APPENDIX 19

STUDY ON TREATMENT METHOD

APPENDIX 19 STUDY ON TREATMENT METHOD

A19.1 General

Important items to be considered in the selection of treatment method are as follows:

a. Quantity and quality of sewage and their variation
b. Conditions in the areas of discharge and water use
c. Scale of treatment plant
d. Location and environment of treatment plant
e. Operation and maintenance organization
f. Operation and maintenance cost

Investigations must be made on these items in relation to the present Project and the most suitable treatment method selected accordingly.

A19.2 Requirements of the System

(1) Influent Sewage Condition

- Design Flow

From investigations in Section 5.2, the discharge from Colector Surco at present is estimated at 5.0 m^3/sec and is predicted to increase to around 6.5 m^3/sec in the year 2000.

From the study in Chapter 6, the design flow of sewage treatment plant in each proposed site for several given alternatives are shown in TABLE A19-1.

TABLE A19-1 Design Flow for Sewage Treatment Plant in Each Proposed Site

(unit : m^3/s)

Proposed Site		a. San Juan STP		b. San Juan		c. Villa El Salvador		e & f San Bartolo	
Alternatives		Ph-I	Ph-II	Ph-I	Ph-II	Ph-I	Ph-II	Ph-I	Ph-II
A	A_1	-	-	-	-	0.5	-	3.5	-
	A_2	-	-	-	-	0.5	-	1.5	2.0
	A_3	-	-	-	-	0.5	-	0.5	3.0
B	B_1	-	-	-	-	0.5	-	3.5	-
	B_2	-	-	-	-	0.5	-	1.5	2.0
	B_3	-	-	-	-	0.5	-	0.5	3.0
C	C_1	0.5*1	-	1.0	-	0.83	-	-	1.67
	C_2	-	-	1.0	-	0.83	-	-	2.17
	C_3	-	-	-	0.5	0.83	-	-	2.67
	C_3'	-	-	-	0.5	1.0	-	-	2.5
D	D_1	0.5*1	-	1.0	-	-	-	-	2.5
	D_2	-	-	1.0	-	-	-	-	3.0
E	E_1	-	-	-	-	0.5	-	1.5	2.0
	E_2	-	-	-	0.5	-	-	1.0	2.5

*1 0.5 m^3/s is the increase in quantity by reconstruction.

(2) Influent Sewage Quality

From the investigation in Section 5.5, Projected Sewage Quality, influent sewage quality values are decided as follows;

BOD_5 : 250 mg/l

SS : 250 mg/l

- Flow variation

In accordance with the results obtained in Section 5.2, the hourly variation of discharge flow in Collector Surco is minimal. The flow ratio varies between 0.7 and 1.2 of the average flow. The reasons for such low variation is attributed to very extensive catchment area, and the considerable amount of leakage from the water supply facilities of users.

(3) Target Treated Water Quality

The primary purpose of this Project is to lower the contamination level of sea water in the coastal area of Metropolitan Lima. As a secondary purpose, it is aimed to reuse treated sewage for irrigation.

Target treated water quality must therefor be set in consideration of both purposes.

a. Target treated water quality from viewpoint of lowering sea water contamination level

If the raw sewage presently discharging at the Cerro La Chira is diverted for irrigation reuse, purpose of improvement will be satisfied.

However, in case treated water is discharged to the sea, middle level sewage treatment, such as, under 60 mg/l of BOD_5 and under 5,000 MPN/100 ml of Total-Coliform should be considered as requirement.

b. Target treated water quality from viewpoint of reuse

As for the reuse of sewage for irrigation, many standards and guidelines are reported. Actual values to be adopted for Method of Reuse according to Recommended Quality Standard for Irrigation (Technical Paper of World Bank) and Water Quality Standard in Peru (refer to APPENDIX 10) are shown in TABLE A19-2.

TABLE A19-2 Recommended Water Quality for Irrigation

Level	Methods of Reuse	BOD5 (mg/l)	Fecal Coliforms (MPN/100 ml)
1	Irrigation of trees, cotton, and other non-edible crops	60	50,000
2	Irrigation of citrus fruit, trees, fodder crops & nuts	45	10,000
3	Irrigation of deciduous fruit trees, sugar cane, cooked vegetables and sports fields	35	1,000
4	Agricultural water for use on vegetables to be consumed by people and drinking water for cattle	15	1,000 (T-Coli. 5,000)

c. Target Treated Water Quality

- In case of treatment plant on the west bank of Rio Lurin

On the west bank of Rio Lurin, the reuse of sewage is already widely practiced. Effluent water from Waste Stabilization Pond in San Juan as well as raw sewage is used in irrigation for silviculture and agriculture (vegetables and others).

Because of this, hygienic problems which result to water borne diseases and helminthiasis occur. Treated water in this area is largely utilized for irrigation of vegetables, hence, the above-mentioned Level 3 treated water quality shall at least be satisfied.

- In case of treatment plant in San Bartolo

The present purposes of the reuse in this area are to make the desert suitable for cultivation and for irrigation of citrus fruits and other crops of commercial value, so that target treated water quality shall be Level 2 grade.

If higher level of water quality for other farm crops is necessary in the future, upgrading of treatment level shall be done during that time.

(4) Location and Environment Conditions of Treatment Plant

All of the areas surrounding the prospective sites which are discussed in Section 6.1 and APPENDIX 11, except the San Bartolo Plain, are expected to undergo a rapid increase in housing construction.

There is, therefore, a need to reduce as much as possible the emission of odor and the proliferation of harmful insects such as mosquitoes. The operation of stabilization ponds within the Parque Zonal No.26 of the Villa El Salvador district has been stopped because of complaints of bad odors by occupants of neighboring houses/establishments.

(5) Operation and Maintenance Organization

It is a prerequisite that operation and maintenance of the sewage treatment system be simple and easy. As mentioned in the Progress Report, two systems are mostly used in Peru: Stabilization Ponds and Aerated Lagoon. In Metropolitan Lima, there are currently two sewage treatment plants: the San Juan Stabilization Pond and the Carapongo Aerated Lagoon (Carapongo S.T.P.). Therefore, the implementation of more sophisticated sewage treatment system is not appropriate at this time.

On the other hand, SEDAPAL is operating and maintaining a drinking water purification plant with a capacity of approximately 1,200,000 m^3/day, including well water pumping plants and sewage pumping stations. Because SEDAPAL has experience with these plants, it is felt that it will have no problem in handling the operation and maintenance of pumps, motors, valves and

other sewage treatment equipment.

(6) Construction, Operation and Maintenance Costs

Low operation and maintenance costs are a prerequisite for sewage treatment, because they are not direct-productive investments. On the other hand, as these activities are sustained and continuing, low operation and maintenance costs are necessary. These factors must be considered in relation to the current economic status of SEDAPAL.

A19.3 Treatment Method

(1) Basic Conception

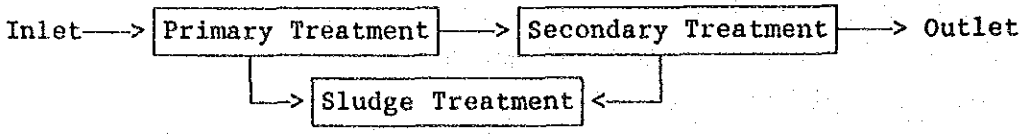
As mentioned in subsection A19.2, two main factors should be taken into account in this Project: the land and the operation & maintenance problem.

For the purpose of selecting alternatives, following aspects shall be considered in the evaluation:

	Land Requirement	Operation and Maintenance
1.	Large	Easy, low cost
2.	Small	Slightly easy, slightly lower cost

(2) Treatment Method

Sewage treatment processes are categorized into two groups; sewage water treatment and treatment of sludge which is a by-product of sewage treatment. In general, sewage water treatment is further divided into the primary and secondary stages as illustrated below:



Sedimentation tanks are normally used in the primary treatment process. Here the solid and light materials are separated from the liquid, preparatory

to processing in the secondary stage. The sedimented sludge, which contains organic material, is extracted from the tank and processed separately in a completely different manner. The anaerobic pond in stabilization pond systems is considered as a primary treatment process.

The secondary treatment process normally consists of the reaction tank and followed by the sedimentation process. This stage is the most important in sewage treatment as it is in this stage where the organic materials/objects and floating bodies are removed through various methods. TABLE A19-3 compares the advantages and disadvantages of major methods of removal.

The sludge extracted from the primary process and the secondary process is finally disposed after some treatment processes, such as thickening digestion, dewatering, drying and others. Primary sedimentation tanks are normally utilized in sewage treatment plant employing activated sludge method and trickling filter method. Sedimentation tanks are not used in the other four methods where the secondary treatment process takes a longer time to reduce and stabilize the sludge.

(3) Selection of Treatment Method.

a. Recommended Treatment Methods.

The methods shown in TABLE A19-3 are classified according to the load in the reaction tanks as follows:

High Load	:	Activated Sludge Plant (ASP)
Medium Load	:	Trickling Filter (TF)
		Extended Aeration Plant (EAP)
		Oxidation Ditch (OD)
Low Load	:	Aerated Lagoon System (AL)
		Waste Stabilization Pond System (WSP)

Normally, when the load is lowered, the land requirement becomes larger, but operation and maintenance become more simple and easy. Considering the aforementioned requirements for the project, following

may be affirmed:

- The ASP method is the most compact as to size but its system is more complicated, its cost is very high, and its operation and maintenance is very complicated. The TF method is more advantageous than the ASP in terms of operation and maintenance, but its efficiency is minimal and bad odors are inevitable. Both methods require a specialized sludge treatment system. Therefore, both methods are inadequate for this Project.

- The EAP and OD methods are medium load activated sludge processes. EAP is similar to ASP in terms of system complexity and costs. The OD system is simpler and more accessible in terms of operation and maintenance. Neither method normally uses a primary sedimentation tank. The sludge is extracted from the final sedimentation tank relatively stabilized. Because of the ease of operation and maintenance the OD method is advantageous.

- The WSP and AL methods require more land area but their operation and maintenance is simple. There have been some very positive experiences with their application and use in Peru. In addition, a sludge treatment system is not necessary because its reaction period is so long that the sludge is stabilized and lightened during this time. The sludge that accumulates in the bottom of the pond is extracted once every few years after it is drained of water and sun-dried.

- A low load processing method is recommendable where the production of sludge is minimal since the elimination of much sludge incurs much work and high costs.

- Although the primary treatment process hastens the secondary process, a method that does not require the primary process is recommended. This is because the sludge originating in the primary process always produces a strong fetid odor, much stronger than that of the sludge originating in the secondary process.

Because of the aforementioned reasons, following three methods are

recommendable as alternative systems for sewage treatment:

I) First Condition: The land requirement is large but its operation and maintenance is easy and entails low cost.

i) Waste Stabilization Pond System (WSP)
ii) Aerated Lagoon System (AL)

II) Second Condition: Operation and maintenance is more or less simple and the cost is also somewhat low.The land requirement is small.

iii) Oxidation Ditch (OD)

The most appropriate alternative should be selected from among the three recommended methods according to the site area and other conditions.

FIGUREs A19-1 to A19-3 show the characteristics of these three methods.

(i) Waste Stabilization Pond System (WSP)

Waste stabilization ponds are classified according to the relative dominance of the two processes by which organic material, expressed as BOD_5, is removed. Anaerobic, facultative and maturation ponds are often used in series. Each of them may be broken down into two or more units operated in parallel.

Anaerobic ponds operate under heavy organic loading rates as the primary units in a pond system, and rely totally on anaerobic digestion to achieve organic removal. Anaerobic ponds are sometimes used in order to reduce the required area of facultative ponds.

Facultative ponds operate under a lighter organic loading enabling algae to develop in the surface layers and an aerobic zone to form. Below this, anaerobic digestion is presented in the

absence of oxygen. Above, the aerobic bacterial oxidation occurs in symbiosis with algal photosynthesis, which provides the bulk of the oxygen for the oxidation process. Facultative ponds may be used as primary or secondary units in a pond series.

Maturation ponds follow facultative ponds and are largely aerobic since most of the organic load is removed in the anaerobic and facultative units and thus the organic loading on these ponds is light. Maturation ponds are used in instances where a high-grade effluent is necessary, especially with regard to pathogenic organisms. This is the case of effluent use for agricultural purposes.

The San Juan Stabilization Pond, as mentioned in section 3.4, work under a system of facultative ponds with two cells and it is proven that while the range of the load is adequate, its effectiveness is good.

The WSP system is the most simple since it needs no machinery, but requires ample land area and its process require a long detention time. One of its inconveniences is its sensitivity to environmental temperature changes, producing bad odors. These inconveniences can be avoided with forced aerating mechanisms or a recirculation (agitating) in the ponds with effluent of the pond at the downstream.

(ii) Aerated Lagoon System (AL)

This process has a shorter detention time than the WSP system since the oxidation is forced, apart from the natural oxidation produced on its surface.

AL system may be classified into two types: the partial mix type (or facultative type) and the complete mix type.

Aerators used in a partially mixed lagoon provide enough energy to satisfy the oxygen demand for aerobic oxidation. They also allow a sludge layer to form at the bottom of the lagoon.

Aerators used in a completely mixed lagoon provide enough energy to maintain the solids in suspension. Completely mixed aerated lagoons are in essence activated sludge units without sludge return.

The partially mixed lagoons take longer detention time, but are more economical and more effective for BOD removal than the completely mixed process.

The dual-power aerated lagoon is simply a group of one or more partially mixed lagoons coming after completely mixed lagoon. It is proven to be more effective in BOD removal in relatively short detention time.

In any cases a sedimentation pond is installed as a final stage to increase the SS removal.

iii) Oxidation Ditch (OD)

OD is an "activated sludge process" when the load is low. The sewage is circulated with the activated sludge which attract the organic materials during the mixing process. This process is technically simple and its maintenance is easy. The sludge extracted from the sedimentation tank are processed separately. But this process is much more simple because they are previously stabilized and bad odor is less.

TABLE A19-3 Advantages and Disadvantages of Various Sewage Treatment Systems

Criteria \ Sewage Treatment System	Activated Sludge	Trickling Filter	Extended Aeration	Oxidation Ditch	Aerated Lagoon	Waste Stabilization Pond	
						With Anaerobic Units	Without Anaerobic Units
BOD_5 Removal	***	**	***	***	***	*** a/	*** a/
FC Removal c/	*	*	**	**	***	***	***
SS Removal	***	***	***	***	**	**	**
Helminth Removal	**	*	**	**	**	***	***
Virus Removal	**	*	**	**	***	***	***
Ancillary Use Possibilities	*	*	*	*	***	***	***
Effluent Reuse Possibilities	* b/	* b/	**	**	***	***	***
Simple and Cheap Construction	*	*	*	**	**	***	***
Simple Operation	*	**	*	**	***	***	***
Land Requirement	***	***	***	***	**	**	*
Maintanance Costs	*	**	*	*	**	***	***
Energy Demand	*	**	*	*	**	***	***
Minimization of Sludge for Removal	*	*	**	**	***	***	***

a/: Assumes provision of sufficient facility against inlet lead.
b/: The effluents from activated sludge and trickling filter often have high ammonium levels (5 mg/l) and fecal coliform bacteria concentration, and usually not suitable for irrigation or fish farming without tertiary treatment.
c/: Chlorination facility is necessary in case of low FC removal rate.

key : *** good, ** fair, * poor

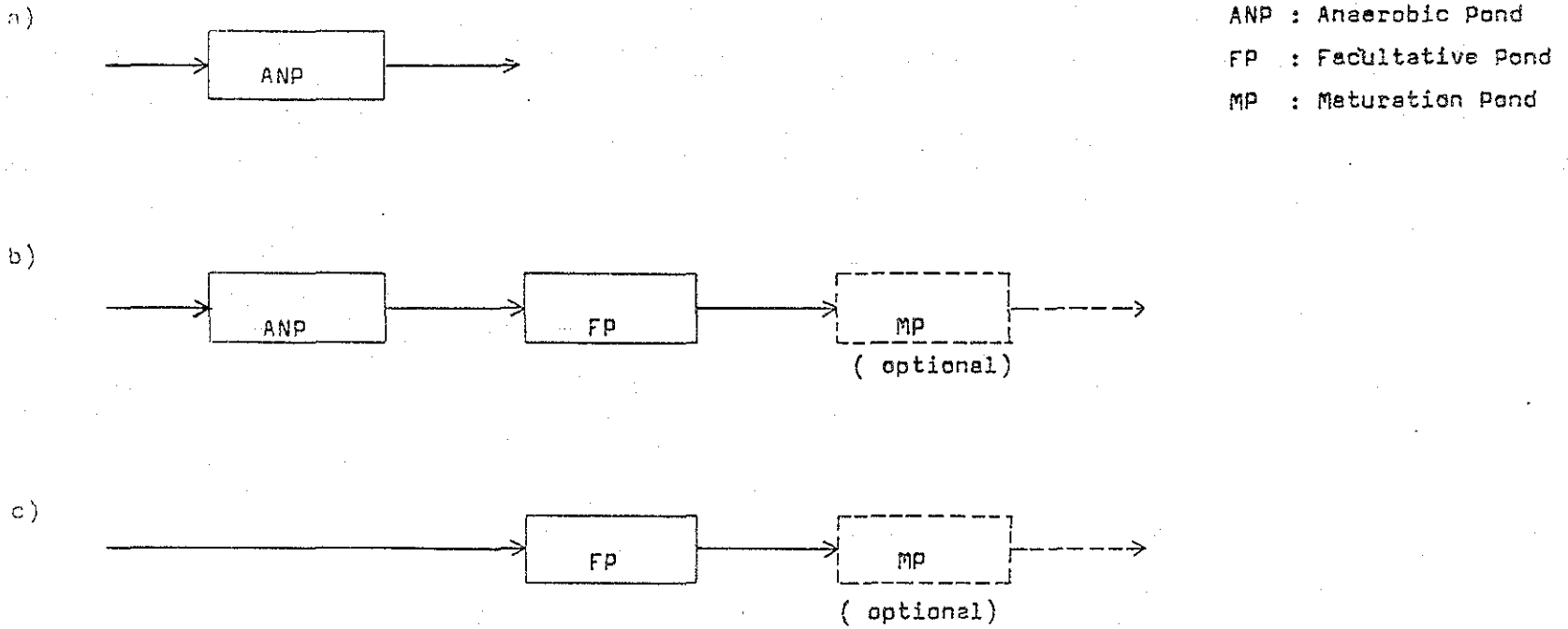
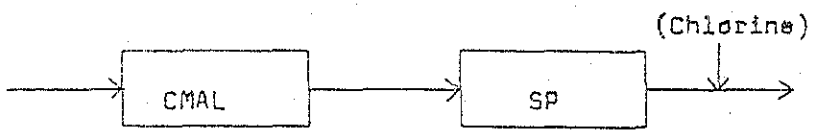
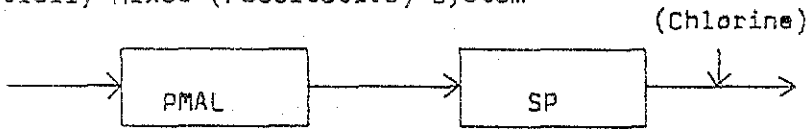


FIGURE A19-1 TYPICAL FLOW DIAGRAM OF WASTE STABILIZATION POND SYSTEM

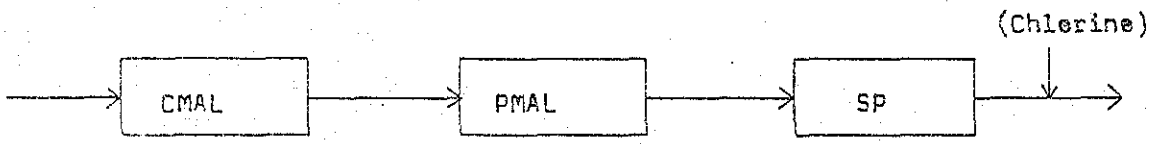
a) Completely Mixed System



b) Partially Mixed (Facultative) System



c) Dual - Power Aerated Lagoon System



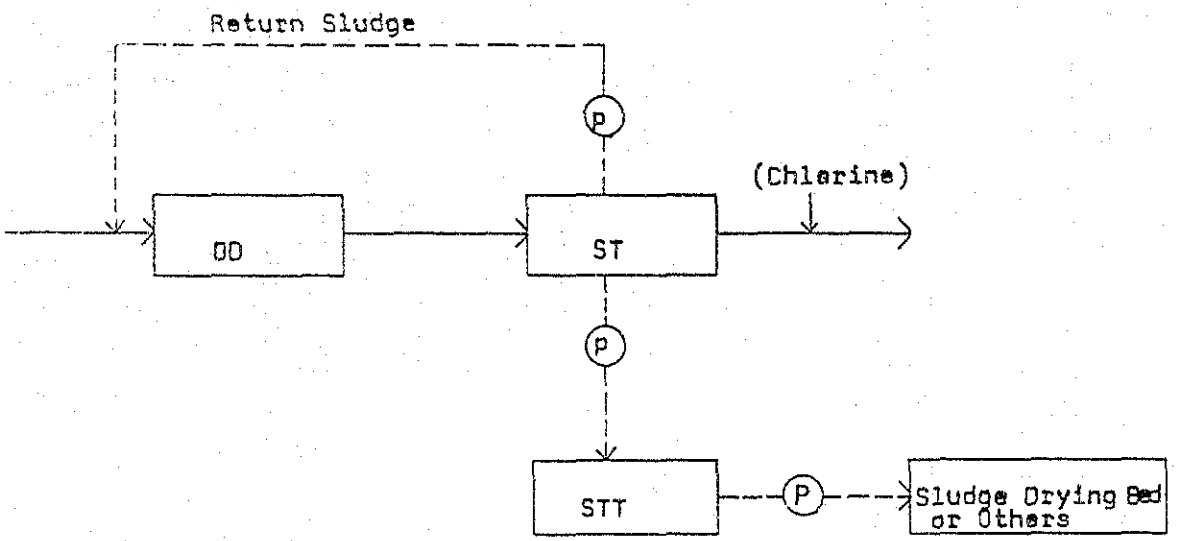
Symbols

CMAL : Completely Mixed Aerated Lagoon.

PMAL : Partially Mixed Aerated Lagoon.

SP : Sedimentation Pond

FIGURE A19-2 TYPICAL FLOW DIAGRAM OF AERATED LAGOON SYSTEM



Symbols

OD = Oxidation Ditch

ST = Sedimentation Tank

STT= Sludge Thickning Tank

(P) = Pump

FIGURE A19-3 TYPICAL FLOW DIAGRAM OF OXIDATION DITCH

b. Selection of Treatment Method on Each Proposed Site

Treatment method for each proposed site, as mentioned in Subsection A19.2, must be studied mainly from the viewpoints of target treated water quality, available site area and cost.

- Treated Water Quality Level of three treatment methods mentioned above are as follows;

  Waste Stabilization Ponds : Level 2 (excluding Maturation Pond)
  Aerated Lagoon : Level 3
  Oxidation Ditch : above Level 3

- Comparison of Land Requirement and Cost of three treatment methods for 1.0 m^3/s design flow are as follows:

Treatment Method	Land Requirement	Power Cost	Construction	O/M Cost*2
Stabilization Pond	Approx. 160	-	3,502,000	16,000
Aerated Lagoon	Approx. 20	1,390	9,118,000	235,000
Oxidation Ditch	Approx. 17*1	1,870	62,000,000	320,000

*1 In case of Sludge Drying Bed for sludge treatment process.
In case of mechanical dewatering facility, land requirement is around 10 ha.

*2 Including chlorine for disinfection.

- Available area and possible treatment flow in each proposed site are as follows:

Proposed site		a. San Juan STP (Upper Battery)	b. San Juan	c. Villa El Salvador	e. & f. San Bartolo
Available Area		Approx.12 ha	Approx.20 ha	Approx.40 ha*2	Unlimited
Possible Treatment Flow	WSP	-	0.19 m^3/s	0.19 m^3/s	All design flow
	AL	0.63 m^3/s	1.0 m^3/s	0.83 m^3/s	All design flow
	OD*1	0.71 m^3/s	1.2 m^3/s	1.5 m^3/s	All design flow

*1 In case of Sludge Drying Bed.

*2 Effective available area is small because of constraints brought about by topographic condition.

- From the following reasons, it is recommended that treatment method in each Proposed Site be Aerated Lagoon in sites (a), (b) and (c) and be Waste Stabilization Pond in sites (e) and (f).

  (i) Waste Stabilization Pond is recommendable for reason of cost. However, in sites (a), (b) and (c), treated water quality is required to be Level 3, hence the degree of treatment must be as high as possible.

  In case of Aerated Lagoon, major equipment required are aerators only, so that if aerator is stopped, operation as Stabilization Pond is possible.

(ii) Oxidation Ditch is costly and requires many equipment. Considering the replacement cost in the future, it is not recommendable to adopt Oxidation Ditch at present.

(iii) Less odor treatment system is desirable in sites (a), (b) and (c), since dwellings are increasing rapidly in the surrounding areas of the sites.

APPENDIX 20

DESIGN CRITERIA AND CASE STUDY FOR SEWAGE TREATMENT PLANT

APPENDIX 20 DESIGN CRITERIA AND CASE STUDY FOR SEWAGE TREATMENT PLANT

Treatment Methods for Case Study

Subjects of the case study are the following three alternative treatment methods:

(i) Waste Stabilization Pond System (WSP)
(ii) Aerated Lagoon System (AL)
(iii) Oxidation Ditch (OD)

In this case study, land requirement for each treatment method is roughly estimated.

Design Criteria

(1) Design Fundamentals

Design Inflow Rate	:	$1m^3/s = 86,400\ m^3/day$
Influent BOD5	:	250mg/l
Influent SS	:	250mg/l
Treatment Level	:	Better than middle level

(2) Waste Stabilization Pond System - WSP

The design methods for WSP system are known to many institutes and researchers. However, these are all empirical or experimental formulas. Because WSP system is influenced greatly by temperature, design loadings and removal rates are indicated in mutual relation with temperature.

a. Anaerobic Ponds

Anaerobic ponds (utilizing anaerobic digestion only) is designed on the basis of volumetric organic loadings. J. P. Arthur recommends the following values (World Bank, Technical Paper No.7):

BOD Volumetric Loadings : v = 0.1 to 0.4 kg-BOD_5/m^3/day
(at ambient temperature 12-30 degrees centigrades)
Detention Time : t* = 2 days or more
Water Depth : D= 2.5 - 4.0 m
BOD_5 Removal Rate : 45-70% (at 12 - 25 degrees centigrades)

b. Facultative Ponds

Faculatative ponds is designed on the basis of BOD areal loadings.

- Information by Arthur

BOD Areal Loadings : Li = 20T -60 (kg-BOD_5/ha/day)
T = Minimum mean monthly ambient temperature
(15 to 30 degrees centigrades)
Water Depth : D = 1.2 m - 1.8 m
BOD_5 Removal Rate : 75% - 84% (12 to 25 degrees)

- Information by Yanez

Facultative ponds system is usually employed in Peru. The existing San Juan Stabilization Pond is such type of pond which has remained in good condition over many years and which can provide useful data for the design of facultative ponds in South America. San Juan Stabilization Pond consists of primary and secondary facultative ponds. Yanez recommends the suitable BOD_5 areal loadings of 200 to 400 kg-BOD/ha/day for primary facultative. ponds under the climatic condition of Lima, according to the results of studies from 1980 to 1984.

Water depth of pond is 1.3 to 1.6 m. However, there are no detailed data for BOD areal loadings of secondary ponds, hence estimates of such values are based on past working conditions.

c. Maturation Ponds

Maturation ponds, which are mainly aerobic, should primarily be designed to achieve fecal bacterial removal since most of BOD_5 is removed

in the anaerobic and facultative ponds. Maturation ponds are specially adopted for irrigation reuse. The design procedure assumes that fecal coliform removal is a first order kinetic reaction given by the formula:

$$Be = \frac{Bi}{(1 + KB\ (T) * t*i)^{ni}}$$

Where, Be = Bacterial concentration in No. FC/100ml of effluent
Bi = Bacterial concentration in No. FC/100ml of influent
KB(T) = First order FC removal rate constant at T°C in a day
KB(T) = 2.6 (1.19)(T-20)
t*i = Determination time of pond-i, include AP and FP in a series
ni = No. of pond-i
Detention time = 5 days or more
Water Depth = 1.2 m to 1.5 m

Stabilization Ponds System in this case study is applied to the 2-cell series of facultative ponds as San Juan STP because of the following factors:

- Anaerobic ponds reduce the area of the succeeding facultative ponds. However, because of bad odor that it generates, anaerobic pond is not considered suitable for this Project wherein the environmental condition is restricted.

- In this Project, the treatment level is expected to be middle-high level. Therefore, maturation pond is not applied because it is perceived as high level treatment.

The design criteria used in this Study are based on the information by Yanez and are given in TABLE A20-1.

TABLE A20-1 Design Criteria of Waste Stabilization Ponds

Parameter	Symbol	Unit	Formula or Value	Application
Primary Facultative Pond				
. Water Temperature	Tw	°C	Tw= 8.49 + 0.82 Ta	Ta = 15 °C Tw = 8.49 + 0.82 x 15 = 20.8 °C
. BOD_5 Areal Loading	Li_1	kg-BOD/ha/d	under 400 $Li_1 = 357.4 \times 1.085^{(Tw-20)}$	$Li_1 = 357.4 \times 1.085^{(20.8-20)}$ = 382
. Water Depth	D1	m	1.3 - 1.6	1.5
. BOD_5 Removal Rate	R1	%	65 - 75	70
Secondary Facultative Pond				
. BOD_5 Areal Loading	Li_2	kg-BOD/ha/d	40 - 210	200
. Water Depth	D2	m	1.3 - 1.6	1.5
. BOD_5 Removal Rate	R2	%	30 - 40	35

(3) Aerated Lagoon Systems - AL

There are many informations on the design criteria for Aerated Lagoon. Detention time and BOD removal rate of this system is determined with correlation constants on the basis of ambient temperature and water temperature.

The basic formula is as follows:

$$Le = \frac{Li}{1 + k.X.t^*}$$

where: Le = Effluent BOD (mg/l)
Li = Influent BOD (mg/l)
k = Substrate removal rate constant (mg/l/day)
X = Concentration of VSS in the lagoon (mg/l)
t* = Detention time

In case of Partial Aerated Lagoon, the design methods based on BOD volumetric loadings is also known, and this value is 0.02 to 0.03 kg-BOD/m^3/day.

- Aerated Lagoons are mainly classified into Partially Mixed (Facultative) Type and Completely Mixed Type according to the difference of power input per unit volume. Comparison of characteristics of these two types are given in TABLE A20-2. In both types, SS removal rate can be raised through the installation of sedimentation ponds at the downstream portion.

TABLE A20-2 Characteristics of Different Types of Aerated Lagoons

Characteristics	Partially Mixed Type	Completely Mixed Tipe
Control of solids	Not controlled. Some settle, some flow out with effluent	Partially controlled. Solids cannot settle. They must flow out with effluent.
Solids concentration in lagoon (mg/l)	30 - 150	30 - 300
Sludge disposal	Accumulates in lagoon. Manual removal may be needed after some years.	Sludge solids go out with effluent. No accumulation in lagoon
Power	Low power input per unit volume 1 - 1.5 w/m^3 Power requirement based on oxygenation needs since solids are not required to be kept in suspension	More power input per unit volume 5 - 10 w/m^3 Power input based on oxygenation or mixing requirement whichever is higher
Detention Time (days)	3 - 12	2 - 10
Depth of Lagoon (m)	3 - 5	3 - 5
BOD_5 Removal Rate (%)	75 - 90	70 - 85
Land for Sludge Disposal or Drying	None	None
Effluent Quality	Good	Poorer in spite of higher power

In general, Partially Mixed Type Aerated Lagoon requires a little longer detention time which means larger land requirement than the Com-

pletely Mixed Type, but it has high BOD removal rate and is economical.

Treatment method used in the Carapongo Sewage Treatment Plant is the Partial Aerated Lagoon, which plant is presently in good operational condition.

There are much information on the design criteria for Dual-Power Aerated Lagoon. Partially Mixed Lagoon in 1 to 3 cell with a detention time of 0.5 to 1.0 day is installed after Completely Mixed Lagoon with the detention time of 1.5 to 2.0 days.

In this case study, Dual Power Aerated Lagoon is applied because of requirement of high BOD removal rate with relatively less detention time. Design criteria is given in TABLE A20-3.

TABLE A20-3 Design Criteria for Aerated Lagoon
(Dual Power Aeration System)

Parameter	Symbol	Unit	Formula or Value	Application
Complete Mixing Aerated Lagoon				
. Detention Time	t*c	day	1.5 - 2.0	2.0
. Water Depth	Dc	m	3.0 - 4.0	3.0
. Number of Lagoon	Nc	-	1	1
. Oxygen Requirement	Rc	kg/hr	$Ro=6.24 \times 10^{-5} \times Q.Li$	Same as left
. Power Requirement for Mixing	pc	w/m^3	$pc>=6w/m^3$	$6w/m^3$
Facultative Aerated Lagoon				
. Detention Time for One-Cell	t*f	day	0.5 - 1.0	0.67
. Water Depth	Df	m	3.0 - 4.0	3.0
. Power Requirement for Partially Mixing	pf	w/m^3	$pf >=1 w/m^3$	$1.0-1.5w/m^3$
. Number of Lagoon	nf	-	1 - 3 (series)	3 cells
Sedimentation Ponds				
. Detention Time	t*s	day	1 - 2	1

(4) Oxidation Ditch System - OD

Operation and maintenance of Oxidation Ditch is relatively simple and easy. The Oxidation Ditch process is applied in many municipal sewage treatment works as a high rate method.

The design criteria is decided based on the standard design criteria of Japan. Sludge treatment facility consisting of Thickening Tank and Sludge Drying Beds is applied because it seems to be the method most suitable for sludge treatment in areas, of very low rainfall Design criteria is shown in TABLE A20-4.

TABLE A20-4 Design Criteria for Oxidation Ditch

Parameter	Symbol	Unit	Formula or Value	Application
Oxidation Ditch				
BOD - SS Loadings	l	kg-BOD/kg-SS/d	0.03 - 0.05	0.05
BOD Volumetric Loadings	v	kg-BOD/m^3/day	0.1 - 0.2	0.2
Mixed Liquar Suspended Solid	MLSS	mg/l	3,000 - 4,000	4,000
Aeration Time	t*	hr	24 - 48	Approx. 24
Return Sludge Rate	r	%	50 - 150	max. 150
Water Depth	Do	m	1.0 - 2.5	2.5
Oxygen Requirement	Or	kg-O_2/kg-BOD removal	2.0	2.0
Sedimentation Tank				
Water Areal Loadings	Wa	m^3/m^2/day	10 - 15	15
Water Depth	Ds	m	2.5 - 4.0	3.0
Water Overflow Rate	Wo	m^3/m/day	under 150	same as left
Thickening Tank				
Solid Loadings	Sl	kg/m^2/day	60 - 90	under 60
Water Depth	Dt	m	4.0	4.0
Detention Time	t*	hr	over 12	over 12
Sludge Drying Bed				
Drying Time	t*d	day	15 - 20	15
Thickness of Sludge	t	m	0.1 - 0.2	0.2
No. of Beds	n	--	Over drying time	over 15

Result of Case Study

Results of capacity calculation relative to the case study for the three treatment methods, namely Waste Stabilization Ponds (WSP), Aerated Lagoon (AL) and Oxidation Ditch System (OD) are shown in TABLE A20-5. The following are the fundamental design data used for all calculations:

Design Flow : Qd.an = 1.0 m^3/s = 86,400 m^3/day
Influent BOD_5: Li = 250 mg/l
Influent SS : Si = 250 mg/l

TABLE A20-5 Case Study for Sewage Treatment Plant

(1/4)

ITEM \ TREATMENT METHOD	WASTE STABILIZATON POND	AERATED LAGOON (DUAL POWER)	OXYDATION DITCH
1. Design Criteria	Design Flowrate : Qd.av = 1.0 m³/s = 86,400 m³/day Influent BOD_5 : Li = 250 mg/l Influent SS : Si = 250 mg/l Influent BOD_5 Load : Li.l = 86,400 x 250 x 10^{-3} = 21,600 kg-BOD/day Influent SS Load : Si.l = 86,400 x 250 x 10^{-3} = 21,600 kg-SS/day		
2. Flowchart	Inlet ↓ Screen & Grit Chamber ↓ Primary Facultative Pond ↓ Secondary Facultative Pond ↓ Maturation Pond or Chlorination Tank (option) ↓	Inlet ↓ Screen & Grit Chamber ↓ Complete Mixing Aerated Lagoon ↓ Facultative Aerated Lagoon - 3 cells ↓ Sedimentation Tank ↓ Chlorination Tank ↓	Inlet ↓ Screen & Grit Chamber ↓ Oxydation Ditch ↓ Sedimentation Tank ↓ Chlorination Tank ↓ P — Return Sludge Pump P — Excess Sludge Pump Sludge Thickening Tank ↓ Sludge Drying Bed
3. Estimate Effluent Removal Rate BOD (%) SS (%) Effluent Quality BOD (mg/l) SS (mg/l)	(Exclude Maturation Pond) 80 — 49 —	88 76 30 60	92 88 20 30

TABLE A20-5 Case Study for Sewage Treatment Plant (cont'd - 1)

ITEM \ TREATMENT METHOD	WASTE STABILIZATION POND	AERATED LAGOON (DUAL POWER)	OXYDATION DITCH
4. Capacity Calculation	(1) Grit Chamber Type : Plug Flow Water Surface Load : 1,800 m³/m²/day Water Surface Area : A = 86,400 x 1/1,800 = 48 m² (2) Primary Faclutative Pond Type : Embanked Rectangular Type Water Surface Area (mid-depth) : Ap = Lil * 1/λ il = 21,600 * 1/382 = 56.55 ha (565,445 m²) Water Depth : Dp = 1.5 m Volume : Vp = 565,445 m² x 1.5m = 848,168 m³ Detention Time : t*p= 848,168 /86,400 = 9.82 days Effluent BOD : Lal= 250 x (1-0.7) = 75 mg/l Dimension : 100 m x 100 m x D 1.5 m x 57 basins (3) Secondary Facultative Pond Type : Embanked Rectangular Type Water Surface Area (mid-depth) : As = 86,400 x 75 x 10^{-3} x 1/200 = 32.4 ha (324,000m²) Water Depth : Ds = 1.5 m Volume : Vs = 324,000 * 1.5 = 486,000 m³ Detention Time : t* s Vs x 1/Qd.av = 486,000 / 86,400 Effluent BOD : Ls2= 75 * (1-0.35) = 48.8 mg/l Dimension : 100 m x 100 m x D 1.5 m x 49 basins	(1) Grit Chamber Same as left (2) Complete Mixing Aerated Lagoon Type : Embanked Rectangular Type Detention Time : t*c= 2.0 days Volume : Vc = 86,400 x 2.0 = 172,800 m³ Depth : Dc = 3.0 m Water Surface Area (mid-depth) : Ac = Vc/Dc = 172,800/3.0 = 57,600 m² Oxygen Requirment : Re = 6.24 x 10^{-5} x 86,400 x 250 = 1,348 kg-02/hr Power Requirment : a. as for Oxygen Requirment P = 1,348 kg-O_2/hr /2.0 kg/kWH = 674 kW b. as for Complete Mixing Power P= Vc x pc = 1,037 kW Dimension : 100 m x 48 m x D 3.0 m x 12 basins (3) Partial Mixing Aerated Lagoon (Facultative) Type : Embanked Rectangular Detention Time : t*p= 0.67 days x 3 cells Volume : Vf = 86,400 x 0.67 = 57,888 m³/cell Depth : Df = 3.0 m Water Surface Area : Ap = 57,888/3.0 = 19,296 m²/1-cell Power Requirment For Mixing: P = 57,888 x 1.5 x 10^{-3} x 3 = 261 kW Dimension : 100 m x 33 m x D 3.0 m x 18 basins	(1) Grit Chamber Same as left (2) Oxidation Ditch Type : Circulating Channel Volume : Vo = $\frac{86,400 \times 250}{4,000 \times 0.05}$ = 108,000 m³ Detention Time : t* = 108,000/86,400 x 24 = 30 hrs BOD Volumetric Load: Vv = $\frac{86,400 \times 250 \times 10^{-3}}{108,000}$ = 0.2 kg/m³/day Depth : Do = 2.5 m Water Surface Area : Ae = 108,000/2.5 = 4,320 m² Dimension W 6.0 m x L 300 m x D 2.5 m x 24 basins Oxygen Requirment Ro = 86,400 x 250 x 10^{-3} x 2.0 x 1.3 = 56,160 kg-O_2/day Power Requiement p = 56,160 kg-O_2/hr x 1/24 x 1/2.0 kg-O_2/kWH = 1,170 kw (3) Sedimentation Tank Type : Circular Tank Water Surface Area : As = 86,400/15 5,760 m² Depth : Ds = 3.0 m Volume : Vs = 5,760 x 3 = 17,280 m³ Detention Time : t* = 17,280/86,400 x 24 = 4.8 hrs Dimension : ϕ24.8 m x D 3.0 m x 12 basins (4) Thickening Tank Excess Sludge: Ds = 85,400 x (250-30) x 10^{-3} = 19,008 kg-Ds/day Ve = $\frac{19,008}{100 - 99.2}$ x 100 = 2,736 m³/day

TABLE A20-5 Case Study for Sewage Treatment Plant (cont'd - 2)

(3/4)

ITEM \ TREATMENT METHOD	WASTE STABILIZATION POND	AERATED LAGOON (DUAL POWER)	OXYDATION DITCH
		(4) Sedimentation Pond Type : Embanked Rectangular Detention Time : t*s= 1 day Volume : Vs = 86,400 x 1 = 86,400 m³ Depth : Ds = 3.0 m Water Surface Area (mid-depth) : As = 86,400/3.0 = 28,800 m² Dimension : 100 m x 48 m x D 3.0 m x 6 basins	Dry Solid Surface Area: Di = 40 kg-Ds/m²/day Water Surface Area : At = 19,008/40 = 475.2 m² Depth : Dt = 4.0 m Volume : Vt = 475.2 x 4.0 = 1,901 m³ Detention Time : t* = 1,901/2,376 x 24 = 19.2 hrs Dimension : φ12.3 m x D 4.0 m x 4 basins (5) Sludge Drying Bed Thickened Sludge : Vt = $\frac{19,008}{100-97}$ = 643 m³/day Area of Beds Ab = 634 m³/day x 15 days x 1/0.2 m = 47,550 m²
5. Total Detention Time	Primary Facultative Pond 9.82 days Secondary Facultative Pond 5.63 days total 15.45 days	Complete Mixing Aerated Lagoon 2.0 days Partial Mixing Aerated Lagoon 2.0 days Sedimentation Pond 1.0 days total 5.0 days	Oxydation Ditch 30.0 days Sedimentation Tank 4.8 days total 34.8 days
6. Estimated Effactive Land Requirment			
1) Total Surface Area	Primary Facultative Pond 56.55 ha Secondary Facultative Pond 32.40 ha total 88.95 ha	Complete Mixing Aerated Lagoon 5.76 ha Partial Mixing Aerated Lagoon 1.93x3=5.79 ha Sedimentation Pond total 14.43 ha	Oxydation Ditch 43,200 m² Sedimentation Tank 5,797 m² Thickening Tank 476 m² Sludge Drying Bed 47,700 m² total 97,173 m² (9.7 ha)
2) Estimated Effective Land Requirment	Approx. 180 ha	Approx. 29.0 ha	Approx. 17.0 ha

TABLE A20-5 Case Study for Sewage Treatment Plant (cont'd - 3)

ITEM \ TREATMENT METHOD	WASTE STABILIZATION POND	AERATED LAGOON (DUAL POWER)	OXYDATION DITCH
7. Total Motor Power	———	Aerator-I (C.A.L) 30 kW x 24 sets = 720 kW 18.5 kW x 24 sets = 444 kW Aerator-II (p.A.L) 5.5 kW x 36 sets = 198 kW Total = 1,362 kW	Aerator 15 kW x 96 sets = 1,440 kW S.T.Sludge Collector 3.7 kW x 12 sets = 44.4 kW Return Sludge Pump 11 kW x 24 sets = 264 kW Excess Sludge Pump 7.5 kW x 12 sets = 90 kW T.T.Sludge Collector 2.2 kW x 4 sets = 8.8 kW Thickened Sludge Pump 5.5 kW x 4 sets = 22 kW Total = 1,871 kW

APPENDIX 21

COST ESTIMATES

TABLE A21-1 BREAKDOWN OF UNIT PRICE (STABILIZATION POND Q=1.00 m3/s)

US($)

Particular	Description	Unit	Q'ty	L. Currency					F. Currency					Remarks	
				Unit Cost	Sub Amount	Tax	Total Tax	Amount	Unit Cost	Sub Amount	Tax	Total Tax	Amount		
Pharshall Flume	Q=1.00m3/s	m3/s	0.19	1,349.38	256.38	163.75	31.11	287.49	3,781.51	718.49	5,120.17	972.83	1,691.32	Item No.3	
Grit Chamber	Q=1.00m3/s	m3/s	0.19	13,161.70	2,500.72	1,698.00	322.62	2,823.34	6,426.00	1,220.94	8,700.80	1,653.15	2,874.09	Item No.4	
Embankment	Excavation	m3	252,520.00	1.31	330,801.20			330,801.20							
	Embankment	m3	127,310.00	0.54	68,420.96			68,420.96							
	Disposal soil	m3	125,210.00	1.15	143,991.50			143,991.50							
Connection Pipe	Detail A+E	Nos	6.00	2,236.51	13,419.06			13,419.06							
	Detail A+E+F	Nos	30.00	3,545.45	106,363.50			106,363.50							
	Detail C+F	Nos	6.00	941.87	5,651.22			5,651.22							
	Detail D+G+2	Nos	18.00	3,163.62	56,945.16			56,945.16							
Plain Concrete	For Base	m3	4,320.00	32.49	140,356.80	4.80	20,736.00								
Others	5% of Concrete	L.S			7,017.84									Caulking etc.	
Total Per Q=0.19m3/s					875,724.35		21,089.73	728,703.44		1,939.43		2,625.93	4,565.00		
Per Q=1.00m3/s (1/0.19m3*0.7)					3,226,352.87		77,699.01	2,684,696.89		7,145.26		9,674.68	16,819.94		

Work Site _____ Price 3,320,871.82

Work _____

Item No. 1 Q=1.00m3/s

L.C	3,226,352.87	Tax	77,699.01
F.C	7,145.26	Tax	9,674.68
Total	3,233,498.13		87,373.70
G. Total	3,320,871.82		

Remarks

A21-1

TABLE A2i-2 BREAKDOWN OF UNIT PRICE (AELATED LAGOON, Q=1.00 m3/s)

Particular	Description	Unit	Q'ty	L.Currency					f.Currency					Remarks	
				Unit Cost	Sub Amount	Tax	Total Tax	Amount	Unit Cost	Sub Amount	Tax	Total Tax	Amount		
Pharshall Flime	Q=1.00m3/s	m3/s	1.00	1,349.38	1,349.38	163.75	163.75	1,513.13	3,781.51	3,781.51	5,120.17	5,120.17	8,901.68	Item No.3	
Grit Chamber	Q=1.00m3/s	m3/s	1.00	13,161.70	13,161.70	1,698.00	1,698.00	14,859.70	6,426.00	6,426.00	8,700.80	8,700.80	15,126.80	Item No.4	
Embankment	Excavation	m3	540,000.00	1.31	707,400.00			707,400.00							
	Embankment	m3	122,320.00	0.54	65,739.16			65,739.16							
	Disposal soil	m3	417,680.00	1.15	480,332.00			480,332.00							
Rainforced Concrete		m3	500.40	41.54	20,786.62	5.73	2,867.29	23,653.91							
Rainforcing Bar		Ton	60.50	516.45	31,245.23	80.22	4,853.31	36,098.54							
Connection Pipe	Detail A+E	Nos	6.00	2,485.02	14,910.12			14,910.12							
	Detail A+E+F	Nos	30.00	3,939.39	118,181.70			118,181.70							
	Detail C+F	Nos	6.00	1,046.53	6,279.18			6,279.18							
	Detail D+G*2	Nos	18.00	3,515.14	63,272.52			63,272.52							
Others	5% of Concrete	L.S	1.00		1,039.33									Caulking etc.	
Total Per Q=1.00m3/s					1,523,696.93		9,582.35	1,532,239.95		10,207.51		13,820.97	24,028.48		

	Work Site		Price	1,557,307.77			
	Work Aerated Ragoon						Remarks
Item No.2	q=1.00m3/s	L.C	1,523,696.93	Tax	9,582.35		
		F.C	10,207.51	Tax	13,820.97		
		Total	1,533,904.45		23,403.32		
		G. Total	1,557,307.77				

TABLE A21-3 BREAKDOWN OF UNIT PRICE (PARSHALL FLUME, Q=1.00 m3/s)

Particular	Description	Unit	Q'ty	L.Currency					F.Currency					Remarks	
				Unit Cost	Sub Amount	Tax	Total Tax	Amount	Unit Cost	Sub Amount	Tax	Total Tax	Amount		
Excavation		m3	73.90	1.31	96.81			96.81							
Disposal soil		m3	29.60	3.72	110.11			110.11							
Backfill		m3	44.30	1.15	50.95			50.95							
Rainforced Concrete		m3	8.30	41.54	344.78	5.73	49.55	394.33							
Plain Concrete		m3	6.70	32.49	217.68	4.80	33.50	251.18							
Rainforcing Bar		Ton	1.10	516.45	568.10	80.22	91.97	660.07							
Form Work		m2	65.10	3.97	258.45	0.47	31.90	290.35							
Scaffold		m2	59.80	3.77	225.45	0.43	26.91	252.36							
Luders		Nos	5.00	7.70	38.50			38.50							
Water Level Gage		L.S	1.00						5,400.00	5,400.00		7,311.60	12,711.60		
P.V.C Pipe		L.S	1.00	16.10	16.10			16.10							
Others		L.S	1.00												
Total Q=1.428m3/2					1,926.92		233.83	2,160.75		5,400.00		7,311.60	12,711.60		
Per 1.00m3/sec					1,349.38		163.75	1,513.13		3,781.51		5,120.17	8,901.68		

	Work Site		Price	10,414.81	
	Work Pharshall Flum				Remarks
Item No. 3	Q=1.000m3/s	L.C	1,349.38	Tax	163.75
		F.C	3,781.51	Tax	5,120.17
		Total	5,130.90		5,283.92
		G. Total	10,414.81		

TABLE A21-4 BREAKDOWN OF UNIT PRICE (GRIT CHAMBER Q=1.00 m3/s)

Particular	Description	Unit	Q'ty	L.Currency					F.Currency					Remarks	
				Unit Cost	Sub Amount	Tax	Total Tax	Amount	Unit Cost	Sub Amount	Tax	Total Tax	Amount		
Excavation		m3	361.10	1.31	473.04			473.04							
Disposal Soil		m3	204.90	3.72	762.23			762.23							
Backfill		m3	156.20	1.15	179.63			179.63							
Ground Leveling		m3	17.50	16.67	291.73	2.28	41.65	333.38							
Leveling Concrete		m3	8.80	32.49	285.91	4.80	44.00	329.91							
Rainforced Concrete		m3	76.10	41.54	3,161.19	5.73	454.32	3,615.51							
Plain concrete		m3	11.00	32.49	357.39	4.80	55.00	412.39							
Rainforcing Bar		T	9.90	516.45	5,112.86	80.22	827.74	5,940.59							
Form Work		m2	431.30	3.97	1,712.26	0.47	211.34	1,923.60							
Scaffold		m2	142.13	3.77	535.84	0.43	63.96	599.80							
Set of Luders		set	30.00	7.70	231.00			231.00							
Stop Log		set	6.00	9.77	58.62			58.62							
Set of Bar Screen	1.2w*1.5h	set	3.00						2,142.00	6,426.00	2,900.27	8,700.80	15,126.80		
Total Q=1.00m3/s					13,161.70		1,698.00	14,859.70		6,426.00		8,700.80	15,126.80		

	Work Site Grit Chamber	Price	29,986.51			
	Work					Remarks
Item No.4	Q=1.00m3/s	L.C	13,161.70	Tax	1,698.00	
		F.C	6,426.00	Tax	8,700.80	
		Total	19,587.70		10,398.81	
		G. Total	29,986.51			

TABLE A21-5 BREAKDOWN OF UNIT PRICE (INTAKE FACILITY, Q=1.00 m3/s)

Particular	Description	Unit	Q'ty	L.Currency					F.Currency					Remarks	
				Unit Cost	Sub Amount	Tax	Total Tax	Amount	Unit Cost	Sub Amount	Tax	Total Tax	Amount		
Excavation		m3	1,092.20	1.31	1,430.78			1,430.78							
Disposal Soil		m3	544.50	3.72	2,025.54			2,025.54							
Backfill		m3	577.70	1.15	664.36			664.36							
Ground Leveling		m3	24.48	16.67	408.08	2.38	58.26	466.34							
Leveling Concrete		m3	12.24	32.49	397.68	5.00	61.20	458.88							
Rainforced Concrete		m3	210.43	41.54	8,741.26	5.97	1,256.27	9,997.53							
Plain concrete		m3	10.75	32.49	349.27	5.00	53.75	403.02							
Rainforcing Bar		Ton	27.36	516.45	14,130.07	83.61	2,287.57	16,417.64							
Form Work		m2	808.96	3.97	3,211.57	0.49	396.39	3,607.96							
Scaffold		m2	105.00	3.77	395.85	0.45	47.25	443.10							
Luders		Nos	74.00	7.70	569.80			569.80							
Gate	φ600	Nos	2.00					0.00	22,378.00	44,756.00	30,299.81	60,599.62	105,355.62		
Bar Screen	1.2w*1.5h	Nos	2.00					0.00	4,285.00	8,570.00	5,801.89	11,603.78	20,173.78		
Stop Log		Nos	2.00	9.77	19.54			19.54							
Maintenance House		m2	63.00	1,400.00	90,720.00	160.00	10,080.00	10,800.00							
Pharshall Flume	Q=2.00m3/s	m3/s	2.00	2,698.76	2,698.75	327.50	327.50	3,026.26	7,563.02	7,563.02	10,240.35	10,240.34	17,803.36		
Total Q=2.00m3/s					125,762.56		14,568.19	140,330.75		60,889.02		82,443.74	143,332.76		
Per Q=1.00m3/s					62,881.28		7,284.09	70,165.37		30,444.51		41,221.87	71,666.38		

	Work Site	Intake Facility	Price	141,831.76			
	Work						Remarks
Item No. 5			L.C	62,881.28	Tax	7,284.09	
			F.C	30,444.51	Tax	41,221.87	
			Total	93,325.79		48,505.97	
			G. Total	141,831.76			

TABLE A21-6
Alternative E-1
Construction cost for conduit
Phase 1

	L.C		F.C	
	Cost	Tax	Cost	tax
span A - B	34,221.40	4,368.07	72,798.26	89,937.06
span B - C	1,774,048.97	232,551.98		
span C - D	507,447.60	61,890.34		
span D - E	3,349,567.35	433,633.95	692,712.00	856,883.28
span E - F	2,520,911.30	304,959.69	2,142.00	2,960.00
span F - G	3,103,147.65	349,712.10	4,925,569.35	6,963,780.98
span G - H	844,764.20	73,385.60		
Sub Total	12,134,108.47	1,460,501.73	5,693,221.61	7,913,501.32
Total Cost		¥2,495,826,211		17,827,330.08
Total Tax		¥1,312,360,427		9,374,003.05
G.Total		¥3,808,186,638		27,201,333.13

TABLE A21-7
Alternative E-1
Construction Cost for Conduit
Phase II

	L.C		F.C	
	Cost	Tax	Cost	Tax
Span A - B	2,213,538.40	286,707.40	22,194.80	35,996.55
Span B - C	1,643,350.70	201,266.15		
Span C - D	1,496,207.40	182,314.77		
Span D - E	1,384,078.90	162,140.50	1,868,042.00	2,373,041.50
Span E - F	248,646.40	9,058.75	2,542,228.00	3,239,064.75
Span F - G	640,320.70	60,043.10	2,432,878.00	3,099,962.00
Span G - H	2,053,120.00	250,310.48		
Span H - I	1,536,692.10	188,186.80	669,026.00	849,215.75
Span I - J	1,718,469.20	157,245.60		
Sub Total	12,934,423.80	1,497,273.55	7,534,368.80	9,597,280.55
Total Cost		¥2,865,630,964		20,468,792.60
Total Tax		¥1,553,237,574		11,094,554.10
G.Total		¥4,418,868,538		31,563,346.70

TABLE A21-8
SPAN A - B (Phase I)

Span A - B

Discription	Q'ty unit	L.C Unit Cost	L.C Unit Cost Tax	L.C Total	L.C Total Tax	F.C Unit Cost	F.C Unit Cost Tax	F.C Total	F.C Total Tax
Concrete Pipe Φ800	146 m	145.14	21.77	21,190.44	3,178.42				
Piping Work	146 m	34.58		5,048.68					
Ashalt Pavement 2x164	328 m2	3.56	0.59	1,167.68	193.52				
Manhole	1 nos	690.60	89.13	690.60	89.13				
Inlet Manhole 1	50 I.V	122.48	18.14	6,124.00	907.00				
				34,221.40	4,368.07				

TABLE A21-9
SPAN B-C (Phase I)

SPAN B - C

Description	Q'ty Unit	L.C Unit Cost	L.C Unit Cost Tax	L.C Total	L.C Total Tax	F.C Unit Cost	F.C Unit Cost Tax	F.C Total	F.C Total Tax
P.C Pipe Φ1000(4kg)	2,587 m	352.28	52.84	911,348.36	136,697.08				
Piping Work	2,587 m	40.93		105,885.91					
P.C Pipe Φ1000(6kg)	1,500 m	378.13	56.72	567,195.00	85,080.00				
Piping Work	1,500 m	40.93		61,395.00					
Tight Manhole 1	40 I.V	122.48	18.14	4,899.20	725.60				
Valve Box 1	40 I.V	122.48	18.14	4,899.20	725.60				
Tee 1000x500	2 nos					2,671.43	3,793.90	5,342.86	7,587.80
Stop Valve φ1000	1 nos					57,194.20	70,096.93	57,194.20	70,096.93
Stop Valve φ500	1 nos					8,161.20	10,002.33	8,161.20	10,002.33
Air Relief Valve	1 nos					2,100.00	2,250.00	2,100.00	2,250.00
Excavation for Rock 3x2x500	3,000 m3	10.16		30,480.00					
Wash-Out Pipe φ500	50 m	100.90	15.13	5,045.00	756.50				
Piping Work	50 m	25.16		1,258.00					
Pipe Protection φ1000	60 m	66.89	9.67	4,013.40	580.20				
Drainage	30 Day	151.83		4,554.90					
Diversion Channel φ1000	100 m	393.21	27.65	39,321.00	2,765.00				
Asphalt Pavement 2x3500	7,000 m	3.56	0.59	24,920.00	4,130.00				
Concrete Pavement 2x700	1,400 m	6.31	0.78	8,834.00	1,092.00				
Total				1,774,048.97	232,551.98			72,798.26	89,937.06

TABLE A21-10

SPAN C-D (Phase I)

Span C - D

Description	Q'ty	Unit	L.C Unit Cost	L.C Tax	L.C Total	L.C Tax	F.C Unit Cost	F.C Tax
Concrete Pipe φ1100	1,590	m	253.28	37.99	402,715.20	60,404.10		
Piping Work	1,590	m	58.92		93,682.80			
Manhole	16	nos	690.60	92.89	11,049.60	1,486.24		
Total					507,447.60	61,890.34		

TABLE A21-11

SPAN D-E (Phase I)

Span D - E

Description	Q'ty	Unit	L.C Unit Cost	L.C Tax	L.C Total	L.C Tax	F.C Unit Cost	F.C Tax	F.C Total	F.C Tax
P.C Pipe φ1400 (4kg)	5,145	m	545.52	81.83	2,806,700.40	421,015.35				
Piping Work	5,145	m	86.27		443,859.15					
Valve Box S	200	I.V	122.48	18.14	24,496.00	3,628.00				
Tee 1350x600	4	nos					5,250.00	7,455.92	21,000.00	29,823.68
Tee 1350x300	5	nos					5,250.00	7,455.92	26,250.00	37,279.60
Stop valve φ300	5	nos					2,390.20	2,929.42	11,951.00	14,647.10
Stop valve φ1350	5	nos					125,022.20	153,226.58	625,111.00	766,132.90
Wash-out Pipe φ300	250	m	19.08	2.98	4,770.00	745.00				
Piping Work	250	m	11.83		2,957.50					
Pipe Protection φ1350	60	m	108.89	15.81	6,533.40	948.60				
Drainage	30	Day	151.83		4,554.90					
Diversion Channel φ1350	100	m	439.26	53.72	43,926.00	5,372.00				
Timbering	500	m2	2.18	0.31	1,090.00	155.00				
Asphalt Pavement 2x1500	3,000	m2	3.56	0.59	10,680.00	1,770.00				
Air Relief Valve	4	nos					2,100.00	2,250.00	8,400.00	9,000.00
Total					3,349,567.35	433,633.95			692,712.00	856,883.28

TABLE A21-12

SPAN E-F(Phase I)

Span E - F

Description	Q'ty Unit	F.C Unit Cost		F.C Total		L.C Unit Cost		L.C Total	
		Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
Concrete Pipe ϕ600	600 m	100.90	15.13	60,540.00	9,078.00				
Piping Work	600 m	25.16		15,096.00					
Manhole	6 nos	690.69		4,143.60					
Canal 1000x500	3,500 m	8.60		30,100.00					
Concrete Pipe ϕ1350	5,365 m	358.14	53.72	1,921,421.10	288,207.80				
Piping Work	5,365 m	81.12		435,208.80					
Asphlt Pavement 2x2500	5,000 m2	3.56	0.59	17,800.00	2,950.00				
Manhole	53 nos	690.60	89.13	36,601.80	4,723.89				
Screen	1 nos					2,142.00	2,900.00	2,142.00	2,900.00
Total				2,520,911.30	304,959.69			2,142.00	2,900.00

TABLE A21-13

SPAN F-G(Phase I)

Span F - G

Description	Q'ty Unit	F.C Unit Cost		F.C Total		L.C Unit Cost		L.C Total	
		Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
P.C Pipe ϕ1200 (4kg)	3,140 m	524.62	78.69	1,647,306.80	247,086.60				
Piping Work	3,140 m	70.91		222,657.40					
P.C Pipe ϕ1200 (5kg)	1,000 m	580.92	87.14	580,920.00	87,140.00				
Piping Work	1,000 m	70.91		70,910.00					
D.C.I Pipe ϕ1200	5,645 m					836.19	1,187.54	4,720,292.55	6,703,663.30
Piping Work	5,645 m	70.91		400,286.95					
Pass tp Rurin River	500 m	190.01	15.81	95,005.00	7,905.00				
Tight Manhole 2	80 I.V	122.48	18.14	9,798.40	1,451.20				
Valve Box 1	80 I.V	122.48	18.14	9,798.40	1,451.20				
Tee 1350x600	4 nos					5,650.00	8,023.98	22,600.00	32,095.96
Stop Valve ϕ600	2 nos					14,440.80	17,698.57	28,881.60	35,397.14
Air Relief Valve	2 nos					2,100.00	2,250.00	4,200.00	4,500.00
Stop Valve ϕ1350	1 nos					125,022.00	153,226.58	125,022.20	153,226.58
Excavation for Rock 3x1.5x500	2,250 m3	10.16		22,860.00					
Excavation for Storn 3x3.5x10	1,050 m3	1.31		1,375.50					
Wash-out Pipe ϕ600(DIP)	100 m					245.73	348.98	24,573.00	34,898.00
Piping Work	100 m	25.16		2,516.00					
Pipe Protection ϕ1350	250 m	108.89	15.81	27,222.50	3,952.50				
Drainage	50 Day	151.83		7,591.50					
Out Fall	40 I.V	122.48	18.14	4,899.20	725.60				
Total				3,103,147.65	349,712.10			4,925,569.35	6,963,780.98

TABLE A21-14

Span G-H (Phase I)

Span G - H

			L.C				F.C			
			Unit Cost		Total		Unit Cost		Total	
Description	Q'ty	Unit	Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
Open Channel 1900x950	3,500	m	233.43	20.76	817,005.00	72,660.00				
Outlet Manhole	40	I.V	122.48	18.14	4,899.20	725.60				
Excavation for Rock (3x1.5x500)	2,250	m3	10.16		22,860.00					
Total					844,764.20	73,385.60				

TABLE A21-15

Span A-B(Phase II)

Span A - B

			L.C				F.C			
			Unit Cost		Total		Unit Cost		Total	
Description	Q'ty	Unit	Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
Concrete Pipe φ1400(4kg)	3,350	m	545.52	81.83	1,827,492.00	274,130.50				
Piping Work	3,350	m	86.27		289,004.50					
Pipe Protection φ1350	160	m	108.89	15.81	17,422.40	2,529.60				
Asphlt Pavement	3,750	m2	3.56	0.59	13,350.00	2,212.50				
Drainage	30	Day	151.83		4,554.90					
Diversion Channel φ1350	100	m	439.28	53.72	43,928.00	5,372.00				
Wash-out Pipe φ300(4kg)	100	m	30.91	2.86	3,091.00	285.00				
Tight Manhole 1	40	I.V	122.48	18.14	4,899.20	725.60				
Valve Box 2	80	I.V	122.48	18.14	9,798.40	1,451.20				
Tee 1350x600	2	nos					5,650.00	8,023.99	5,652.00	16,047.98
Stop Valve φ600	1	nos					14,440.80	17,698.57	14,441.80	17,698.57
Air Relief Valve	1	nos					2,100.00	2,250.00	2,101.00	2,250.00
Total					2,213,538.40	286,707.40			22,194.80	35,996.55

TABLE A2/-16

SPAN B-C(Phase II)

Span B - C

		F.C				L.C			
		Unit Cost		Total		Unit Cost		Total	
Description	Q'ty Unit	Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
Concrete Pipe φ1350	3,675 m	358.14	53.72	1,316,164.50	197,421.00				
Piping work	3,675 m	81.12		298,116.00					
Manhole	35 nos	690.60	89.13	24,171.00	3,119.55				
Outlet Manhole 1	40 l.V	122.48	18.14	4,899.20	752.60				
Total				1,643,350.70	201,293.15				

TABLE A2/-17

SPAN C-D (Phase II)

Span C - D

		L.C				F.C			
		Unit Total		Total		Unit Total		Total	
Description	Q'ty Unit	Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
Concrete Pipe φ1500	3,000 m	399.37	59.91	1,198,110.00	179,730.00				
Piping Work	3,000 m	92.69		278,070.00					
Diversion Channel φ1350	100 m								
Drainage	15 Day								
Manhole	29 nos	690.60	89.13	20,027.40	2,584.77				
Total				1,496,207.40	182,314.77				

TABLE A21-18

SPAN D-E(Phase II)

Span D - E(Phase II)

		L.C				F.C			
		Unit Cost		Total		Unit Cost		Total	
Description	Q'ty Unit	Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
P.C Pipe 4kg φ1400	1,000 m	545.52	81.83	545,520.00	81,830.00				
Piping Work	1,000 m	86.27		86,270.00					
P.C Pipe 6kg φ1400	800 m	617.28	92.59	493,824.60	74,072.00				
Piping Work	800 m	86.27		69,016.00					
D.C.I Pipe φ1350	1,800 m					1,029.50	1,307.46	1,853,100.00	2,353,428.00
Piping Work	1,800 m	81.12		146,016.00					
Tight Manhole 2	80 I.V	122.48	18.14	9,798.40	1,451.20				
Tee 1200x600	1 nos					4,300.00	6,106.75	8,600.00	12,213.50
Inlet Manhole 1	50 I.V	122.48	18.14	6,124.00	907.00				
Screen	1 nos					2,142.00	2,900.00	2,142.00	2,900.00
Pipe Protection φ1200	90 m	91.51	13.27	8,235.90	1,194.30				
Timbering	100 m2	2.18	0.31	218.00	31.00				
Asphalt pavement	4,500 m	3.56	0.59	16,020.00	2,655.00				
Drainage	20 Day	151.83		3,036.60					
Air Relief Valve	2 nos					2,100.00	2,250.00	4,200.00	4,500.00
Total				1,384,078.90	162,140.50			1,868,042.00	2,373,041.50

TABLE A21-19
SPAN E-F (Phase II)

Span E - F

		L.C				F.C			
		Unit Cost		Total		Unit Cost		Total	
Description	Q'ty Unit	Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
D.C.I Pipe φ1350□	2,250 m					1,029.50	1,307.46	2,316,375.00	2,941,785.00
Piping Work	2,250 m	81.12		182,520.00					
Tight Manhole 1	40 I.V	122.48	18.14	4,899.20	725.60				
Pressure relief Manhole	150 I.V	122.48	18.14	18,372.00	2,721.00				
Valve Box 1	40 I.V	122.48	18.14	4,899.20	725.60				
Tee 1200x600	2 nos					4,300.00	6,106.75	8,600.00	12,213.50
Stop Valve φ1200	1 nos					87,979.40	107,827.11	87,979.40	107,827.11
Stop Valve φ600	2 nos					14,440.80	17,698.57	28,881.60	35,397.14
Air Relief Valve	1 nos					2,100.00	2,250.00	2,100.00	2,250.00
Wash-out Pipe DIPφ600	400 m					245.73	348.98	98,292.00	139,592.00
Pipe Protection φ1200	160 m	91.51	13.27	14,641.60	2,123.20				
Out Fall 1	40 I.V	122.48	18.14	4,899.20	725.60				
Drainage	40 Day	151.83		6,073.20					
Timbering	150 m2	2.18	0.31	327.00	46.50				
Asphalt Pavement	3,375 m	3.56	0.59	12,015.00	1,991.25				
Total				248,646.40	9,058.75			2,542,228.00	3,239,864.75

TABLE A21-20
SPAN F-G(Phase II)

Span F - G

		F.C				L.C			
		Unit Cost		Total		Unit Cost		Total	
Description	Q'ty Unit	Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
P.C Pipe 4kg φ1400	400 m	545.52	81.83	218,208.00	32,732.00				
Piping Work	400 m	86.27		34,508.00					
P.C Pipe 6kg φ1400	200 m	617.28	92.59	123,456.00	18,518.00				
Piping Work	200 m	86.27		17,254.00					
D.C.I Pipe φ1350	2,150 m								
Piping Work	2,150 m	81.12		174,408.00		1,029.50	1,307.46	2,213,425.00	2,811,039.00
Pressure relief Manhole	150 I.V	122.48	18.14	18,372.00	2,721.00				
Stop Valve φ1200	1 nos					87,979.40	107,827.11	87,979.40	107,827.11
Stop Valve φ600	2 nos					14,440.80	17,698.57	28,881.60	35,397.14
Tee 1200x600	1 nos					4,300.00	6,106.75	4,300.00	6,106.75
Wash-out Pipe DIP φ600	400 m					245.73	348.98	98,292.00	139,592.00
Pipe Protection φ1200	190 m	91.51	13.27	17,386.90	2,521.30				
Valve Box 2	80 I.V	122.48	18.14	9,798.40	1,451.20				
Out Fall	40 nos	122.48	18.14	4,899.20	725.60				
Drainage	40 Day	151.83		6,073.20					
Timbering	150 m2	2.18	0.31	327.00	46.50				
Asphalt Pavement	2,250 m	3.56	0.59	8,010.00	1,327.50				
Excavation for Rock 1.5x1x500	750 m	10.16		7,620.00					
Total				640,320.70	60,043.10			2,432,878.00	3,099,952.00

TABLE A21-21
SPAN G-H(Phase II)

Span G - H

			F.C			L.C			
		Unit Cost		Total		Unit Cost		Total	
Description	Q'ty Unit	Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
Concrete Pipe φ1500	4,105 m	399.37	59.91	1,639,413.25	245,930.55				
Piping Work	4,105 m	92.69		320,492.45					
Manhole	41 nos	690.60	89.13	28,314.60	3,654.33				
Putlet Manhole 1	40 I.V	122.48	18.14	4,899.20	725.60				
Total				1,993,119.50	250,310.48				

TABLE A21-22
SPAN H-1(Phase II)

Span H - 1

			F.C			L.C			
		Unit Cost		Total		Unit Cost		Total	
Description	Q'ty Unit	Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
P.C Pipe 4kg φ1400	1,000 m	545.52	81.83	545,520.00	81,830.00				
Piping Work	1,000 m	86.27		86,270.00					
P.C Pipe 6kg φ1400	1,000 m	617.28	92.59	617,280.00	92,590.00				
Piping Work	1,000 m	86.27		86,270.00					
D.C.I Pipe φ1350	500 m					1,029.50	1,307.46	514,750.00	653,730.00
Piping Work	500 m	81.12		40,560.00					
Inlet Manhole 1	50 I.V	122.48	18.14	6,124.00	907.00				
Valve Box 2	80 I.V	122.48	18.14	9,798.40	1,451.20				
Pressure relief Manhole	150 I.V	122.48	18.14	18,372.00	2,721.00				
Pass tp Rurin River	500 m	162.42	13.27	81,210.00	6,635.00				
Tee 1200x600	2 nos					4,300.00	6,106.75	8,600.00	12,213.50
Stop Valve φ1200	1 nos					87,979.40	107,827.11	87,979.40	107,827.11
Stop Valve φ600	2 nos					14,440.80	17,698.57	28,881.60	35,397.14
Air Relief Valve	1 nos					2,100.00	2,250.00	2,100.00	2,250.00
Excavation for Rock 1.5x1x500	2,250 m	10.16		22,860.00					
Excavation for Storn 1.5x4x100	600 m	1.31		786.00					
Wash-out Pipe DIPφ600	100 m					245.73	348.98	24,573.00	34,898.00
Pipe Protection φ	100 m	91.51	13.27	9,151.00	1,327.00				
Out Fall	40 I.V	122.48	18.14	4,899.20	725.60				
Drainage	50 Day	151.83		7,591.50					
Screen	1 nos					2,142.00	2,900.00	2,142.00	2,900.00
Total				1,536,692.10	188,186.80			669,026.00	849,215.75

TABLE A2/-23
SPAN I-J(Phase II)

Span I - J

Description	Q'ty	Unit	F.C Unit Cost		F.C Total		L.C Unit Cost		L.C Total	
			Cost	Tax	Cost	Tax	Cost	Tax	Cost	Tax
Outlet Manhole 1	40	l.V	122.48	18.14	4,899.20	725.60				
Excavation for Rock 1.5x1x500	375	m	10.16		3,810.00					
Open Channel 2100x1050	6,500	m	263.04	24.08	1,709,760.00	156,520.00				
Total					1,718,469.20	157,245.60				

APPENDIX 22

RESULT OF SEA WATER QUALITY ANALYSIS

TABLE A22-1 BACTERIAL NUMBER IN SEAWATER IN THE REGULAR SAMPLING AREA (June 5 and 12, 1989)

Date	Station	1	2	3	4	5	6	7	8	9	10
06.05	Total Coliform (MPN/100ml)	3.9x10	2.4x10E7	2.4x10E5	4	2.4x10E4	2.4x10E2	4x10	2.4x10E2	2.4x10E3	4.3x10
06.05	Fecal Coliform (MPN/100ml)	2.3x10	2.4x10E6	2.4x10E5	4	4.6x10E3	<1	4x10	2.4x10E2	2.4x10E2	9

Date	Station	1	2	3	4	5	6	7	8	9	10
06.12	Total Coliform (MPN/100ml)	-	1.1x10E7	9.3x10E5	1.5x10	2.4x10E3	2.3x10	4x10	7	-	2.3x10E2
06.12	Fecal Coliform (MPN/100ml)	-	2.4x10E6	2.4x10E4	4	2.4x10E3	<1	4x10	4	-	2.3x10

TABLE A22-2 SALMONELLA NUMBER FOUND IN COLECTOR SURCO AND SEAWATER (June 12, 1989)

Point	MPN/100ml
Colector Surco -2	2.4 x 10E3
Seawater St.2	2.4 x 10E2
Seawater St.3	<1
Seawater St.5	<1

TABLE A22-3 QUALITY OF SEAWATER AROUND THE OUTFALL OF COLECTOR SURCO
(sampled on May 15 and 23, 1989)

SAMPLE			2	5	2-0m	2-3m	2-5m
Parameter	Date		5.15	5.15	5.23	5.23	5.23
Time			10:30	11:10	11:00	11:10	11:20
pH in the Laboratory			7.2	7.3	-	-	-
Nitrites + Nitrates	as N	mg/l	0.0	0.0	0.0	0.0	0.0
Ammonia	as N	mg/l	0.1	0.0	0.2	0.0	0.0
Organic Nitrogen	as N	mg/l	N.A	N.A	2.6	2.0	1.8
Total Phosphorus	as P	mg/l	0.3	0.2	0.9	0.2	0.1
Orthophosphate	as P	mg/l	N.A	N.A	-	-	-
BOD		mg/l	14	12	-	-	-
COD (Mn)		mg/l	41	10	122	82	41

Station	2	2a	5	6	9
Date	5.15	5.15	5.15	5.15	5.15
Total Coliform (MPN/100ml))	7.5x10E7	1.5x10E3	2.1x10E4	<1	2.1x10E2
Fecal Coliform (MPN/100ml)	-	-	-	-	-

Station	2-0m	2-3m	2-5m	5	6	10
Date	5.23	5.23	5.23	5.23	5.23	5.23
Total Coliform (MPN/100ml)	1.1x10E7	1.5x10E5	<2.4x10E3	1.5x10E2	2.3x10	2.3x10
Fecal Coliform (MPN/100ml)	4.6x10E6	1.2x10E5	<2.4x10E2	7x10	2.3x10	9

TABLE A22-4 QUALITY OF SEA WATER AROUND THE OUTFALL OF COLECTOR SURCO
(sampled on May 29, 1989)

Sampling was started at 11:15 and finished at 12:30. D.O at St.2 was 5.4 mg/l and at St.3 was 4.3 mg/l, respectively. Water temperature at all stations was 16 degrees centigrade.

ITEM \ STATION			1	2	3	4	5	6	7	8	9	10
pH in the Laboratory			7.15	7.15	7.20	7.25	7.25	7.25	7.20	7.25	7.20	7.20
Nitrites + Nitrates	as N	mg/l	0.25	0.1	0.1	0.1	0.1	0.06	1.0	0.3	0.0	0.0
Ammonia	as N	mg/l	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NA	NA	NA
Organic Nitrogen	as N	mg/l	2.0	1.7	1.7	1.5	NA	NA	NA	NA	NA	NA
Total Phosphorus	as P	mg/l	0.1	0.5	1.2	0.03	0.3	0.03	0.1	0.02	0.3	0.1
Orthophosphate	as P	mg/l	0.04	0.4	0.5	0.02	0.2	0.03	0.05	0.0	0.0	0.1
BOD		mg/l	4.3	14.4	17.1	3.8	3.0	3.4	6.3	4.2	4.6	0.8
COD (Mn)		mg/l	80	40	122	40	61	122	244	162	143	162

Station	1	2	3	4	5	6	7	8	9	10
Total Coliform (MPN/100ml)	4.3x10	2.4x10E7	2.4x10E7	<2.4x10E3	2.4x10E4	2.3x10	>2.4x10E3	>2.4x10E3	9	15
Fecal Coliform (MPN/100ml)	2.3x10	1.1x10E7	4.6x10E5	<2.4x10E3	2.4x10E4	<1	>2.4x10E3	>2.4x10E3	4	9

TABLE A22-5 QUALITY OF SEAWATER AROUND THE OUTFALL OF COLECTOR SURCO
(sampled on June 5, 1989)

ITEM \ STATION		1	2	3	4	5	6	7	8	9	10
DO	mg/l	9.0	8.8	9.2	-	5.8	2.9	3.1	3.0	-	8.9
pH in situ	mg/l	8.1	7.9	8.1	-	7.9	7.8	-	-	-	-
NO3-N + NO2-N	mg/l	0.0	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH4-N	mg/l	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Organic -N	mg/l	0.0	4.5	0.5	0.0	-	-	-	-	-	-
Total -P	mg/l	0.15	1.20	0.25	0.20	0.16	0.22	0.30	0.15	0.16	0.20
PO4-P	mg/l	0.10	1.10	0.13	0.11	0.15	0.11	0.12	0.12	0.10	0.17
SS	mg/l	150	180	190	210	300	510	450	502	451	441

TABLE A22-6 FECAL COLIFORM AND SALMONELLA IN SEAWATER

Site	Date	Fecal Coliform MPN/100ml	Salmonella MPN/100ml
Herradura	10.20.87	1.4×10^4	<1
	10.30.87	2.4×10^4	<1
	10.30.87	1.1×10^2	<1
Sampling sites are located in the area within 200 m from the outfall of Colector Surco and Punta La Chira Surco Colector and	10.30.87	2.1×10^2	<1
	10.30.87	1.1×10^5	<1
	11.09.87	4.6×10^6	1
	11.09.87	1.1×10^6	2.1
	11.09.87	1.1×10^6	2.4×10^2
	02.03.88	5.4	<1
	02.08.88	1.1×10^4	1.1×10^2
	03.07.88	3.4×10^5	<1
	03.08.88	3.8×10^2	<1

TABLE A22-7 BACTERIOLOGICAL ANALYSIS RESULTS

(½) 1989

SAMPLE	2	3	4	5	6	7	8	9	10
DATE / PARAMETER	16-10	16-10	16-10	16-10	16-10	16-10	16-10	16-10	16-10
TIME	10:30	10:35	10:40	11:10	11:40	11:45	11:50	12:10	12:00
TOTAL COLIFORM.	2.3×10^{6}	1.1×10^{6}	1.1×10^{4}	$>2.4\times10^{4}$	4.6×10^{2}	4.6×10^{2}	4.3x10	9	2.4x10
FECAL COLIFORM.	2.3×10^{6}	1.5×10^{5}	1.1×10^{4}	1.1×10^{4}	2.4×10^{2}	4.6×10^{2}	4.3x10	<1	4

SAMPLE	2	3	4	5	6	7	8	9	10
DATE / PARAMETER	23-10	23-10	23-10	23-10	23-10	23-10	23-10	23-10	23-10
TIME	10:15	10:25	10:35	10:50	11:45	11:30	11:15	12:15	12:10
TOTAL COLIFORM. MPN/100 ml.	9.3×10^{6}	4×10^{4}	4×10^{2}	2.3×10^{4}	1.1×10^{3}	1.1×10^{3}	1.1×10^{3}	2.4×10^{2}	2.3x10
FECAL COLIFORM. MPN/100 ml.	4.3×10^{6}	4×10^{4}	4×10^{2}	2.3×10^{4}	4.6×10^{2}	1.1×10^{3}	1.1×10^{3}	4.3x10	<1

OFICINA CONTROL DE CALIDAD DE AGUA Y DESAGUE

TABLE A22-7 BACTERIOLOGICAL ANALYSIS RESULTS (cont'd)

SEA WATER (2/2) 1989

SAMPLE	1-A	1-B	1-C	2	3	5	6	7	8
DATE / PARAMETER	30-10	30-10	30-10	30-10	30-10	30-10	30-10	30-10	30-10
TIME	10:20	10:25	10:35	10:50	10:45	11:05	11:25	11:20	11:15
TOTAL COLIFORM. MPN/100 ml.	4.6×10^{6}	4	< 1	4.3×10^{6}	4×10^{2}	9.3×10^{3}	4.6×10^{2}	7.5x10	1.1×10^{4}
FECAL COLIFORM. MPN/100 ml.	4.6×10^{6}	< 1	< 1	9×10^{5}	4×10^{2}	9.3×10^{3}	4.6×10^{2}	2.3x10	9.3×10^{2}

REMARK

1-A : 200 mt FROM SURCO SEWER TO THE SOUTH

2-B : 400 mt. FROM SURCO SEWER TO THE SOUTH

3-C : 1 Km. FROM SURCO SEWER TO THE SOUTH

TABLE A22-8 CORRELATION OF SALMONELLA TO FECAL COLIFORMS

(1989)

(½)

SAMPLE	DATE	TIME	SALMONELLA MPN/1 Lt.	TOTAL COLIFORM MPN/100 ml.	FECAL COLIFORM MPN/100 ml.	SS/FC
SURCO SEWER	19/09	11:00	1.1×10^{3}	4.6×10^{7}	2.4×10^{7}	4.58×10^{-6}
	29/09	10:45	1.1×10^{4}	2.4×10^{7}	1.1×10^{7}	1×10^{-4}
SEA WATER STATION 2	16/10	10:30	9.3	2.3×10^{6}	2.3×10^{6}	4.0×10^{-7}
SEA WATER STATION 3	16/10	10:35	1	1.1×10^{6}	1.1×10^{5}	9.0×10^{-7}
SEA WATER STATION 4	16/10	10:40	< 1	1.1×10^{4}	1.1×10^{4}	9.0×10^{-5}

TABLE A22-8 CORRELATION OF SALMONELLA TO FECAL COLIFORMS (cont'd)
(1987)

(2/2)

SAMPLE	DATE	TIME	SALMONELLA MPN/1 Lt.	TOTAL COLIFORM MPN/100 ml.	FECAL COLIFORM MPN/100 ml.	SS/FC
SEA WATER STATION 1A	30/10	10:20	2.1	4.6×10^6	4.6×10^6	4.5×10^{-5}
SEA WATER STATION 1B	30/10	10:25	< 1	4	< 1	10
SEA WATER STATION 1C	30/10	10:35	< 1	< 1	< 1	10

CEPIS TABLE A22-9 ANALISIS DE CONTAMINACION DE PLAYAS 1984 / 1987

DATOS DE TOTALES

Semana	42	43	44	45	46	47	48	49	50	51	52
PLAYAS	Totales	Totales	totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales
1 Country Club de Villa											
2 Cultural Lima	2400		15		23	1100	39	210	460	11000	4600
3 La Chira	1100		1100		240	46000	11000	2400	1500	46000	46000
4 La Herradura	240		23		43	23	460	2400	9	23	43
5 Regatas Playa	240		15		15	23	39	43	9	93	93
6 Regatas Playa	93		240		4	43	43	43	9	2400	43
7 Regatas Playa	8		23		9	23	240	15	21	2400	93
8 Pescadores	93		240		120	460	1100	240	43	1100	460
9 Agua Dulce	150		240		23	150	240	460	210	460	1100
10 Las Sombrillas			240	46	4	43	240	43	240	43	240
11 Los Yayos			11000	11000	460000	4600	12000	300	460000	21000	460000
12 Barranco	2400		2400	2100	460	2400	750	240	43	1100	460
13 Los Pavos	240		3	2400	460	1100	2400	43	240	93	1100
14 Barranquito	75		23	240	23	23	240	43	43	93	4600
15 Las Cascadas			1100	2100	2400	460	2400	2400	2400	11000	110000
16 Las Piedritas			1100	75	2400	240	460	210	240	1100	1100
17 La Estrella			1100	43	150	240	240	43	15	240	43
18 Redondo	460		39		460	93	15	240	23	460	2400
19 Makana			43		43	240	460	43	43	43	2400
20 La Pampilla	43		240		240000	93	240	110000	1100	460	240
21 Los delfines	240		23		75	93	240	23	93	460	9
22 Marbella	2400		43		150	460	460	23	210	4600	4600

CEPIS

TABLE A22-9 ANALISIS DE CONTAMINACION DE PLAYAS 1986 / 1987 (cont'd)

DATOS DE TOTALES

PLAYASY

Semana	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	MEDIA	DESV. STAD	DATOS	10^MEDIA
PLAYAS	Totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales	Totales				
1 Country Club de Villa					110000	460	2100	1100	150	240	11000	12000	1100	4600	1100	93	150	3.13	0.86	13	1335.83
2 Cultural Lima	43	2400	46000	93	1500	2400	11000	21000	43	43	11000	18000	4600	46000	4600	460	43	2.99	1.09	26	989.76
3 La Chira	7500	4600	4600	1500	11000	2400	640	11000	46000	4600	11000	12000			2400	460		3.51	0.97	24	3218.56
4 La Herradura	1100	460	4600	240	150	11000	93	46000	43	11000	460	1200	1100	460	43	240	460	2.50	0.93	26	319.69
5 Regatas Playa	43	4600	1100	93	43	1100	93	93	240	43	93	580	1100	4600	280	93	15	2.08	0.73	26	121.10
6 Regatas Playa	460	1100	4600	23	460	4600	1100	75	2400	1100	11000	9000	1100	2400	2400	43	2400	2.58	0.96	26	376.55
7 Regatas Playa	1100	4600	2400	930	4600	390	640	46000	460	460	1500	14000	2400	2400	2400	140	4600	2.70	1.01	26	500.34
8 Pescadores	1100	4600	750	11000	4600	46000	15000	110000	24000	2400	930	1700	4600	2400	750	93	460	3.14	0.84	26	1386.04
9 Agua Dulce	3200	1100	4600	46	11000	46000	46000	110000	4600	2400	240	1400	11000	2100	43	240	460	3.00	0.95	26	1004.72
10 Las Sombrillas	2400	240	4600	21	1100	4600	1200	2400	46000	2400	1200	3000	460	1500	240	4600	150	2.66	0.96	26	460.84
11 Los Toyos	5200	240	240	240	460	150	640	460	460	4600	93	450	460	240	43	1100	460	3.23	1.12	26	1717.08
12 Barranco	4800	11000	11000	150	1100	750	210	2100	4300	4600	11000	10000	2400	1500	2400	150	1100	3.14	0.62	27	1372.30
13 Los Pavos	240	43	240	2400	1100	1500	1100	93	150	460	460	93	460	4600	9	240	240	2.48	0.73	27	299.36
14 Barranquito	1200	43	240	2400	4600	240	1100	240	240	43	600	240	1100	240	43	93	240	2.30	0.67	27	200.09
15 Las Cabañas	46000	46000	93000	43	930	43	930	460	1100	43	960	240	460	43	4	43	150	2.94	1.11	26	878.39
16 Las Piedritas	2400	930	11000	4600	24000	2100	24000	460	4600	4600	7000	4600	46000	7500	2400	4600	11000	3.36	0.69	26	2294.65
17 La Estrella	1840	240	240	240	240	93	460	150	1100	240	640	46	1100	4600	75	4600	240	2.41	0.61	26	254.33
18 Redondo	1340	430	93	93	240	75	75	43	150	240	190	43	460	460	93	43	460	2.21	0.53	26	160.84
19 Makana	900	460	240	23	93	200	43	460	240	1100	860	43	150	240	23	43	93	2.16	0.57	25	144.87
20 La Pampilla	93	460	4600	240	240	240	930	240	39	43	280	93	240	460	93	93	23	2.52	0.92	26	332.57
21 Los delfines	2400	240	43	43	150	430	930	460	240	240	340	46	4600	200	150	460	4600	2.30	0.66	26	199.53
22 Marbella	1500	2400	1500	4600	11000	24000	9300	1100	240	11000	1300	460	460	1100	93	110	460	2.96	0.77	26	909.31

CEPIS

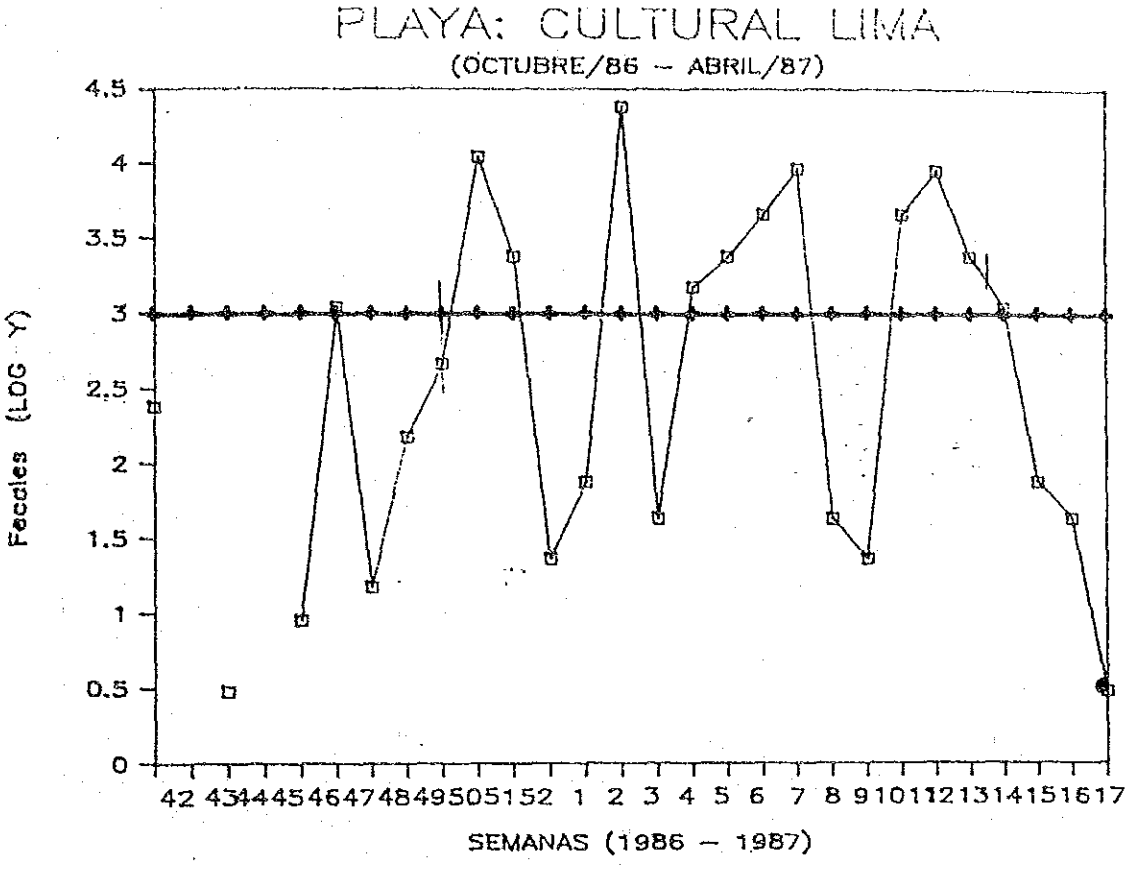
TABLE A22-10 ANALISIS DE CONTAMINACION DE PLAYAS 1986 / 1987

DATOS DE FECALES

Semana	42	43	44	45	46	47	48	49	50	51	52
PLAYAS	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales
1 Country Club de Villa											
2 Cultural Lima	240		3		9	1100	15	150	460	11000	2400
3 La Chira	460		240		93	4300	4600	460	460	9300	9300
4 La Herradura	43		3		9	4	460	43	9	9	15
5 Regatas Playa 3	93		4		3	9	7	9	4	43	43
6 Regatas Playa 2	23		43		3	7	9	9	3	150	15
7 Regatas Playa 1	3		4		4	23	240	3	21	240	43
8 Pescadores	43		4		39	150	28	43	15	150	460
9 Agua Dulce	23		240		4	21	11	23	93	93	460
10 Las Sombrillas			93	3	4	9	93	9	240	9	240
11 Los Yayos			11000	460	460000	4600	460	70	93000	9300	460000
12 Barranco	2400		460	23	460	2400	460	240	9	93	9
13 Los Pavos	240		3	23	28	1100	1100	15	93	43	75
14 Barranquito	75		9	9	23	23	15	3	4	15	140
15 Las Escadas			1100	23	1100	460	460	23	2400	4600	2400
16 Las Piedritas			460	9	2400	240	240	9	15	28	240
17 La Estrella			9	4	150	21	15	3	4	43	43
18 Redondo	23		3		93	15	4	240	4	43	23
19 Makana			4		43	23	23	4	7	9	23
20 La Pampilla	43		15		240000	93	240	110000	150	240	240
21 Los Delfines	23		9		75	23	93	9	23	43	3
22 Marbella	2400		4		93	43	93	9	9	4600	23

TABLE A22-10 ANALISIS DE CONTAMINACION DE PLAYAS 1986 / 1987 (cont'd)

	DATOS DE FECALES																	PLAYAS			
Semana	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	MEDIA	DESV. STAD	DATOS	10^MEDIA
PLAYAS	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales	Fecales				
1 Country Club de Villa					1500	43	2100	240	150	240	2100	8900	460	460	150	3	7	2.40	0.95	13	249.58
2 Cultural Lima	23	75	24000	43	1500	2400	4600	9300	43	23	4600	9000	2400	1100	75	43	3	2.49	1.15	26	309.22
3 La Chira	7500	4600	1500	1100	11000	930	640	11000	15000	2400	2100	6000			240	23		3.07	0.96	24	1163.85
4 La Herradura	1100	240	460	21	75	1200	43	9300	23	4600	460	1100	930	43	24	240	460	2.03	0.94	26	107.00
5 Regatas Playa 3	43	2400	460	15	43	150	43	43	21	43	43	460	1100	460	23	3	3	1.57	0.80	26	37.32
6 Regatas Playa 2	460	93	150	4	460	7	1100	75	460	460	2400	2000	460	43	43	3	3	1.72	0.93	26	52.74
7 Regatas Playa 1	93	240	93	15	2400	23	640	4300	150	460	1500	8000	2400	43	23	3	43	1.94	1.01	26	86.14
8 Pescadores	460	750	240	240	2400	700	9300	9300	4300	2400	460	1400	2400	23	240	3	93	2.38	0.94	26	241.36
9 Agua Dulce	122	150	4600	240	11000	230	9300	46000	4600	2400	240	1200	2400	93	23	3	4	2.32	1.12	26	208.57
10 Las Sombrillas	20	93	150	4	460	930	750	2400	1500	930	750	1000	460	930	15	9	23	1.99	0.92	26	97.52
11 Los Yayos	40	93	240	43	93	3	390	93	460	2400	43	300	93	43	9	20	9	2.53	1.35	26	387.34
12 Barranco	75	46000	1100	3	43	23	150	1500	4300	2400	11000	6000	930	43	23	3	4	2.32	1.14	27	209.16
13 Los Pavos	93	9	240	93	1100	430	460	93	75	240	216	43	93	21	4	43	9	1.88	0.69	27	75.36
14 Barranquito	42	9	93	75	230	93	1100	93	240	43	430	15	75	15	3	4	9	1.51	0.67	27	32.31
15 Las Cascadas	9300	15000	4300	43	90	43	1100	240	460	43	320	23	93	9	3	3	4	2.29	1.07	26	196.33
16 Las Piedritas	12	240	4600	1100	9300	2100	11000	43	2400	4600	1600	210	460	210	3	70	240	2.43	0.99	26	267.28
17 La Estrella	20	43	15	93	93	93	460	150	460	93	420	11	23	15	4	93	4	1.52	0.66	26	32.97
18 Redondo	3	240	93	15	240	43	43	21	150	93	10	4	9	9	4	3	9	1.35	0.62	25	22.38
19 Makana	3	93	240	23	3	23	43	93	240	43	490	43	9	4	3	3	4	1.31	0.65	26	20.19
20 La Paepilla	43	150	4600	93	93	240	230	93	39	43	70	9	4	9	4	3	4	2.00	1.17	26	99.10
21 Los delfines	3	240	15	9	93	240	150	150	93	93	250	20	43	43	23	3	23	1.57	0.85	25	37.20
22 Marbella	93	2400	460	2400	11000	2100	4300	150	240	2100	870	43	93	150	23	23	43	2.30	0.96	26	200.01



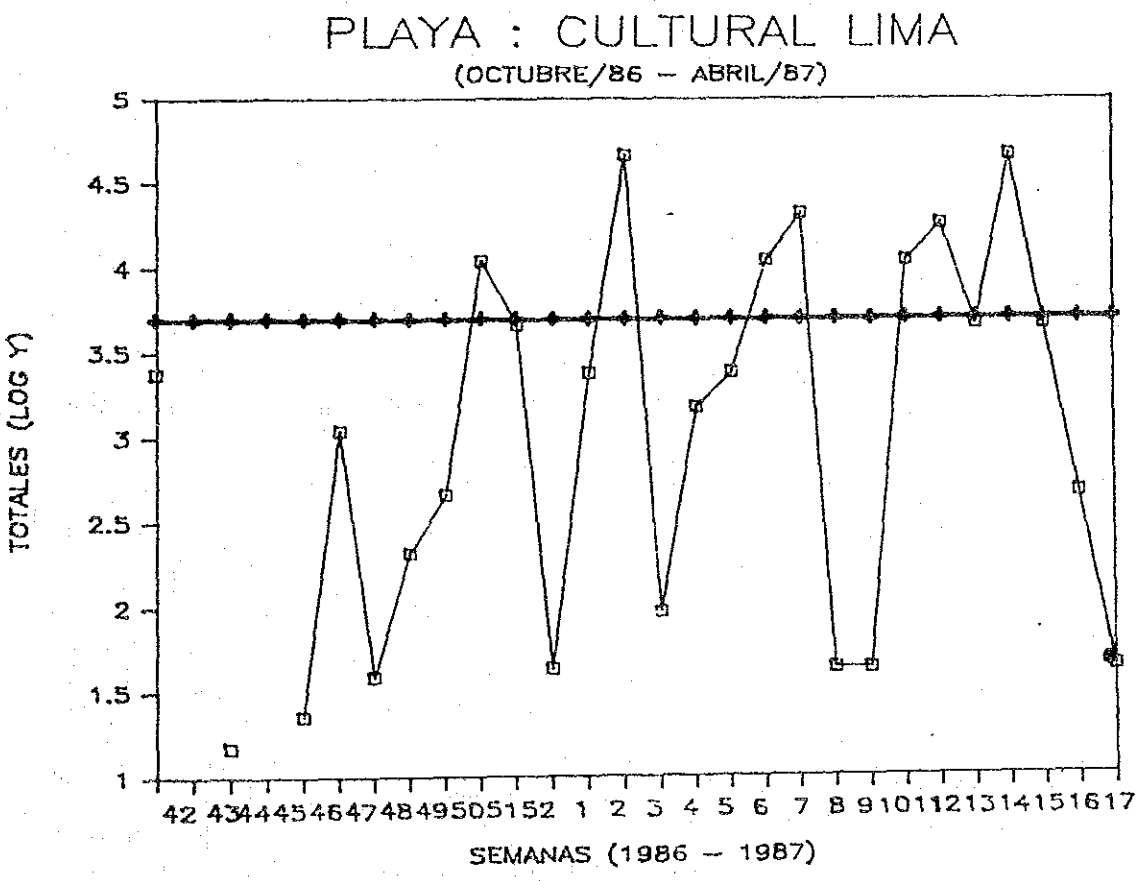
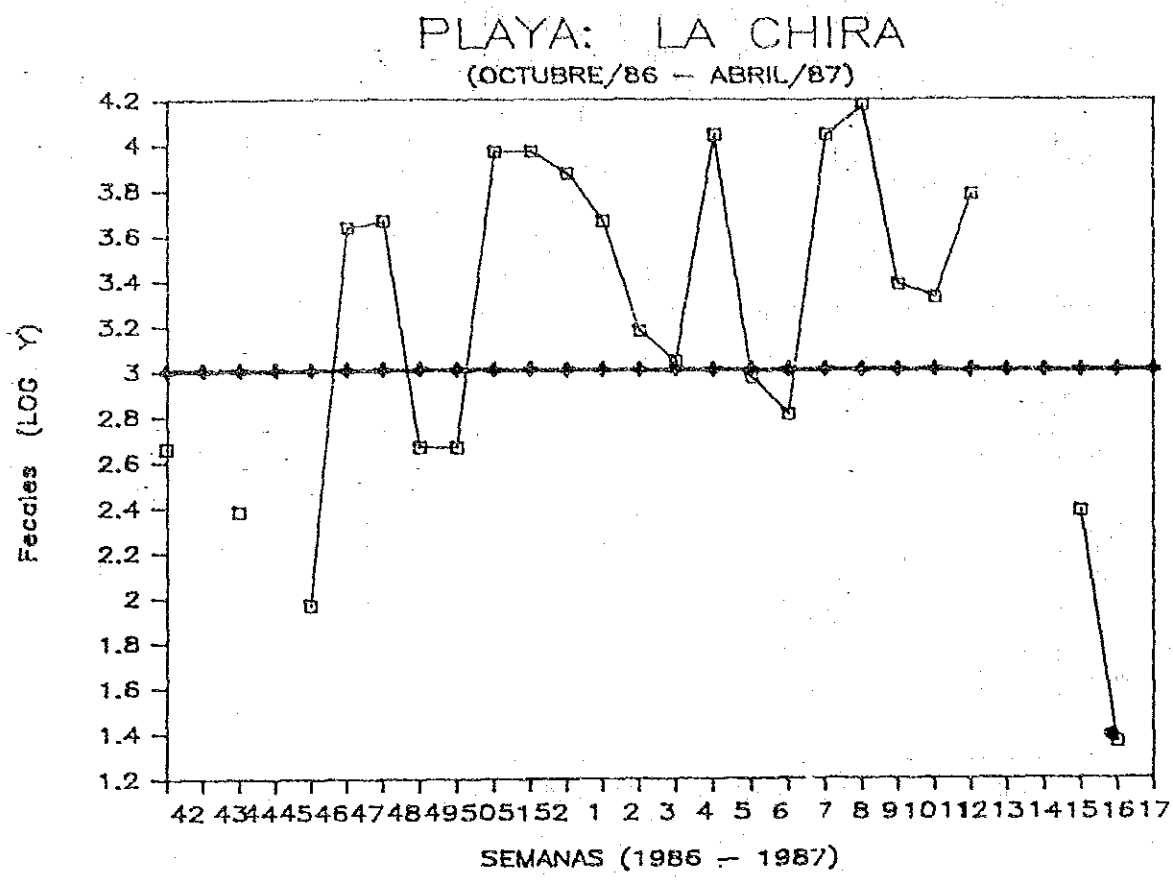


FIGURE A22-1 TRANSITION OF BACTERIA IN SEA WATER (CULTURAL LIMA)



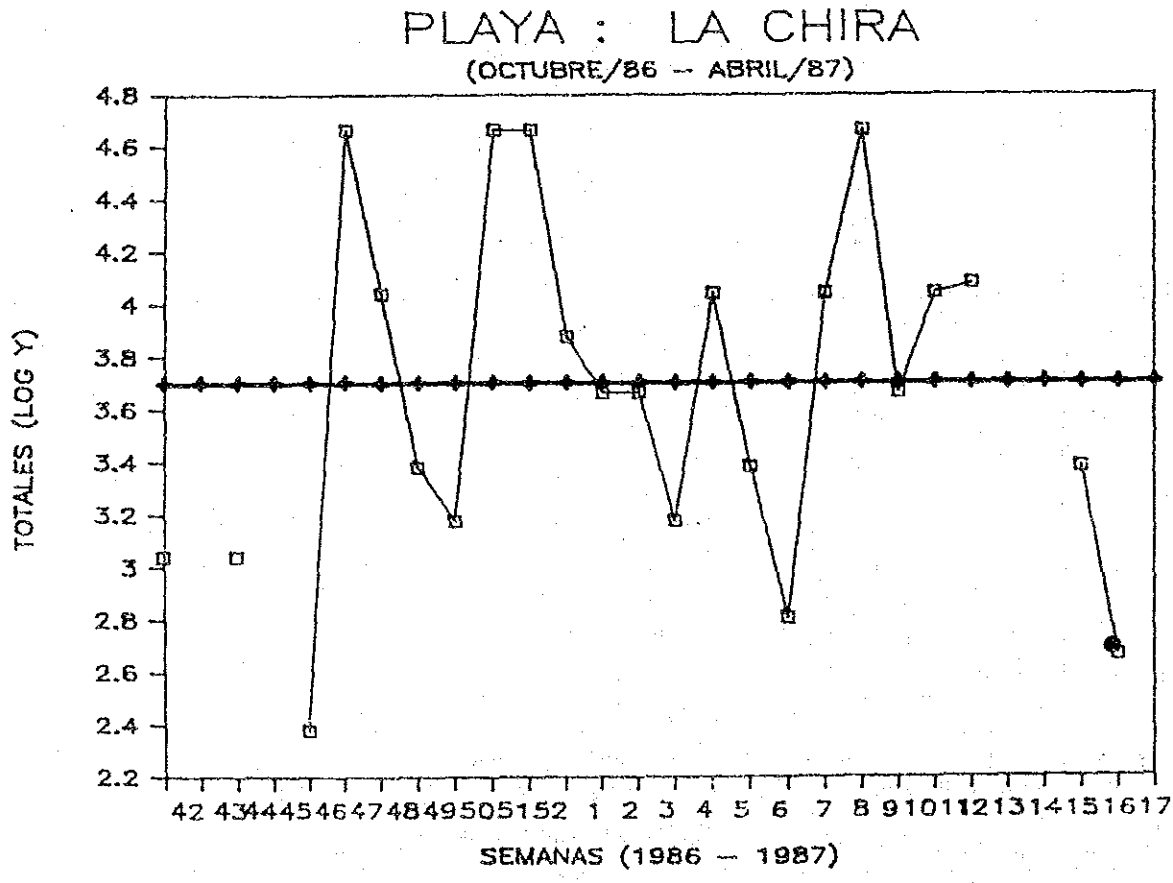
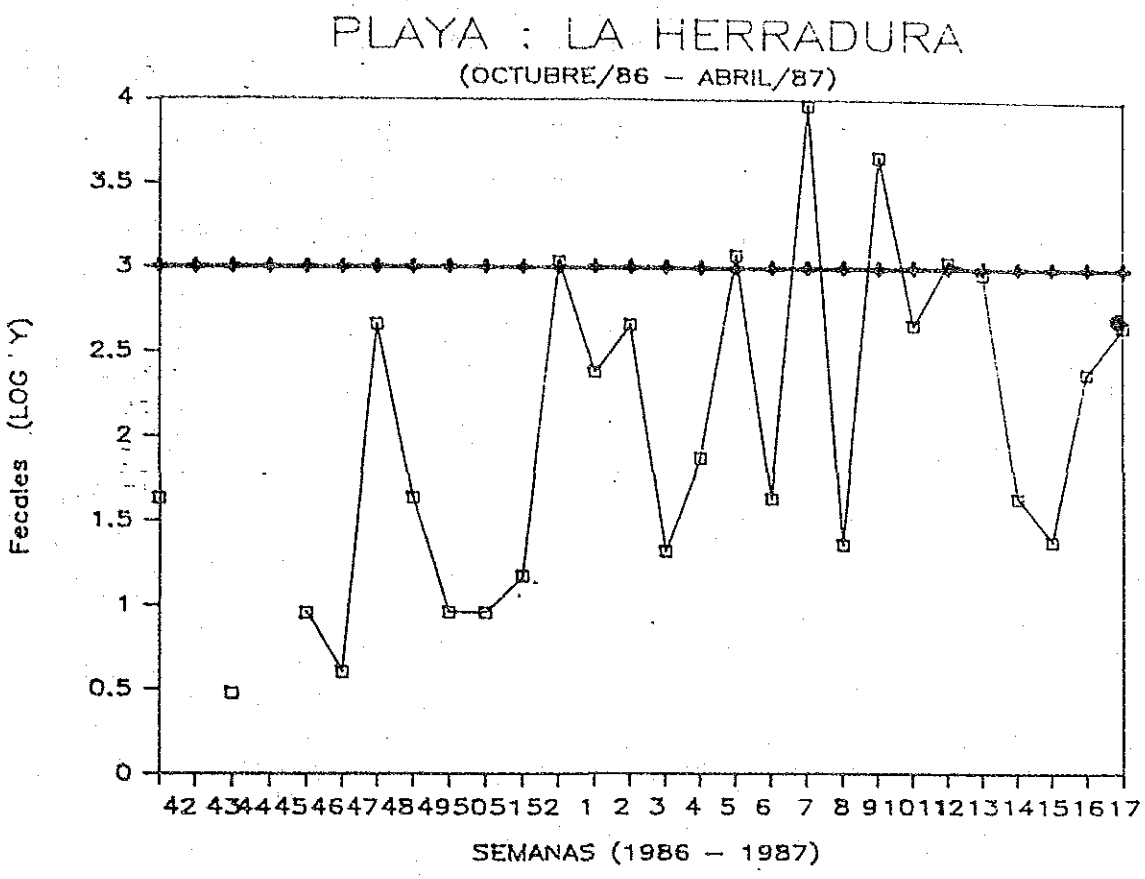


FIGURE A22-2 TRANSITION OF BACTERIA IN SEA WATER (LA CHIRA)



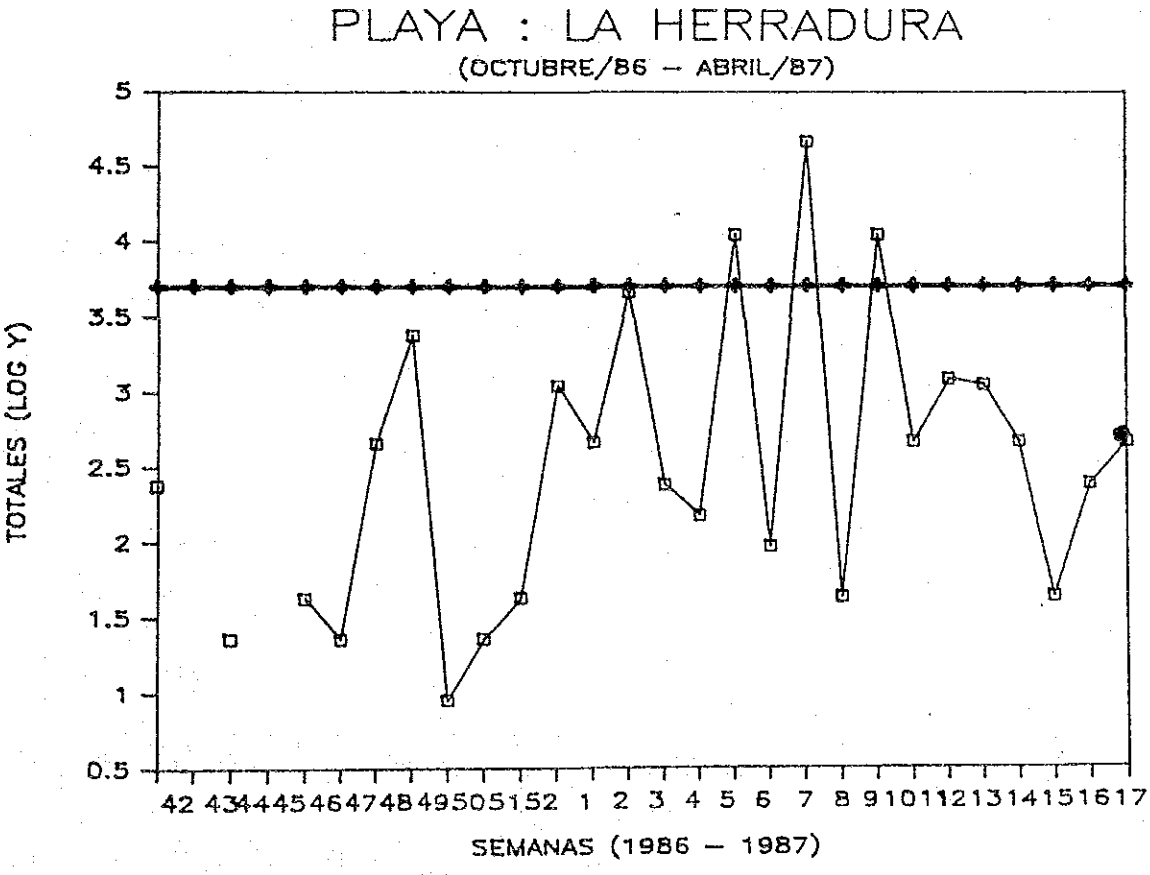
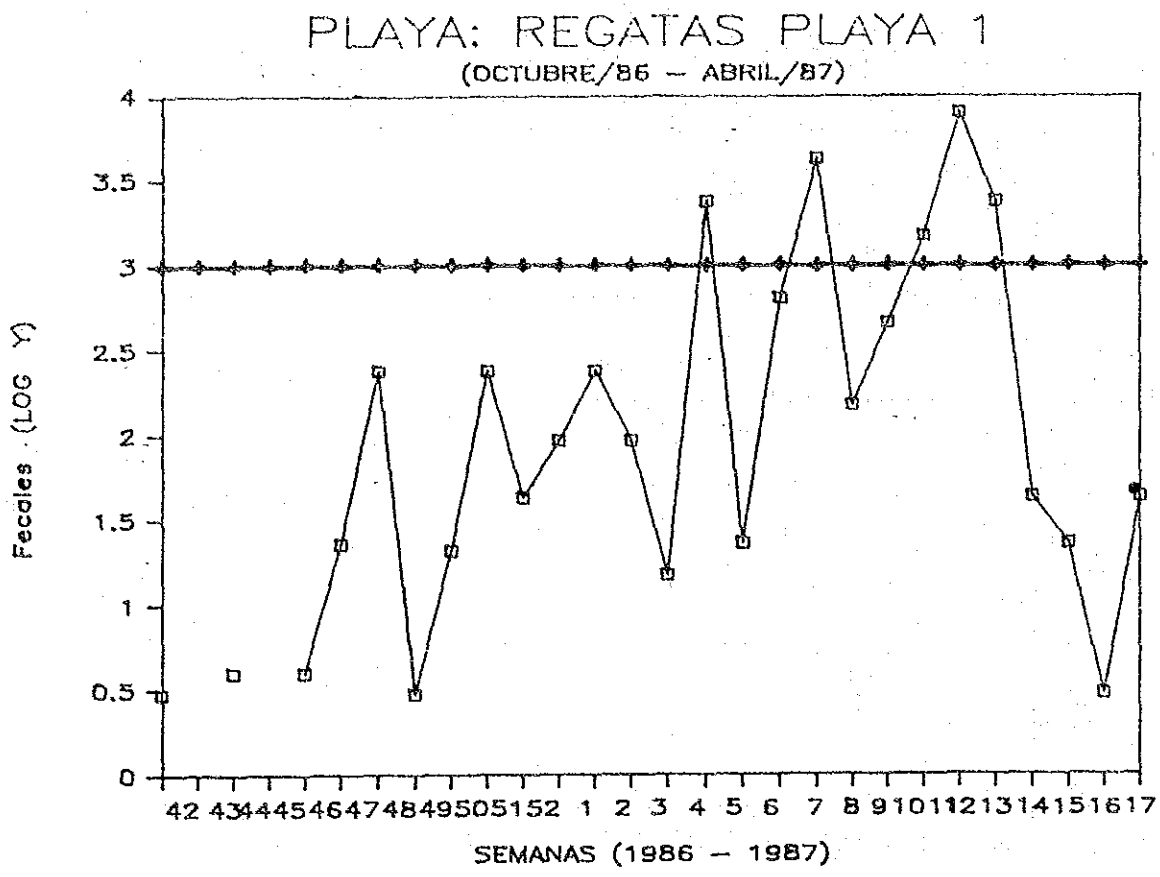


FIGURE A22-3 TRANSITION OF BACTERIA IN SEA WATER (LA HERRADURA)



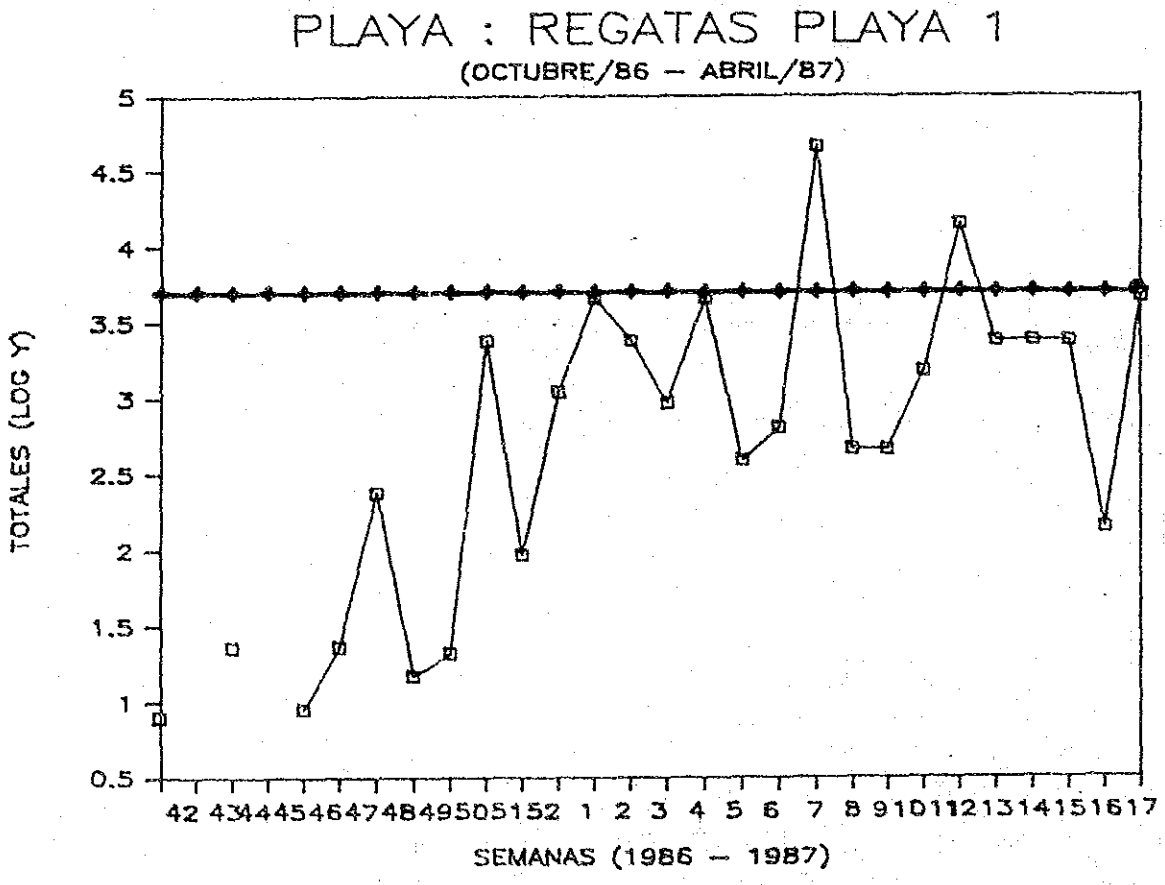
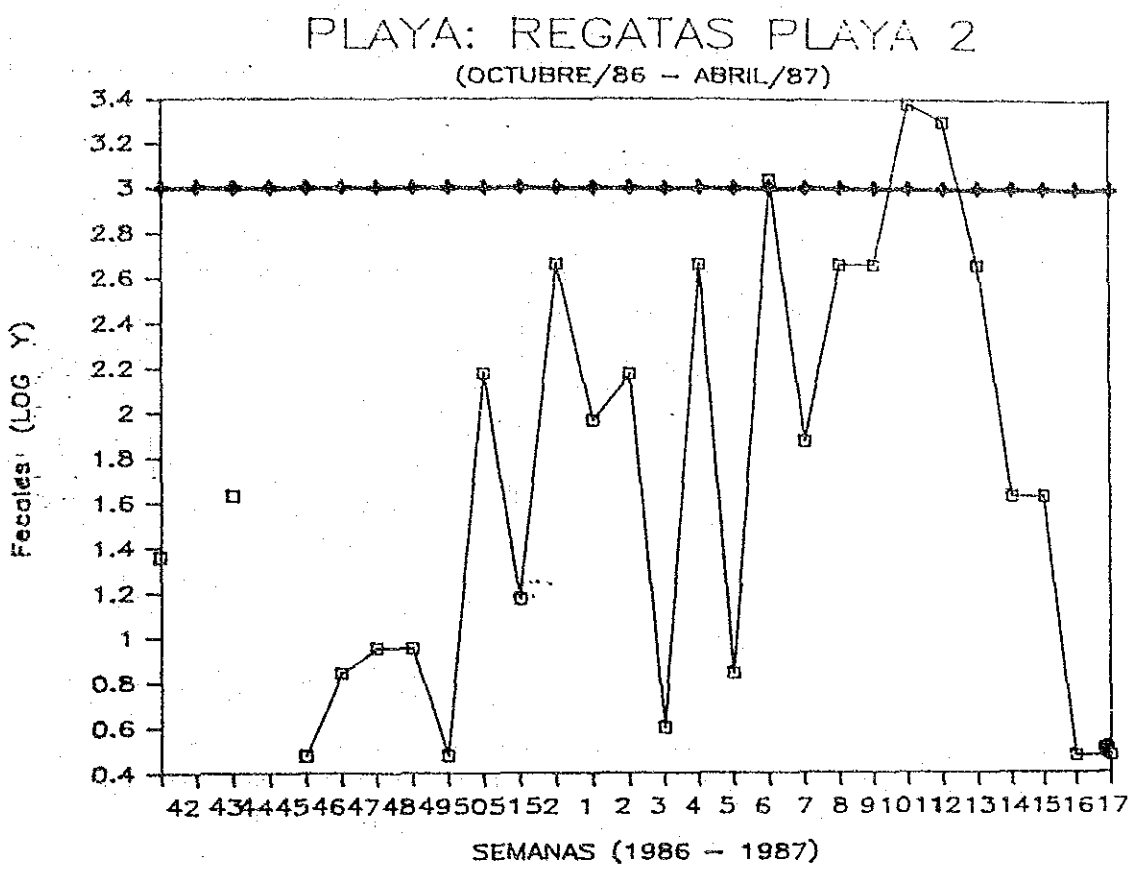


FIGURE A22-4 TRANSITION OF BACTERIA IN SEA WATER (REGATAS PLAYA 1)



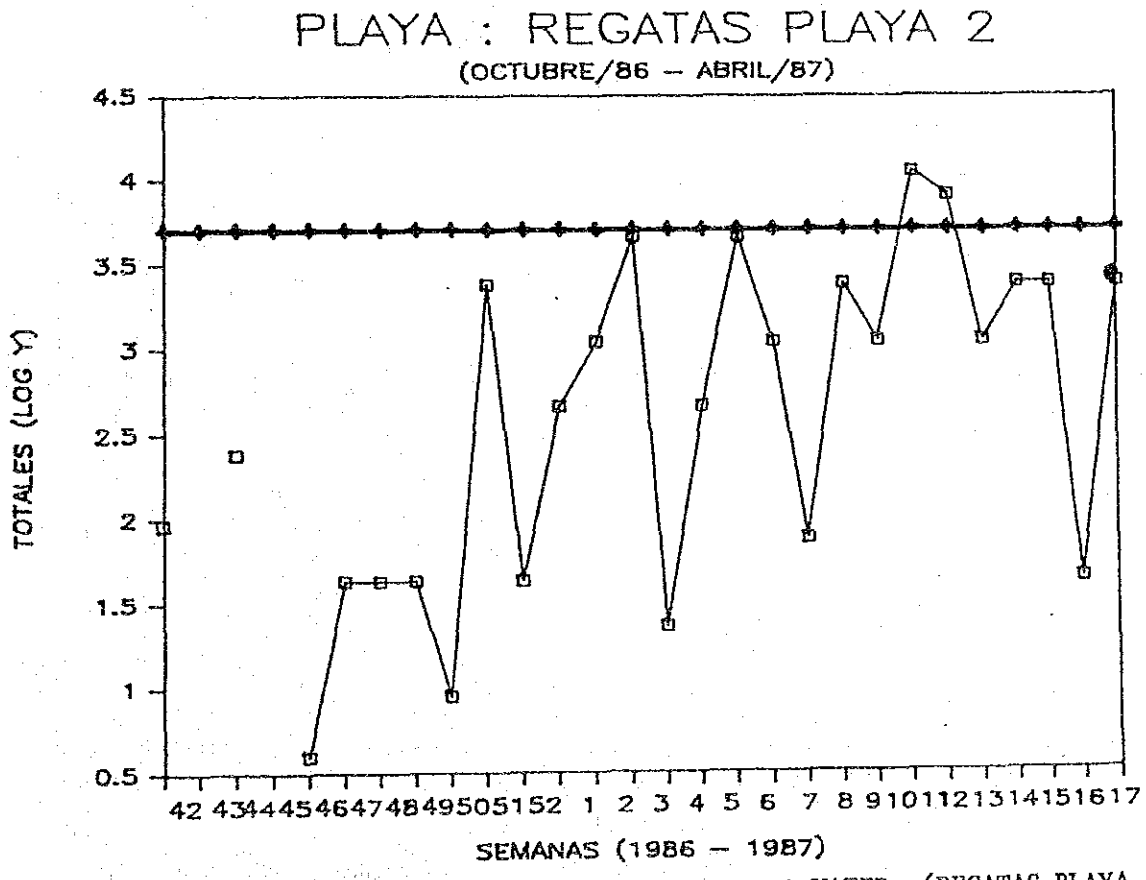
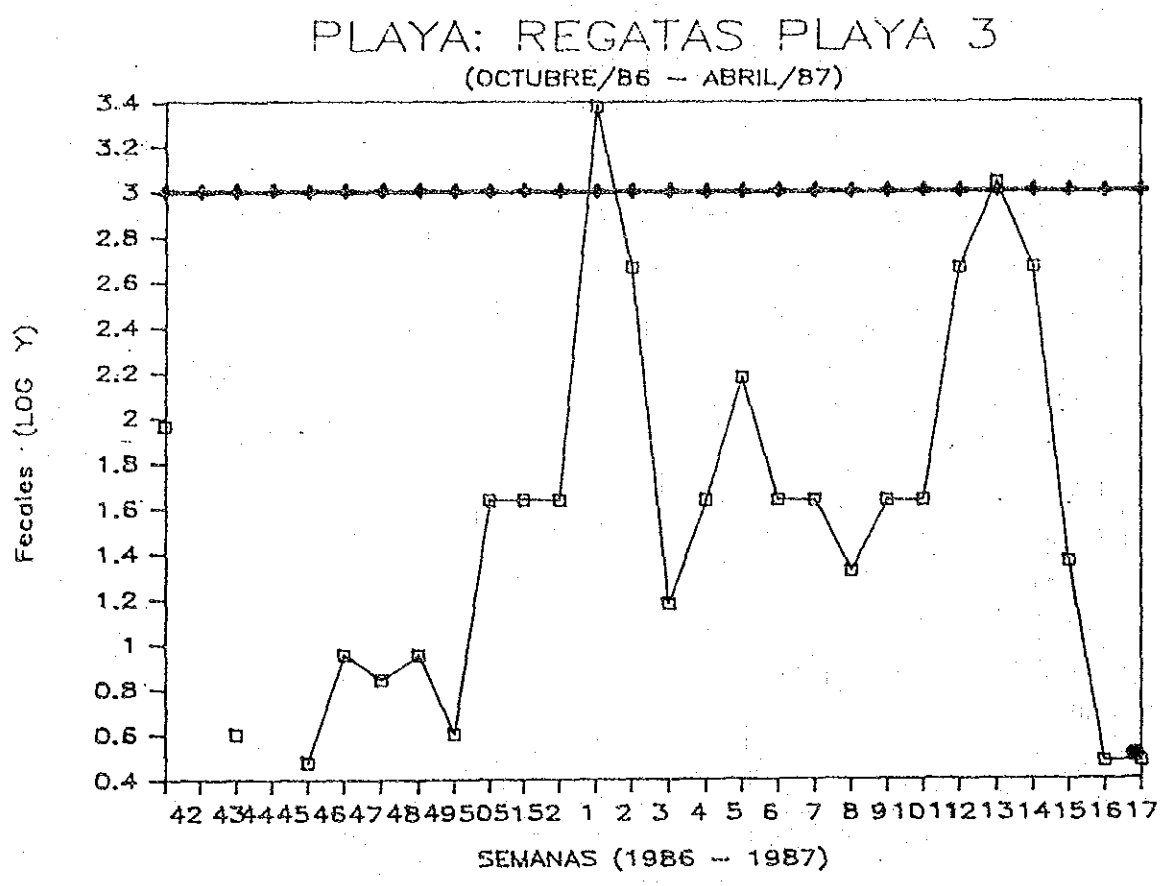


FIGURE A22-5 TRANSITION OF BACTERIA IN SEA WATER (REGATAS PLAYA 2)



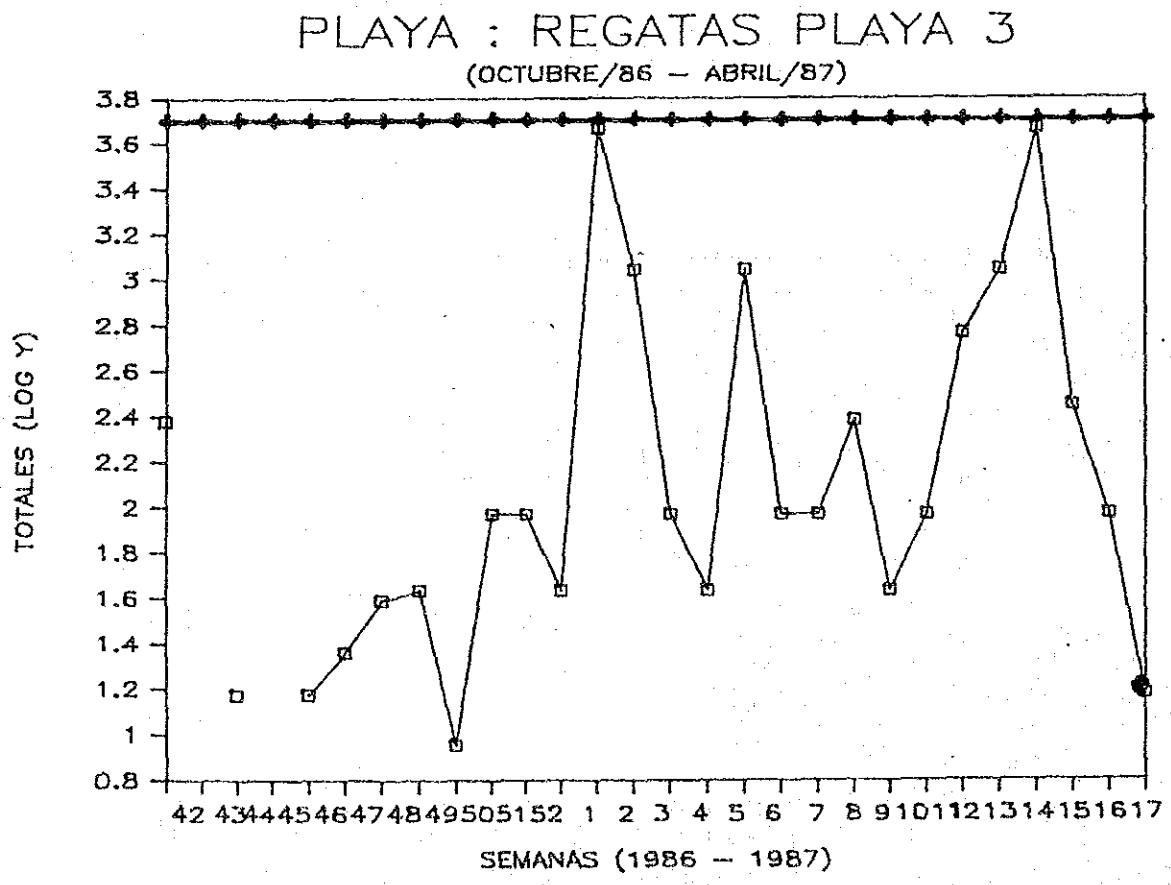
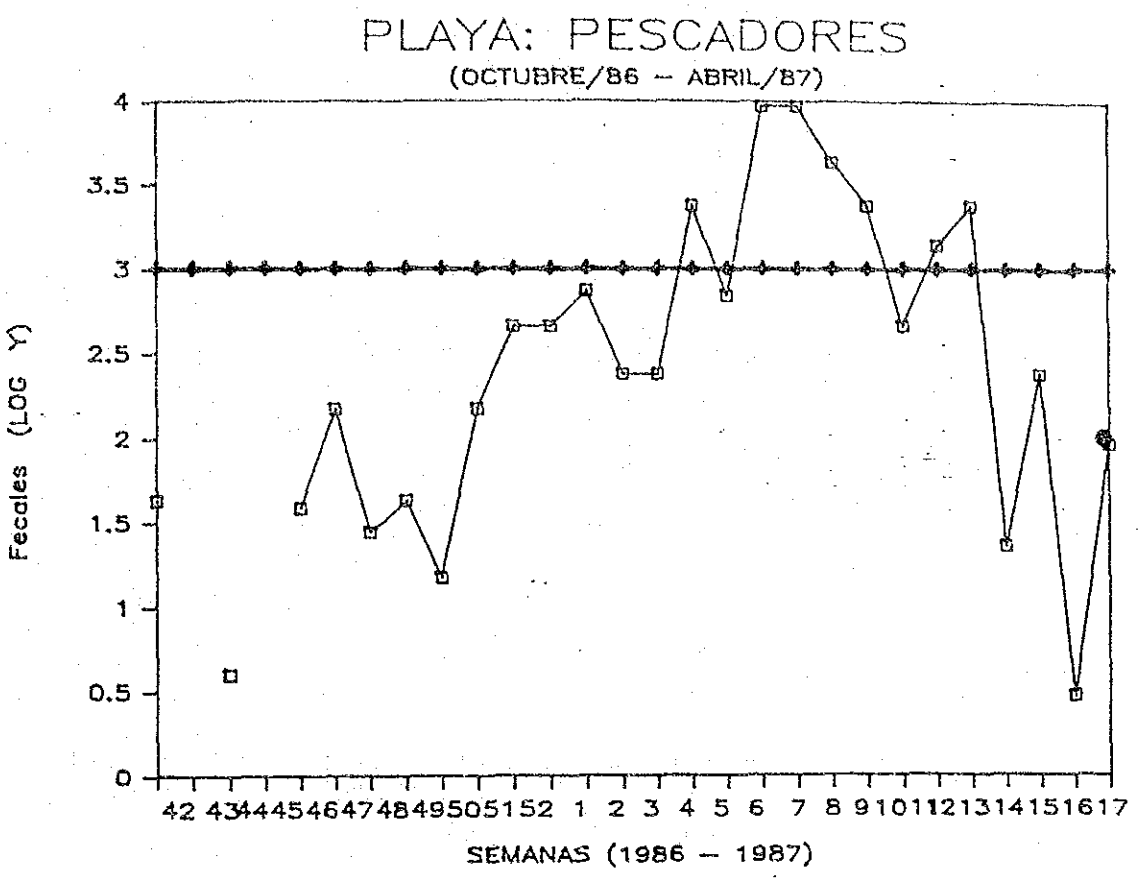


FIGURE A22-6 TRANSITION OF BACTERIA IN SEA WATER (REGATAS PLAYA 3)



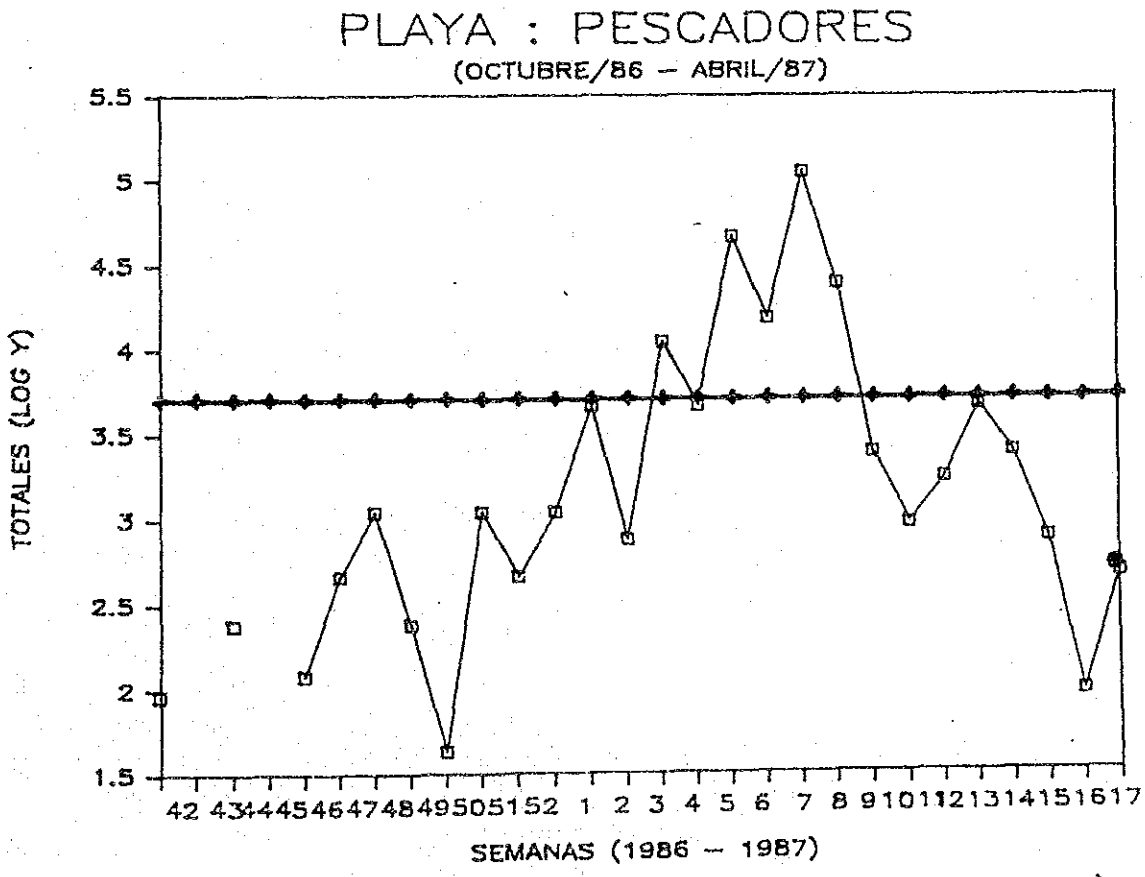
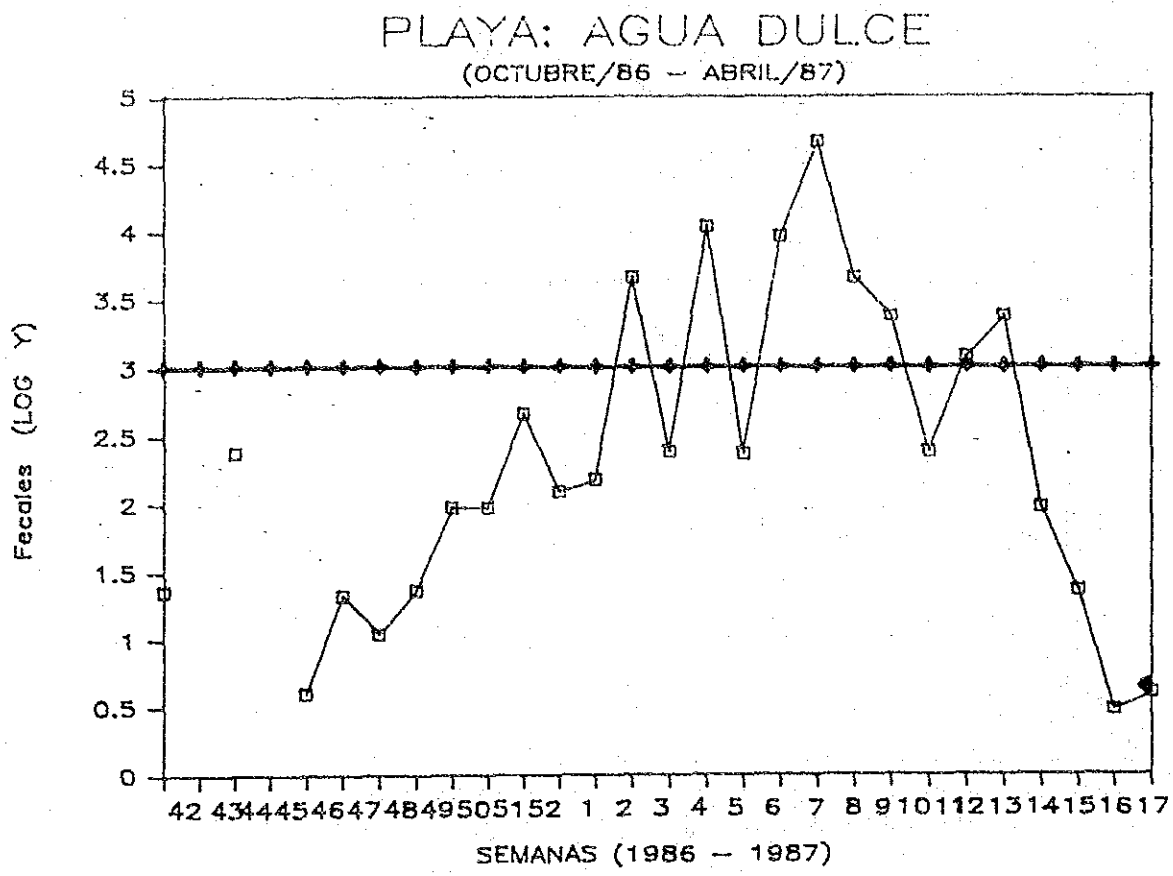


FIGURE A22-7 TRANSITION OF BACTERIA IN SEA WATER (PESCADORES)



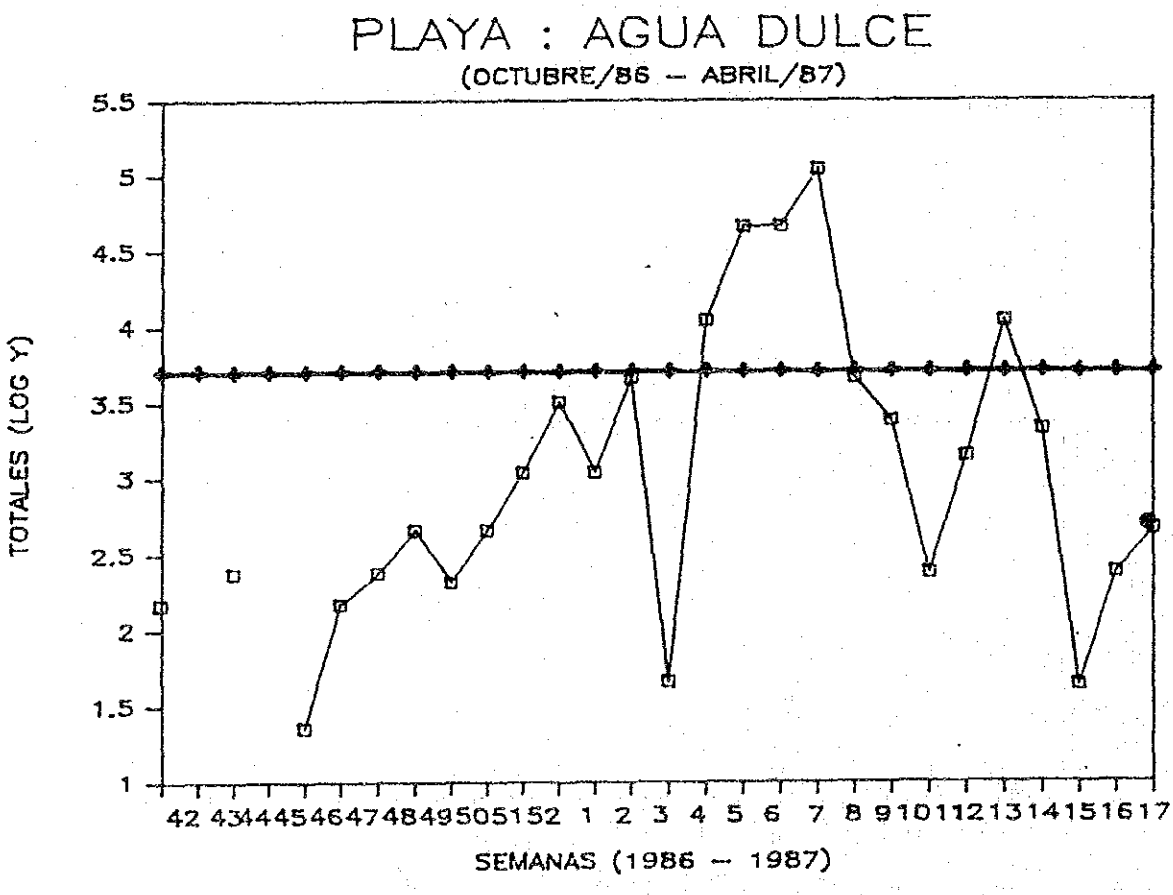


FIGURE A22-8 TRANSITION OF BACTERIA IN SEA WATER (AGUA DULCE)

APPENDIX 23

FINANCIAL AND ECONOMIC ASPECTS

TABLE A23-1 Debt Services for Phase I (Alternative 1)

Condition of Amortization

Loan Amount	49,208 Dollar x 1000
Interest Rate(year)	8 %
Repayment Period	20 years
Grace Period	6 years

(Unit : Dollar x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	141.1	141.1	1,764.0
1991	0	2,053.9	2,053.9	25,674.0
1992	0	3,936.6	3,936.6	49,208.0
1993	0	3,936.6	3,936.6	49,208.0
1994	0	3,936.6	3,936.6	49,208.0
1995	0	3,936.6	3,936.6	49,208.0
1996	0	3,936.6	3,936.6	49,208.0
1997	0	3,936.6	3,936.6	49,208.0
1998	0	3,936.6	3,936.6	49,208.0
1999	0	3,936.6	3,936.6	49,208.0
2000	2,032.1	3,936.6	5,968.8	49,208.0
2001	2,194.7	3,774.1	5,968.8	47,175.9
2002	2,370.3	3,598.5	5,968.8	44,981.2
2003	2,559.9	3,408.9	5,968.8	42,610.9
2004	2,764.7	3,204.1	5,968.8	40,051.0
2005	2,985.9	2,982.9	5,968.8	37,286.3
2006	3,224.7	2,744.0	5,968.8	34,300.4
2007	3,482.7	2,486.1	5,968.8	31,075.7
2008	3,761.3	2,207.4	5,968.8	27,592.9
2009	4,062.2	1,906.5	5,968.8	23,831.6
2010	4,387.2	1,581.5	5,968.8	19,769.3
2011	4,738.2	1,230.6	5,968.8	15,382.1
2012	5,117.3	851.5	5,968.8	10,643.9
2013	5,526.6	442.1	5,968.8	5,526.6
2014	0.0	0.0	0.0	0.0
Total	49,208.0	68,043.0	117,251.0	

TABLE A23-1 Debt Services for Phase II (Alternative 1)
(Cont'd)

Condition of Amortization

Loan Amount	49,093 Dollar x 1000
Interest Rate(year	8 %
Repayment Period	20 years
Grace Period	6 years

(Unit : Dollar x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	0.0	0.0	0.0
1991	0	0.0	0.0	0.0
1992	0	0.0	0.0	0.0
1993	0	50.7	50.7	1,876.0
1994	0	691.8	691.8	25,622.0
1995	0	1,325.5	1,325.5	49,093.0
1996	0	1,325.5	1,325.5	49,093.0
1997	0	1,325.5	1,325.5	49,093.0
1998	0	3,927.4	3,927.4	49,093.0
1999	0	3,927.4	3,927.4	49,093.0
2000	0	3,927.4	3,927.4	49,093.0
2001	0	3,927.4	3,927.4	49,093.0
2002	0	3,927.4	3,927.4	49,093.0
2003	2,027.4	3,927.4	5,954.8	49,093.0
2004	2,189.6	3,765.2	5,954.8	47,065.6
2005	2,364.7	3,590.1	5,954.8	44,876.0
2006	2,553.9	3,400.9	5,954.8	42,511.3
2007	2,758.2	3,196.6	5,954.8	39,957.4
2008	2,978.9	2,975.9	5,954.8	37,199.1
2009	3,217.2	2,737.6	5,954.8	34,220.2
2010	3,474.6	2,480.2	5,954.8	31,003.0
2011	3,752.6	2,202.3	5,954.8	27,528.4
2012	4,052.8	1,902.1	5,954.8	23,775.9
2013	4,377.0	1,577.9	5,954.8	19,723.1
2014	4,727.1	1,227.7	5,954.8	15,346.2
2015	5,105.3	849.5	5,954.8	10,619.0
2016	5,513.7	441.1	5,954.8	5,513.7
Total	49,093.0	58,630.7	107,723.7	

TABLE A23-1 Debt Services (Alternative 1)
(Cont'd)

(Unit : Dollar x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0.0	141.1	141.1	1,764.0
1991	0.0	2,053.9	2,053.9	25,674.0
1992	0.0	3,936.6	3,936.6	49,208.0
1993	0.0	3,987.3	3,987.3	51,084.0
1994	0.0	4,628.4	4,628.4	74,830.0
1995	0.0	5,262.2	5,262.2	98,301.0
1996	0.0	5,262.2	5,262.2	98,301.0
1997	0.0	5,262.2	5,262.2	98,301.0
1998	0.0	7,864.1	7,864.1	98,301.0
1999	0.0	7,864.1	7,864.1	98,301.0
2000	2,032.1	7,864.1	9,896.2	98,301.0
2001	2,194.7	7,701.5	9,896.2	96,268.9
2002	2,370.3	7,525.9	9,896.2	94,074.2
2003	4,587.3	7,336.3	11,923.6	91,703.9
2004	4,954.3	6,969.3	11,923.6	87,116.6
2005	5,350.6	6,573.0	11,923.6	82,162.3
2006	5,778.7	6,144.9	11,923.6	76,811.7
2007	6,241.0	5,682.6	11,923.6	71,033.0
2008	6,740.2	5,183.4	11,923.6	64,792.1
2009	7,279.5	4,644.1	11,923.6	58,051.8
2010	7,861.8	4,061.8	11,923.6	50,772.4
2011	8,490.8	3,432.8	11,923.6	42,910.6
2012	9,170.0	2,753.6	11,923.6	34,419.8
2013	9,903.6	2,020.0	11,923.6	25,249.8
2014	4,727.1	1,227.7	5,954.8	15,346.2
2015	5,105.3	849.5	5,954.8	10,619.0
2016	5,513.7	441.1	5,954.8	5,513.7
Total	98,301.0	124,478.7	222,779.7	

TABLE A23-2 Debt Services (Alternative 2)
for Foreign Portion

(Unit : Dollar x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	29	29	1,147
1991	0	321	321	12,852
1992	0	610	610	24,384
1993	0	643	643	25,604
1994	0	939	939	36,594
1995	0	1,232	1,232	47,445
1996	0	1,232	1,232	47,445
1997	0	1,232	1,232	47,445
1998	0	1,186	1,186	47,445
1999	0	1,186	1,186	47,445
2000	955	1,186	2,141	47,445
2001	978	1,162	2,141	46,490
2002	1,003	1,138	2,141	45,512
2003	1,931	1,113	3,043	44,509
2004	1,979	1,064	3,043	42,578
2005	2,028	1,015	3,043	40,599
2006	2,079	964	3,043	38,571
2007	2,131	912	3,043	36,492
2008	2,184	859	3,043	34,361
2009	2,239	804	3,043	32,176
2010	2,295	748	3,043	29,937
2011	2,352	691	3,043	27,642
2012	2,411	632	3,043	25,290
2013	2,472	572	3,043	22,878
2014	2,533	510	3,043	20,407
2015	2,597	447	3,043	17,874
2016	2,662	382	3,043	15,277
2017	2,728	315	3,043	12,615
2018	2,796	247	3,043	9,887
2019	2,866	177	3,043	7,091
2020	1,374	106	1,479	4,225
2021	1,408	71	1,479	2,851
2022	1,443	36	1,479	1,443
Total	47,445	23,764	71,209	

TABLE A23-2 Debt Services (Alternative 2)
for Local Portion (Cont'd)

(Unit : Dollar x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	49	49	617
1991	0	1,026	1,026	12,822
1992	0	1,986	1,986	24,824
1993	0	2,004	2,004	25,481
1994	0	2,348	2,348	38,237
1995	0	2,689	2,689	50,857
1996	0	2,689	2,689	50,857
1997	0	2,689	2,689	50,857
1998	0	4,069	4,069	50,857
1999	0	4,069	4,069	50,857
2000	1,025	4,069	5,094	50,857
2001	1,107	3,987	5,094	49,832
2002	1,196	3,898	5,094	48,725
2003	2,366	3,802	6,169	47,529
2004	2,556	3,613	6,169	45,162
2005	2,760	3,409	6,169	42,607
2006	2,981	3,188	6,169	39,846
2007	3,220	2,949	6,169	36,865
2008	3,477	2,692	6,169	33,646
2009	3,755	2,413	6,169	30,169
2010	4,056	2,113	6,169	26,413
2011	4,380	1,789	6,169	22,358
2012	4,731	1,438	6,169	17,977
2013	5,109	1,060	6,169	13,247
2014	2,507	651	3,158	8,138
2015	2,707	450	3,158	5,631
2016	2,924	234	3,158	2,924
Total	50,857	64,295	115,152	

TABLE A23-2 Debt Services (Alternative 2) (Cont'd)

(Unit : Dollar x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	78	78	1,764
1991	0	1,347	1,347	25,674
1992	0	2,596	2,596	49,208
1993	0	2,646	2,646	51,085
1994	0	3,287	3,287	74,831
1995	0	3,921	3,921	98,302
1996	0	3,921	3,921	98,302
1997	0	3,921	3,921	98,302
1998	0	5,255	5,255	98,302
1999	0	5,255	5,255	98,302
2000	1,980	5,255	7,234	98,302
2001	2,086	5,149	7,234	96,322
2002	2,199	5,036	7,234	94,237
2003	4,297	4,915	9,212	92,038
2004	4,535	4,677	9,212	87,741
2005	4,789	4,424	9,212	83,206
2006	5,060	4,152	9,212	78,417
2007	5,351	3,862	9,212	73,357
2008	5,662	3,551	9,212	68,006
2009	5,994	3,218	9,212	62,345
2010	6,351	2,861	9,212	56,350
2011	6,733	2,480	9,212	50,000
2012	7,142	2,070	9,212	43,267
2013	7,581	1,632	9,212	36,125
2014	5,040	1,161	6,201	28,545
2015	5,304	897	6,201	23,505
2016	5,585	616	6,201	18,201
2017	2,728	315	3,043	12,615
2018	2,796	247	3,043	9,887
2019	2,866	177	3,043	7,091
2020	1,374	106	1,479	4,225
2021	1,408	71	1,479	2,851
2022	1,443	36	1,479	1,443
Total	98,302	89,135	187,437	

TABLE A23-3 Debt Services (Alternative 3)
for Foreign Portion

(Unit : Dollar x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	92	92	1,147
1991	0	1,028	1,028	12,852
1992	0	1,951	1,951	24,384
1993	0	1,984	1,984	25,604
1994	0	2,280	2,280	36,594
1995	0	2,573	2,573	47,445
1996	0	2,573	2,573	47,445
1997	0	2,573	2,573	47,445
1998	0	3,796	3,796	47,445
1999	0	3,796	3,796	47,445
2000	1,007	3,796	4,803	47,445
2001	1,088	3,715	4,803	46,438
2002	1,175	3,628	4,803	45,350
2003	2,221	3,534	5,755	44,176
2004	2,399	3,356	5,755	41,955
2005	2,590	3,165	5,755	39,557
2006	2,798	2,957	5,755	36,966
2007	3,021	2,733	5,755	34,169
2008	3,263	2,492	5,755	31,147
2009	3,524	2,231	5,755	27,884
2010	3,806	1,949	5,755	24,360
2011	4,111	1,644	5,755	20,554
2012	4,439	1,315	5,755	16,443
2013	4,795	960	5,755	12,003
2014	2,221	577	2,797	7,209
2015	2,398	399	2,797	4,988
2016	2,590	207	2,797	2,590
Total	47,445	60,185	107,630	

TABLE A23-3 Debt Services (Alternative 3)
for Local Portion (Cont'd)

(Unit : Dollar x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	8	8	309
1991	0	160	160	6,411
1992	0	310	310	12,412
1993	0	319	319	12,741
1994	0	491	491	19,119
1995	0	662	662	25,429
1996	0	662	662	25,429
1997	0	662	662	25,429
1998	0	636	636	25,429
1999	0	636	636	25,429
2000	486	636	1,122	25,429
2001	498	624	1,122	24,943
2002	510	611	1,122	24,445
2003	1,033	598	1,631	23,934
2004	1,059	573	1,631	22,901
2005	1,085	546	1,631	21,843
2006	1,112	519	1,631	20,758
2007	1,140	491	1,631	19,645
2008	1,169	463	1,631	18,505
2009	1,198	433	1,631	17,337
2010	1,228	403	1,631	16,139
2011	1,258	373	1,631	14,911
2012	1,290	341	1,631	13,653
2013	1,322	309	1,631	12,363
2014	1,355	276	1,631	11,041
2015	1,389	242	1,631	9,686
2016	1,424	207	1,631	8,297
2017	1,459	172	1,631	6,873
2018	1,496	135	1,631	5,414
2019	1,533	98	1,631	3,918
2020	775	60	835	2,385
2021	795	40	835	1,609
2022	815	20	835	815
Total	25,429	12,717	38,145	

TABLE A23-3 Debt Services (Alternative 3) (Cont'd)

(Unit : Dollar x 1000)

Year	Capital	Interest	Total Annual Repayment	Balance of Capital
1990	0	99	99	1,456
1991	0	1,188	1,188	19,263
1992	0	2,261	2,261	36,796
1993	0	2,303	2,303	38,345
1994	0	2,772	2,772	55,713
1995	0	3,235	3,235	72,874
1996	0	3,235	3,235	72,874
1997	0	3,235	3,235	72,874
1998	0	4,431	4,431	72,874
1999	0	4,431	4,431	72,874
2000	1,493	4,431	5,924	72,874
2001	1,586	4,339	5,924	71,381
2002	1,685	4,239	5,924	69,795
2003	3,254	4,132	7,386	68,110
2004	3,457	3,929	7,386	64,856
2005	3,676	3,711	7,386	61,399
2006	3,910	3,476	7,386	57,724
2007	4,161	3,225	7,386	53,814
2008	4,432	2,954	7,386	49,652
2009	4,722	2,664	7,386	45,221
2010	5,034	2,352	7,386	40,499
2011	5,369	2,017	7,386	35,465
2012	5,729	1,657	7,386	30,096
2013	6,117	1,269	7,386	24,366
2014	3,576	853	4,428	18,250
2015	3,787	641	4,428	14,674
2016	4,014	415	4,428	10,887
2017	1,459	172	1,631	6,873
2018	1,496	135	1,631	5,414
2019	1,533	98	1,631	3,918
2020	775	60	835	2,385
2021	795	40	835	1,609
2022	815	20	835	815
Total	72,874	74,021	146,895	

TABLE A23-4 Income from Sewerage Charge (Domestic)

Year	Projected Population	Served Population	D/S.H	D/S.L	Sewage Flow (m3/month)	Unit Rate (inti/m3)	Income /Month (I/.*1000)	Income /Year (I/.*1000)	Equivarent U.S. Dollar ($)
1990	1,806,500	1,540,060	657,780	882,280	8,908,326	20.14	179,374	2,152,483	4,304,966
1991	1,882,700	1,613,270	676,790	936,480	9,320,769	20.14	187,678	2,252,140	4,504,280
1992	1,961,700	1,689,650	697,060	992,590	9,751,464	20.14	196,351	2,356,207	4,712,414
1993	2,043,300	1,768,950	718,310	1,050,640	10,198,809	20.14	205,358	2,464,297	4,928,595
1994	2,127,000	1,850,750	740,540	1,110,210	10,660,536	20.14	214,655	2,575,863	5,151,725
1995	2,213,200	1,935,450	763,750	1,171,700	11,138,805	20.14	224,285	2,691,425	5,382,850
1996	2,302,300	2,023,310	788,290	1,235,020	11,635,335	20.14	234,283	2,811,399	5,622,799
1997	2,394,400	2,114,500	814,190	1,300,310	12,151,071	20.14	244,668	2,936,015	5,872,029
1998	2,489,000	2,208,540	841,140	1,367,400	12,683,142	20.14	255,381	3,064,577	6,129,154
1999	2,586,600	2,305,940	869,580	1,436,360	13,234,698	20.14	266,487	3,197,847	6,395,694
2000	2,687,100	2,407,150	899,290	1,507,860	13,807,971	20.14	278,030	3,336,365	6,672,730
2001	2,687,100	2,407,150	899,290	1,507,860	13,807,971	20.14	278,030	3,336,365	6,672,730
2002	2,687,100	2,407,150	899,290	1,507,860	13,807,971	20.14	278,030	3,336,365	6,672,730
2003	2,687,100	2,407,150	899,290	1,507,860	13,807,971	20.14	278,030	3,336,365	6,672,730
2004	2,687,100	2,407,150	899,290	1,507,860	13,807,971	20.14	278,030	3,336,365	6,672,730
2005	2,687,100	2,407,150	899,290	1,507,860	13,807,971	20.14	278,030	3,336,365	6,672,730
2006	2,687,100	2,407,150	899,290	1,507,860	13,807,971	20.14	278,030	3,336,365	6,672,730
2007	2,687,100	2,407,150	899,290	1,507,860	13,807,971	20.14	278,030	3,336,365	6,672,730
2008	2,687,100	2,407,150	899,290	1,507,860	13,807,971	20.14	278,030	3,336,365	6,672,730
2009	2,687,100	2,407,150	899,290	1,507,860	13,807,971	20.14	278,030	3,336,365	6,672,730
2010	2,687,100	2,407,150	899,290	1,507,860	13,807,971	20.14	278,030	3,336,365	6,672,730

Note : Exchange Rate is 500 inti/dollar, which is based on MUC at Dec. 1988.
Unit Rate is 35% of average water tariff at Dec. 1988.

TABLE A23-4 Income from Sewerage Charge (Industrial & Commercial)(Cont'd)

Year	Industrial Sewerage (m3/month)	Commercial Sewerage (m3/month)	Sewerage charge Indust. (I/./m3)	Comme. (I/./m3)	Income /Month (I/.*1000)	Income /Year (I/.*1000)	Equivarent U.S. Dollar
1990	1,410,060	629,850	58	46	110,757	1,329,079	2,658,158
1991	1,423,467	629,850	58	46	111,534	1,338,410	2,676,820
1992	1,437,001	629,850	58	46	112,319	1,347,830	2,695,659
1993	1,450,663	629,850	58	46	113,112	1,357,339	2,714,678
1994	1,464,456	629,850	58	46	113,912	1,366,939	2,733,877
1995	1,478,380	629,850	58	46	114,719	1,376,630	2,753,259
1996	1,492,436	629,850	58	46	115,534	1,386,413	2,772,825
1997	1,506,626	629,850	58	46	116,357	1,396,289	2,792,578
1998	1,520,951	629,850	58	46	117,188	1,406,259	2,812,518
1999	1,535,412	629,850	58	46	118,027	1,416,324	2,832,647
2000	1,550,010	629,850	58	46	118,874	1,426,484	2,852,968
2001	1,550,010	629,850	58	46	118,874	1,426,484	2,852,968
2002	1,550,010	629,850	58	46	118,874	1,426,484	2,852,968
2003	1,550,010	629,850	58	46	118,874	1,426,484	2,852,968
2004	1,550,010	629,850	58	46	118,874	1,426,484	2,852,968
2005	1,550,010	629,850	58	46	118,874	1,426,484	2,852,968
2006	1,550,010	629,850	58	46	118,874	1,426,484	2,852,968
2007	1,550,010	629,850	58	46	118,874	1,426,484	2,852,968
2008	1,550,010	629,850	58	46	118,874	1,426,484	2,852,968
2009	1,550,010	629,850	58	46	118,874	1,426,484	2,852,968
2010	1,550,010	629,850	58	46	118,874	1,426,484	2,852,968

Note : Exchange Rate is 500 inti/dollar, which is based on MUC at Dec. 1988.

TABLE A23-5 Unit Cost of Sewerage Treatment after Depreciation

(Unit : Dollar x 1000)

year	Treated Sewerage (cu.m/day)	Operating Expenses	Debt Service	Depre-ciation	Total Expenses	Unit Cost of Sewerage ($/cu.m)
1990	0	0	41	0	41	-----
1991	0	0	414	0	414	-----
1992	0	0	788	509	1,297	-----
1993	172,800	122	835	1,386	2,343	0.04
1994	172,800	122	1,298	1,386	2,806	0.04
1995	172,800	122	1,760	1,971	3,853	0.06
1996	345,600	154	1,760	2,765	4,679	0.04
1997	345,600	154	1,760	2,765	4,679	0.04
1998	345,600	154	1,688	2,765	4,607	0.04
1999	345,600	154	1,688	2,765	4,607	0.04
2000	345,600	154	2,922	2,765	5,841	0.05
2001	345,600	154	2,922	2,765	5,841	0.05
2002	345,600	154	2,922	2,765	5,841	0.05
2003	345,600	154	4,332	2,765	7,251	0.06
2004	345,600	154	4,332	2,765	7,251	0.06
2005	345,600	154	4,332	2,765	7,251	0.06
2006	345,600	154	4,332	2,765	7,251	0.06
2007	345,600	154	4,332	2,765	7,251	0.06
2008	345,600	154	4,332	2,765	7,251	0.06
2009	345,600	154	4,332	2,765	7,251	0.06
2010	345,600	154	4,332	2,765	7,251	0.06
				Average Unit Water Cost (1990-2010) :		0.05

TABLE A23-6 Projected Cash Flow (Sensitivity A)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Cash Inflow															
Government Subsidy															
Capital Contribution															
Laon	1,638	16,722	16,475	1,742	15,699	15,501									
Foreign Loan	1,638	16,722	16,475	1,742	15,699	15,501									
Operating Revenue	7,102	7,325	7,556	7,797	8,044	8,298	8,564	8,838	9,121	9,414	9,717	9,717	9,717	9,717	9,717
Sewerage Charge	6,963	7,181	7,408	7,644	7,886	8,135	8,396	8,665	8,942	9,229	9,526	9,526	9,526	9,526	9,526
Domestic	4,305	4,504	4,712	4,929	5,152	5,382	5,623	5,872	6,129	6,396	6,673	6,673	6,673	6,673	6,673
Others	2,658	2,677	2,696	2,715	2,734	2,753	2,773	2,793	2,813	2,833	2,853	2,853	2,853	2,853	2,853
Other Income	139	144	148	153	158	163	168	173	179	185	191	191	191	191	191
Water Sale Income	0	0	0	0	0	1,047	1,047	1,047	2,186	2,186	2,186	2,186	2,186	2,186	2,186
Total Inflow	8,740	24,047	24,031	9,539	23,743	24,846	9,611	9,885	11,307	11,600	11,903	11,903	11,903	11,903	11,903
Cash Outflow															
Project Expenditures															
Local Portion	617	12,205	12,002	657	12,756	12,620									
Foreign Portion	1,147	11,705	11,532	1,220	10,990	10,851									
Amortization															
Principal	0	0	0	0	0	0	0	0	0	0	1,364	1,398	1,433	2,758	2,827
Interest	41	459	871	918	1,342	1,760	1,760	1,760	1,694	1,694	1,694	1,660	1,625	1,590	1,521
Operating Expenses	0	0	0	122	122	122	154	154	154	154	154	154	154	154	154
Adominstrative Expenses	4,518	4,645	4,777	4,907	5,038	5,173	5,310	5,452	5,589	5,723	5,868	5,868	5,868	5,868	5,868
Payment to SENAPA	209	215	222	229	237	244	252	260	268	277	286	286	286	286	286
Total Outflow	6,532	29,229	29,404	8,053	30,485	30,770	7,476	7,626	7,705	7,848	9,366	9,366	9,366	10,656	10,656
Net Cash Flow	2,208	-5,183	-5,373	1,486	-6,742	-5,924	2,135	2,259	3,602	3,752	2,537	2,537	2,537	1,247	1,247
Accumulated	2,208	-2,974	-8,348	-6,862	-13,604	-19,528	-17,393	-15,134	-11,532	-7,780	-5,244	-2,707	-170	1,076	2,323

TABLE A23-6 Projected Cash Flow (Sensitivity A) (Cont'd)

(Unit : Dollar x 1000)

Year	2005	2006	2007	2008	2009	2010
Cash Inflow						
Government Subsidy						
Capital Contribution						
Laon						
Foreign Loan						
Operating Revenue	9,717	9,717	9,717	9,717	9,717	9,717
Sewerage Charge	9,526	9,526	9,526	9,526	9,526	9,526
Domestic	6,673	6,673	6,673	6,673	6,673	6,673
Ohters	2,853	2,853	2,853	2,853	2,853	2,853
Ohter Income	191	191	191	191	191	191
Water Sale Income	2,186	2,186	2,186	2,186	2,186	2,186
Total Inflow	11,903	11,903	11,903	11,903	11,903	11,903
Cash Outflow						
Project Expenditures						
Local Portion						
Foreign Portion						
Amortization						
Principal	2,898	2,970	3,044	3,121	3,199	3,279
Interest	1,450	1,377	1,303	1,227	1,149	987
Operating Expenses	154	154	154	154	154	154
Adominstrative Expenses	5,868	5,868	5,868	5,868	5,868	5,868
Payment to SENAPA	286	286	286	286	286	286
Total Outflow	10,656	10,655	10,655	10,656	10,656	10,574
Net Cash Flow	1,247	1,248	1,248	1,247	1,247	1,329
Accumulated	3,570	4,818	6,065	7,312	8,559	9,888

TABLE A23-7 Projected Cash Flow (Sensitivity B)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Cash Inflow															
Government Subsidy															
Capital Contribution															
Laon	1,638	16,722	16,475	1,742	15,699	15,501									
Foreign Loan	1,638	16,722	16,475	1,742	15,699	15,501									
Operating Revenue	7,102	7,325	7,556	7,797	8,044	8,298	8,564	8,838	9,121	9,414	9,717	9,717	9,717	9,717	9,717
Sewerage Charge	6,963	7,181	7,408	7,644	7,886	8,135	8,396	8,665	8,942	9,229	9,526	9,526	9,526	9,526	9,526
Domestic	4,305	4,504	4,712	4,929	5,152	5,382	5,623	5,872	6,129	6,396	6,673	6,673	6,673	6,673	6,673
Ohters	2,658	2,677	2,696	2,715	2,734	2,753	2,773	2,793	2,813	2,833	2,853	2,853	2,853	2,853	2,853
Ohter Income	139	144	148	153	158	163	168	173	179	185	191	191	191	191	191
Water Sale Income															
Total Inflow	8,740	24,047	24,031	9,539	23,743	23,799	8,564	8,838	9,121	9,414	9,717	9,717	9,717	9,717	9,717
Cash Outflow															
Project Expenditures															
Local Portion	617	12,205	12,002	657	12,756	12,620									
Foreign Portion	1,147	11,705	11,532	1,220	10,990	10,851									
Amortization															
Principal	0	0	0	0	0	0	0	0	0	0	1,364	1,398	1,433	2,758	2,827
Interest	41	459	871	918	1,342	1,760	1,760	1,760	1,694	1,694	1,694	1,660	1,625	1,590	1,521
Operating Expenses	0	0	0	122	122	122	154	154	154	154	154	154	154	154	154
Adominstrative Expenses	4,518	4,645	4,777	4,907	5,038	5,173	5,310	5,452	5,589	5,723	5,868	5,868	5,868	5,868	5,868
Payment to SENAPA	209	215	222	229	237	244	252	260	268	277	286	286	286	286	286
Total Outflow	6,532	29,229	29,404	8,053	30,485	30,770	7,476	7,626	7,705	7,848	9,366	9,366	9,366	10,656	10,656
Net Cash Flow	2,208	-5,183	-5,373	1,486	-6,742	-6,971	1,088	1,212	1,416	1,566	351	351	351	-939	-939
Accumulated	2,208	-2,974	-8,348	-6,862	-13,604	-20,575	-19,487	-18,275	-16,859	-15,293	-14,943	-14,592	-14,241	-15,181	-16,120

TABLE A23-7 Projected Cash Flow (Sensitivity B) (Cont'd)

(Unit : Dollar x 1000)

Year	2005	2006	2007	2008	2009	2010
Cash Inflow						
Government Subsidy						
Capital Contribution						
Laon						
Foreign Loan						
Operating Revenue	9,717	9,717	9,717	9,717	9,717	9,717
Sewerage Charge	9,526	9,526	9,526	9,526	9,526	9,526
Domestic	6,673	6,673	6,673	6,673	6,673	6,673
Ohters	2,853	2,853	2,853	2,853	2,853	2,853
Ohter Income	191	191	191	191	191	191
Water Sale Income						
Total Inflow	9,717	9,717	9,717	9,717	9,717	9,717
Cash Outflow						
Project Expenditures						
Local Portion						
Foreign Portion						
Amortization						
Principal	2,898	2,970	3,044	3,121	3,199	3,279
Interest	1,450	1,377	1,303	1,227	1,149	987
Operating Expenses	154	154	154	154	154	154
Adoministrative Expenses	5,868	5,868	5,868	5,868	5,868	5,868
Payment to SENAPA	286	286	286	286	286	286
Total Outflow	10,656	10,655	10,655	10,656	10,656	10,574
Net Cash Flow	-939	-938	-938	-939	-939	-857
Accumulated	-17,059	-17,997	-18,936	-19,875	-20,814	-21,671

TABLE A23-8 Projected Cash Flow (Sensitivity C)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Cash Inflow															
Government Subsidy															
Capital Contribution															
Laon	1,764	23,910	23,534	1,877	23,746	23,471									
Foreign Loan(1)	617	12,205	12,002	657	12,756	12,620									
Foreign Loan(2)	1,147	11,705	11,532	1,220	10,990	10,851									
Operating Revenue	7,102	7,325	7,556	7,797	8,044	8,298	8,564	8,838	9,121	9,414	9,717	9,717	9,717	9,717	9,717
Sewerage Charge	6,963	7,181	7,408	7,644	7,886	8,135	8,396	8,665	8,942	9,229	9,526	9,526	9,526	9,526	9,526
Domestic	4,305	4,504	4,712	4,929	5,152	5,382	5,623	5,872	6,129	6,396	6,673	6,673	6,673	6,673	6,673
Ohters	2,658	2,677	2,696	2,715	2,734	2,753	2,773	2,793	2,813	2,833	2,853	2,853	2,853	2,853	2,853
Ohter Income	139	144	148	153	158	163	168	173	179	185	191	191	191	191	191
Water Sale Income	0	0	0	0	0	1,047	1,047	1,047	2,186	2,186	2,186	2,186	2,186	2,186	2,186
Total Inflow	8,866	31,235	31,090	9,674	31,790	32,816	9,611	9,885	11,307	11,600	11,903	11,903	11,903	11,903	11,903
Cash Outflow															
Project Expenditures															
Local Portion	617	12,205	12,002	657	12,756	12,620									
Foreign Portion	1,147	11,705	11,532	1,220	10,990	10,851									
Amortization															
Principal	0	0	0	0	0	0	0	0	0	0	1,980	2,086	2,199	4,297	4,535
Interest	78	1,347	2,596	2,646	3,287	3,921	3,921	3,921	5,255	5,255	5,255	5,149	5,036	4,915	4,677
Operating Expenses	0	0	0	122	122	122	154	154	154	154	154	154	154	154	154
Adominstrative Expenses	4,518	4,645	4,777	4,907	5,038	5,173	5,310	5,452	5,589	5,723	5,868	5,868	5,868	5,868	5,868
Payment to SENAPA	209	215	222	229	237	244	252	260	268	277	286	286	286	286	286
Total Outflow	6,569	30,117	31,129	9,781	32,430	32,931	9,637	9,787	11,266	11,409	13,543	13,543	13,543	15,520	15,520
Net Cash Flow	2,297	1,117	-39	-107	-640	-115	-26	98	41	191	-1,640	-1,640	-1,640	-3,617	-3,617
Accumulated	2,297	3,415	3,375	3,268	2,628	2,513	2,487	2,585	2,626	2,817	1,176	-464	-2,104	-5,722	-9,339

TABLE A23-8 Projected Cash Flow (Sensitivity C)(Cont'd)

(Unit : Dollar x 1000)

Year	2005	2006	2007	2008	2009	2010
Cash Inflow						
Government Subsidy						
Capital Contribution						
Laon						
Foreign Loan(1)						
Foreign Loan(2)						
Operating Revenue	9,717	9,717	9,717	9,717	9,717	9,717
Sewerage Charge	9,526	9,526	9,526	9,526	9,526	9,526
Domestic	6,673	6,673	6,673	6,673	6,673	6,673
Ohters	2,853	2,853	2,853	2,853	2,853	2,853
Ohter Income	191	191	191	191	191	191
Water Sale Income	2,186	2,186	2,186	2,186	2,186	2,186
Total Inflow	11,903	11,903	11,903	11,903	11,903	11,903
Cash Outflow						
Project Expenditures						
Local Portion						
Foreign Portion						
Amortization						
Principal	4,789	5,060	5,351	5,662	5,994	6,351
Interest	4,424	4,152	3,862	3,551	3,218	2,861
Operating Expenses	154	154	154	154	154	154
Adominstrative Expenses	5,868	5,868	5,868	5,868	5,868	5,868
Payment to SENAPA	286	286	286	286	286	286
Total Outflow	15,521	15,520	15,521	15,521	15,520	15,520
Net Cash Flow	-3,618	-3,617	-3,618	-3,618	-3,617	-3,617
Accumulated	-12,957	-16,574	-20,193	-23,811	-27,428	-31,045

TABLE A23-9 Projected Cash Flow (Sensitivity D)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Cash Inflow															
Government Subsidy															
Capital Contribution	0	0	0	0	0	0									
Laon	1,764	23,910	23,534	1,877	23,746	23,471									
Foreign Loan(1)	617	12,205	12,002	657	12,756	12,620									
Foreign Loan(2)	1,147	11,705	11,532	1,220	10,990	10,851									
Operating Revenue	7,102	7,325	7,556	8,187	8,446	8,713	9,442	9,744	10,056	10,897	11,248	11,248	11,810	11,810	11,810
Sewerage Charge	6,963	7,181	7,408	8,026	8,280	8,542	9,257	9,553	9,859	10,684	11,028	11,028	11,579	11,579	11,579
Domestic	4,305	4,504	4,712	5,175	5,410	5,651	6,199	6,474	6,757	7,404	7,725	7,725	8,111	8,111	8,111
Ohters	2,658	2,677	2,696	2,851	2,871	2,891	3,057	3,079	3,101	3,280	3,303	3,303	3,468	3,468	3,468
Ohter Income	139	144	148	161	166	171	185	191	197	214	221	221	232	232	232
Water Sale Income	0	0	0	0	0	1,047	1,047	1,047	2,186	2,186	2,186	2,186	2,186	2,186	2,186
Total Inflow	8,866	31,235	31,090	10,064	32,192	33,231	10,489	10,791	12,242	13,083	13,434	13,434	13,996	13,996	13,996
Cash Outflow															
Project Expenditures															
Local Portion	617	12,205	12,002	657	12,756	12,620									
Foreign Portion	1,147	11,705	11,532	1,220	10,990	10,851									
Amortization															
Principal	0	0	0	0	0	0	0	0	0	0	1,980	2,086	2,199	4,297	4,535
Interest	78	1,347	2,596	2,646	3,287	3,921	3,921	3,921	5,255	5,255	5,255	5,149	5,036	4,915	4,677
Operating Expenses	0	0	0	122	122	122	154	154	154	154	154	154	154	154	154
Adominstrative Expenses	4,518	4,645	4,777	4,907	5,038	5,173	5,310	5,452	5,589	5,723	5,868	5,868	5,868	5,868	5,868
Payment to SENAPA	209	215	222	241	248	256	278	287	296	321	331	331	347	347	347
Total Outflow	6,569	30,117	31,129	9,793	32,441	32,943	9,663	9,814	11,294	11,453	13,588	13,588	13,604	15,581	15,581
Net Cash Flow	2,297	1,117	-39	271	-250	287	826	978	948	1,631	-154	-154	392	-1,585	-1,585
Accumulated	2,297	3,415	3,375	3,646	3,397	3,684	4,510	5,488	6,436	8,067	7,913	7,759	8,151	6,567	4,982

TABLE A23-9 Projected Cash Flow (Sensitivity D)(Cont'd)

(Unit : Dollar x 1000)

Year	2005	2006	2007	2008	2009	2010
Cash Inflow						
Government Subsidy						
Capital Contribution						
Laon						
Foreign Loan(1)						
Foreign Loan(2)						
Operating Revenue	12,401	12,401	12,401	13,021	13,021	13,021
Sewerage Charge	12,158	12,158	12,158	12,766	12,766	12,766
Domestic	8,517	8,517	8,517	8,942	8,942	8,942
Ohters	3,641	3,641	3,641	3,823	3,823	3,823
Ohter Income	243	243	243	255	255	255
Water Sale Income	2,186	2,186	2,186	2,186	2,186	2,186
Total Inflow	14,587	14,587	14,587	15,207	15,207	15,207
Cash Outflow						
Project Expenditures						
Local Portion						
Foreign Portion						
Amortization						
Principal	4,789	5,060	5,351	5,662	5,994	6,351
Interest	4,424	4,152	3,862	3,551	3,218	2,861
Operating Expenses	154	154	154	154	154	154
Adominstrative Expenses	5,868	5,868	5,868	5,868	5,868	5,868
Payment to SENAPA	365	365	365	383	383	383
Total Outflow	15,600	15,599	15,600	15,618	15,617	15,617
Net Cash Flow	-1,013	-1,012	-1,013	-411	-410	-410
Accumulated	3,969	2,957	1,944	1,534	1,124	714

TABLE A23-10 Projected Cash Flow (Sensitivity E)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Cash Inflow															
Government Subsidy															
Capital Contribution	126	7,188	7,059	134	8,047	7,970									
Laon	1,638	16,722	16,475	1,742	15,699	15,501									
Foreign Loan	1,638	16,722	16,475	1,742	15,699	15,501									
Operating Revenue	7,102	7,325	7,556	7,797	8,044	8,298	8,564	8,838	9,121	9,414	9,717	9,717	9,717	9,717	9,717
Sewerage Charge	6,963	7,181	7,408	7,644	7,886	8,135	8,396	8,665	8,942	9,229	9,526	9,526	9,526	9,526	9,526
Domestic	4,305	4,504	4,712	4,929	5,152	5,382	5,623	5,872	6,129	6,396	6,673	6,673	6,673	6,673	6,673
Ohters	2,658	2,677	2,696	2,715	2,734	2,753	2,773	2,793	2,813	2,833	2,853	2,853	2,853	2,853	2,853
Ohter Income	139	144	148	153	158	163	168	173	179	185	191	191	191	191	191
Water Sale Income	0	0	0	0	0	0	0	0	1,047	1,047	1,047	2,186	2,186	2,186	2,186
Total Inflow	8,866	31,235	31,090	9,673	31,790	31,769	8,564	8,838	10,168	10,461	10,764	11,903	11,903	11,903	11,903
Cash Outflow															
Project Expenditures															
Local Portion	617	12,205	12,002	657	12,756	12,620									
Foreign Portion	1,147	11,705	11,532	1,220	10,990	10,851									
Amortization															
Principal	0	0	0	0	0	0	0	0	0	0	1,364	1,398	1,433	2,758	2,827
Interest	41	459	871	918	1,342	1,760	1,760	1,760	1,694	1,694	1,694	1,660	1,625	1,590	1,521
Operating Expenses	0	0	0	122	122	122	154	154	154	154	154	154	154	154	154
Adominstrative Expenses	4,518	4,645	4,777	4,907	5,038	5,173	5,310	5,452	5,589	5,723	5,868	5,868	5,868	5,868	5,868
Payment to SENAPA	209	215	222	229	237	244	252	260	268	277	286	286	286	286	286
Total Outflow	6,532	29,229	29,404	8,053	30,485	30,770	7,476	7,626	7,705	7,848	9,366	9,366	9,366	10,656	10,656
Net Cash Flow	2,334	2,005	1,686	1,620	1,305	999	1,088	1,212	2,463	2,613	1,398	2,537	2,537	1,247	1,247
Accumulated	2,334	4,340	6,025	7,645	8,950	9,949	11,037	12,249	14,712	17,325	18,722	21,259	23,796	25,042	26,289

TABLE A23-10 Projected Cash Flow (Sensitivity E)(Cont'd)

(Unit : Dollar x 1000)

Year	2005	2006	2007	2008	2009	2010
Cash Inflow						
Government Subsidy						
Capital Contribution						
Laon						
Foreign Loan						
Operating Revenue	9,717	9,717	9,717	9,717	9,717	9,717
Sewerage Charge	9,526	9,526	9,526	9,526	9,526	9,526
Domestic	6,673	6,673	6,673	6,673	6,673	6,673
Ohters	2,853	2,853	2,853	2,853	2,853	2,853
Ohter Income	191	191	191	191	191	191
Water Sale Income	2,186	2,186	2,186	2,186	2,186	2,186
Total Inflow	11,903	11,903	11,903	11,903	11,903	11,903
Cash Outflow						
Project Expenditures						
Local Portion						
Foreign Portion						
Amortization						
Principal	2,898	2,970	3,044	3,121	3,199	3,279
Interest	1,450	1,377	1,303	1,227	1,149	987
Operating Expenses	154	154	154	154	154	154
Adominstrative Expenses	5,868	5,868	5,868	5,868	5,868	5,868
Payment to SENAPA	286	286	286	286	286	286
Total Outflow	10,656	10,655	10,655	10,656	10,656	10,574
Net Cash Flow	1,247	1,248	1,248	1,247	1,247	1,329
Accumulated	27,536	28,784	30,031	31,278	32,525	33,854

Table A23-11 Financial Benefit and Cost (Sensitivity A)

(Unit : Dollar x 1000)

year	Loan	Govern. Subsidy	Operating Income	Water Sale	Total Income	Capital Invest.	Operating Expenses	Debt Service	Total Expenses	Net Income	Present Value Benefit	Present Value Cost	Present Value Net Income
1990	1,638	0	7,102	0	8,740	1,764	4,727	41	6,532	2,208	8,740	6,532	2,208
1991	16,722	0	7,325	0	24,047	23,910	4,860	459	29,229	-5,182	22,266	27,064	-4,798
1992	16,475	0	7,556	0	24,031	23,534	4,999	871	29,404	-5,373	20,603	25,209	-4,606
1993	1,742	0	7,797	0	9,539	1,876	5,168	1,040	8,084	1,455	7,572	6,417	1,155
1994	15,699	0	8,044	0	23,743	23,746	5,307	1,464	30,517	-6,774	17,452	22,431	-4,979
1995	15,501	0	8,298	1,047	24,846	23,471	5,449	1,882	30,802	-5,956	16,910	20,963	-4,054
1996	0	0	8,564	1,047	9,611	0	5,716	1,914	7,630	1,981	6,057	4,808	1,248
1997	0	0	8,838	1,047	9,885	0	5,866	1,914	7,780	2,105	5,768	4,540	1,228
1998	0	0	9,121	2,186	11,307	0	6,011	1,848	7,859	3,448	6,109	4,246	1,863
1999	0	0	9,414	2,186	11,600	0	6,154	1,848	8,002	3,598	5,803	4,003	1,800
2000	0	0	9,717	2,186	11,903	0	6,308	3,212	9,520	2,383	5,513	4,410	1,104
2001	0	0	9,717	2,186	11,903	0	6,308	3,212	9,520	2,383	5,105	4,083	1,022
2002	0	0	9,717	2,186	11,903	0	6,308	3,212	9,520	2,383	4,727	3,781	946
2003	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	4,377	3,975	402
2004	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	4,053	3,680	372
2005	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	3,752	3,408	345
2006	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	3,474	3,155	319
2007	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	3,217	2,922	295
2008	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	2,979	2,705	274
2009	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	2,758	2,505	253
2010	0	0	9,717	2,186	11,903	0	6,308	4,502	-34,634	46,537	2,554	-7,431	9,984
Salvage Value									(-45,444)				
									Total Present Value		159,787	153,406	6,381

B.C.Ratio is 1.04

Table A23-12 Financial Benefit and Cost (Sensitivity B)

(Unit : Dollar x 1000)

year	Loan	Govern. Subsidy	Operating Income	Water Sale	Total Income	Capital Invest.	Operating Expenses	Debt Service	Total Expenses	Net Income	Present Value Benefit	Present Value Cost	Present Value Net Income
1990	1,638	0	7,102	0	8,740	1,764	4,727	41	6,532	2,208	8,740	6,532	2,208
1991	16,722	0	7,325	0	24,047	23,910	4,860	459	29,229	-5,182	22,266	27,064	-4,798
1992	16,475	0	7,556	0	24,031	23,534	4,999	871	29,404	-5,373	20,603	25,209	-4,606
1993	1,742	0	7,797	0	9,539	1,876	5,168	1,040	8,084	1,455	7,572	6,417	1,155
1994	15,699	0	8,044	0	23,743	23,746	5,307	1,464	30,517	-6,774	17,452	22,431	-4,979
1995	15,501	0	8,298	0	23,799	23,471	5,449	1,882	30,802	-7,003	16,197	20,963	-4,766
1996	0	0	8,564	0	8,564	0	5,716	1,914	7,630	934	5,397	4,808	589
1997	0	0	8,838	0	8,838	0	5,866	1,914	7,780	1,058	5,157	4,540	617
1998	0	0	9,121	0	9,121	0	6,011	1,848	7,859	1,262	4,928	4,246	682
1999	0	0	9,414	0	9,414	0	6,154	1,848	8,002	1,412	4,709	4,003	706
2000	0	0	9,717	0	9,717	0	6,308	3,212	9,520	197	4,501	4,410	91
2001	0	0	9,717	0	9,717	0	6,308	3,212	9,520	197	4,167	4,083	84
2002	0	0	9,717	0	9,717	0	6,308	3,212	9,520	197	3,859	3,781	78
2003	0	0	9,717	0	9,717	0	6,308	4,502	10,810	-1,093	3,573	3,975	-402
2004	0	0	9,717	0	9,717	0	6,308	4,502	10,810	-1,093	3,308	3,680	-372
2005	0	0	9,717	0	9,717	0	6,308	4,502	10,810	-1,093	3,063	3,408	-345
2006	0	0	9,717	0	9,717	0	6,308	4,502	10,810	-1,093	2,836	3,155	-319
2007	0	0	9,717	0	9,717	0	6,308	4,502	10,810	-1,093	2,626	2,922	-295
2008	0	0	9,717	0	9,717	0	6,308	4,502	10,810	-1,093	2,432	2,705	-274
2009	0	0	9,717	0	9,717	0	6,308	4,502	10,810	-1,093	2,252	2,505	-253
2010	0	0	9,717	0	9,717	0	6,308	4,502	-34,634	44,351	2,085	-7,431	9,515
Salvage Value									(-45,444)				
									Total Present Value		147,723	153,406	-5,683

B.C.Ratio is 0.96

Table A23-13 Financial Benefit and Cost (Sensitivity C)

(Unit : Dollar x 1000)

year	Loan	Govern. Subsidy	Operating Income	Water Sale	Total Income	Capital Invest.	Operating Expenses	Debt Service	Total Expenses	Net Income	Present Value Benefit	Present Value Cost	Present Value Net Income
1990	1,764	0	7,102	0	8,866	1,764	4,727	78	6,569	2,297	8,866	6,569	2,297
1991	23,910	0	7,325	0	31,235	23,910	4,860	1,347	30,117	1,118	28,921	27,886	1,035
1992	23,534	0	7,556	0	31,090	23,534	4,999	2,596	31,129	-39	26,655	26,688	-33
1993	1,876	0	7,797	0	9,673	1,876	5,168	2,646	9,690	-17	7,679	7,692	-13
1994	23,746	0	8,044	0	31,790	23,746	5,307	3,287	32,340	-550	23,367	23,771	-404
1995	23,471	0	8,298	0	31,769	23,471	5,449	3,921	32,841	-1,072	21,621	22,351	-730
1996	0	0	8,564	0	8,564	0	5,716	3,921	9,637	-1,073	5,397	6,073	-676
1997	0	0	8,838	0	8,838	0	5,866	3,921	9,787	-949	5,157	5,711	-554
1998	0	0	9,121	0	9,121	0	6,011	5,255	11,266	-2,145	4,928	6,087	-1,159
1999	0	0	9,414	0	9,414	0	6,154	5,255	11,409	-1,995	4,709	5,707	-998
2000	0	0	9,717	0	9,717	0	6,308	7,234	13,542	-3,825	4,501	6,273	-1,772
2001	0	0	9,717	0	9,717	0	6,308	7,234	13,542	-3,825	4,167	5,808	-1,640
2002	0	0	9,717	0	9,717	0	6,308	7,234	13,542	-3,825	3,859	5,378	-1,519
2003	0	0	9,717	0	9,717	0	6,308	9,212	15,520	-5,803	3,573	5,707	-2,134
2004	0	0	9,717	0	9,717	0	6,308	9,212	15,520	-5,803	3,308	5,284	-1,976
2005	0	0	9,717	0	9,717	0	6,308	9,212	15,520	-5,803	3,063	4,893	-1,829
2006	0	0	9,717	0	9,717	0	6,308	9,212	15,520	-5,803	2,836	4,530	-1,694
2007	0	0	9,717	0	9,717	0	6,308	9,212	15,520	-5,803	2,626	4,195	-1,568
2008	0	0	9,717	0	9,717	0	6,308	9,212	15,520	-5,803	2,432	3,884	-1,452
2009	0	0	9,717	0	9,717	0	6,308	9,212	15,520	-5,803	2,252	3,596	-1,345
2010	0	0	9,717	0	9,717	0	6,308	9,212	-29,924	39,641	2,085	-6,420	8,505
Salvage Value									(-45,444)				
									Total Present Value		172,001	181,661	-9,659

B.C.Ratio is 0.95

Table A23-14 Financial Benefit and Cost (Sensitivity D)

(Unit : Dollar x 1000)

year	Loan	Govern. Subsidy	Operating Income	Water Sale	Total Income	Capital Invest.	Operating Expenses	Debt Service	Total Expenses	Net Income	Present Value Benefit	Present Value Cost	Present Value Net Income
1990	1,764	0	7,102	0	8,866	1,764	4,727	78	6,569	2,297	8,866	6,569	2,297
1991	23,910	0	7,325	0	31,235	23,910	4,860	1,347	30,117	1,118	28,921	27,886	1,035
1992	23,534	0	7,556	0	31,090	23,534	4,999	2,596	31,129	-39	26,655	26,688	-33
1993	1,876	0	8,187	0	10,063	1,876	5,168	2,646	9,690	373	7,988	7,692	296
1994	23,746	0	8,446	0	32,192	23,746	5,307	3,287	32,340	-148	23,662	23,771	-109
1995	23,471	0	8,713	1,047	33,231	23,471	5,449	3,921	32,841	390	22,616	22,351	265
1996	0	0	9,442	1,047	10,489	0	5,716	3,921	9,637	852	6,610	6,073	537
1997	0	0	9,744	1,047	10,791	0	5,866	3,921	9,787	1,004	6,296	5,711	586
1998	0	0	10,056	2,186	12,242	0	6,011	5,255	11,266	976	6,614	6,087	527
1999	0	0	10,897	2,186	13,083	0	6,154	5,255	11,409	1,674	6,545	5,707	837
2000	0	0	11,248	2,186	13,434	0	6,308	7,234	13,542	-108	6,223	6,273	-50
2001	0	0	11,248	2,186	13,434	0	6,308	7,234	13,542	-108	5,762	5,808	-46
2002	0	0	11,810	2,186	13,996	0	6,308	7,234	13,542	454	5,558	5,378	180
2003	0	0	11,810	2,186	13,996	0	6,308	9,212	15,520	-1,524	5,146	5,707	-560
2004	0	0	11,810	2,186	13,996	0	6,308	9,212	15,520	-1,524	4,765	5,284	-519
2005	0	0	12,401	2,186	14,587	0	6,308	9,212	15,520	-933	4,598	4,893	-294
2006	0	0	12,401	2,186	14,587	0	6,308	9,212	15,520	-933	4,258	4,530	-272
2007	0	0	12,401	2,186	14,587	0	6,308	9,212	15,520	-933	3,942	4,195	-252
2008	0	0	13,021	2,186	15,207	0	6,308	9,212	15,520	-313	3,806	3,884	-78
2009	0	0	13,021	2,186	15,207	0	6,308	9,212	15,520	-313	3,524	3,596	-73
2010	0	0	13,021	2,186	15,207	0	6,308	9,212	-29,924	45,131	3,263	-6,420	9,683
Salvage Value									(-45,444)				
									Total Present Value		195,618	181,661	13,957
									B.C.Ratio is	1.08			

Table A23-15 Financial Benefit and Cost (Sensitivity E)

(Unit : Dollar x 1000)

year	Loan	Govern. Subsidy	Operating Income	Water Sale	Total Income	Capital Invest.	Operating Expenses	Debt Service	Total Expenses	Net Income	Present Value Benefit	Present Value Cost	Present Value Net Income
1990	1,638	126	7,102	0	8,866	1,764	4,727	41	6,532	2,334	8,866	6,532	2,334
1991	16,722	7,188	7,325	0	31,235	23,910	4,860	459	29,229	2,006	28,921	27,064	1,857
1992	16,475	7,059	7,556	0	31,090	23,534	4,999	871	29,404	1,686	26,655	25,209	1,445
1993	1,742	134	7,797	0	9,673	1,876	5,168	1,040	8,084	1,589	7,679	6,417	1,261
1994	15,699	8,047	8,044	0	31,790	23,746	5,307	1,464	30,517	1,273	23,367	22,431	936
1995	15,501	7,970	8,298	0	31,769	23,471	5,449	1,882	30,802	967	21,621	20,963	658
1996	0	0	8,564	0	8,564	0	5,716	1,914	7,630	934	5,397	4,808	589
1997	0	0	8,838	0	8,838	0	5,866	1,914	7,780	1,058	5,157	4,540	617
1998	0	0	9,121	1,047	10,168	0	6,011	1,848	7,859	2,309	5,493	4,246	1,247
1999	0	0	9,414	1,047	10,461	0	6,154	1,848	8,002	2,459	5,233	4,003	1,230
2000	0	0	9,717	1,047	10,764	0	6,308	3,212	9,520	1,244	4,986	4,410	576
2001	0	0	9,717	2,186	11,903	0	6,308	3,212	9,520	2,383	5,105	4,083	1,022
2002	0	0	9,717	2,186	11,903	0	6,308	3,212	9,520	2,383	4,727	3,781	946
2003	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	4,377	3,975	402
2004	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	4,053	3,680	372
2005	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	3,752	3,408	345
2006	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	3,474	3,155	319
2007	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	3,217	2,922	295
2008	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	2,979	2,705	274
2009	0	0	9,717	2,186	11,903	0	6,308	4,502	10,810	1,093	2,758	2,505	253
2010	0	0	9,717	2,186	11,903	0	6,308	4,502	-34,634	46,537	2,554	-7,431	9,984
Salvage Value									(-45,444)				
									Total Present Value		180,370	153,406	26,964
									B.C.Ratio is	1.18			

TABLE A23-16 Economic Benefit and Cost (Sensitivity B)

(Unit : Dollar x 1000)

year	Land Value	Health Benefit	Tourism Income	Water Value	Total Income	Capital Invest.	Operat. Exp.	Total Exp.	Net Income	Present Value Benefit	Present Value Cost	Present Value Net Income
1990	0	0	0	0	0	906	0	906	-906	0	906	-906
1991	0	0	0	0	0	13,117	0	13,117	-13,117	0	12,145	-12,145
1992	0	0	0	0	0	12,909	0	12,909	-12,909	0	11,067	-11,067
1993	0	242	1,696	0	1,938	985	94	1,079	859	1,538	856	682
1994	4,320	252	1,696	0	6,268	13,368	94	13,462	-7,194	4,607	9,895	-5,288
1995	540	262	1,696	0	2,498	13,217	94	13,311	-10,813	1,700	9,059	-7,359
1996	540	272	3,391	0	4,203	0	118	118	4,085	2,649	75	2,574
1997	6,540	283	3,391	0	10,214	0	118	118	10,096	5,960	69	5,891
1998	1,290	294	3,391	0	4,975	0	118	118	4,857	2,688	64	2,624
1999	750	306	3,391	0	4,447	0	118	118	4,329	2,225	59	2,165
2000	750	318	3,391	0	4,459	0	118	118	4,341	2,065	55	2,011
2001	750	318	3,391	0	4,459	0	118	118	4,341	1,912	51	1,862
2002	0	318	3,391	0	3,709	0	118	118	3,591	1,473	47	1,426
2003	0	318	3,391	0	3,709	0	118	118	3,591	1,364	44	1,320
2004	0	318	3,391	0	3,709	0	118	118	3,591	1,263	40	1,222
2005	0	318	3,391	0	3,709	0	118	118	3,591	1,169	37	1,132
2006	0	318	3,391	0	3,709	0	118	118	3,591	1,083	35	1,048
2007	0	318	3,391	0	3,709	0	118	118	3,591	1,002	32	970
2008	0	318	3,391	0	3,709	0	118	118	3,591	928	30	899
2009	0	318	3,391	0	3,709	0	118	118	3,591	859	27	832
2010	0	318	3,391	0	3,709	0	118	-26,809	30,518	796	-5,752	6,547
Salvage Value								(-26,927)				
								Present Value		35,280	38,842	-3,562

B.C.Ratio is 0.91 IRR is 6.88%

TABLE A23-17 Economic Benefit and Cost (Sensitivity E)

(Unit : Dollar x 1000)

year	Land Value	Health Benefit	Tourism Income	Water Value	Total Income	Capital Invest.	Operat. Exp.	Total Exp.	Net Income	Present Value Benefit	Present Value Cost	Present Value Net Income
1990	0	0	0	0	0	906	0	906	-906	0	906	-906
1991	0	0	0	0	0	13,117	0	13,117	-13,117	0	12,145	-12,145
1992	0	0	0	0	0	12,909	0	12,909	-12,909	0	11,067	-11,067
1993	0	242	1,696	0	1,938	985	94	1,079	859	1,538	856	682
1994	4,320	252	1,696	0	6,268	13,368	94	13,462	-7,194	4,607	9,895	-5,288
1995	540	262	1,696	0	2,498	13,217	94	13,311	-10,813	1,700	9,059	-7,359
1996	540	272	3,391	0	4,203	0	118	118	4,085	2,649	75	2,574
1997	6,540	283	3,391	0	10,214	0	118	118	10,096	5,960	69	5,891
1998	1,290	294	3,391	806	5,781	0	118	118	5,663	3,123	64	3,059
1999	750	306	3,391	806	5,253	0	118	118	5,135	2,628	59	2,569
2000	750	318	3,391	806	5,265	0	118	118	5,147	2,439	55	2,384
2001	750	318	3,391	1,681	6,140	0	118	118	6,022	2,633	51	2,583
2002	0	318	3,391	1,681	5,390	0	118	118	5,272	2,140	47	2,093
2003	0	318	3,391	1,681	5,390	0	118	118	5,272	1,982	44	1,938
2004	0	318	3,391	1,681	5,390	0	118	118	5,272	1,835	40	1,795
2005	0	318	3,391	1,681	5,390	0	118	118	5,272	1,699	37	1,662
2006	0	318	3,391	1,681	5,390	0	118	118	5,272	1,573	35	1,539
2007	0	318	3,391	1,681	5,390	0	118	118	5,272	1,457	32	1,425
2008	0	318	3,391	1,681	5,390	0	118	118	5,272	1,349	30	1,319
2009	0	318	3,391	1,681	5,390	0	118	118	5,272	1,249	27	1,221
2010	0	318	3,391	1,681	5,390	0	118	-26,809	32,199	1,156	-5,752	6,908
Salvage Value								(-26,927)				
									Present Value	41,717	38,842	2,875

B.C.Ratio is 1.07 IRR is 8.83%