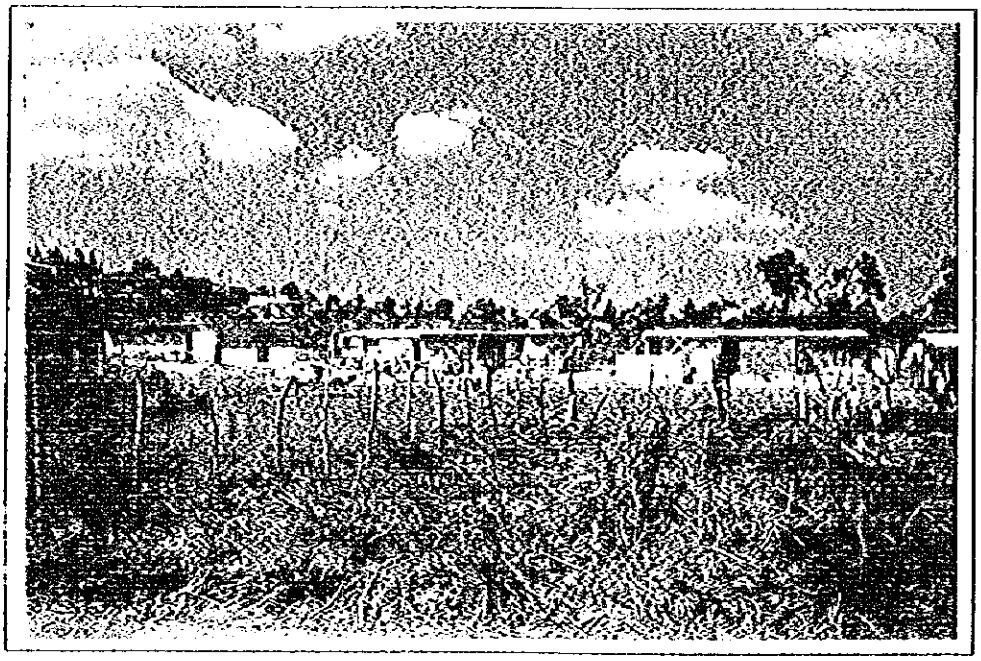
Fig. SA - 21

FOTOGRAFÍA (arriba)
REGIÓN SUR 3:
Aldea Loma Blanca, frontera urbana. En la parte derecha área sub-urbana de cultivos agrícolas.

PHOTO *(above)*
SOUTH 3 REGION:
"Loma Blanca" Village, urban border at the right a sub-urban area that has agricultural crops.

FOTOGRAFÍA (Abajo)
REGIÓN SUR 3:
Aldea Loma Blanca, nuevos asentamientos, casas provisionales de block y madera (lapa). Expansión de la frontera urbana.

PHOTO *(Below)*
Loma Blanca Village, new settlements, provisional houses built with wood and concrete blocks. Expansion of the urban border.



THE REPUBLIC OF GUATEMALA GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE SANITATION AREAS : SOUTH 3 REGION