SUPPORTING REPORT

F : ENVIRONMENT

Supporting Report F: Environment

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F. ENVIRONMENT

1. SOCIAL AND NATURAL ENVIRONMENT

This section focuses on the environmental conditions which may be impacted by the implementation of the Priority Project.

1.1 Social Environment

1.1.1 Conflict between farmers and fishermen

In the past there has been many conflicts between farmers and fishermen on the lake water level, affecting fish catch and the area of farm land, and the problem is very sensitive.

In the case of Lake Olomega, an NGO which is representing the fishermen constructed a concrete weir at the outlet of the lake in 1995. Since the construction, the water level has been kept over 64.5 m.

A weir was first constructed accross the Jocotal Drainage in the 1970's by the land owner for saving irrigation water. The weir was destroyed by the new land owner to expand his farm land in 1990. The conflict has continued since then because the destruction affected the fish catch by lowering the lake water level.
However, they achieved an agreement mediated by ONUSAL (United Nations Observation Office for El Salvador) in 1993. Based on the agreement, Decree No. 689 was legislated by El Salvadorian Assembly in 1996. It states the maintenance of existing weir to keep water level. The conflict has ceased since the agreement.

1.1.2 Cultural Property

There are two cultural heritages in the study area as shown in the table below.

(Cultural Heritage in the Study Area)

Dept	Place	Contents
San Miguel Morazan	Quelepa Corinto	Vestiges of a pre-columbian city in an area of 6 Km. Two caves on a broad plain (36m long, 16m high, 7m wide), and prehistoric drawings about 10,000 years old on the walls of these caves.

(Source : Salvadorian Institute of Tourism)

1.2 Natural Environment

1.2.1 Lake Jocotal

Lake Jocotal covers 500 ha in dry season and 1,500 ha in rainy season, and its average depth is 1.5 m and 3.0 m, respectively. The main water source is the water springs from the San Miguel Volcano.

The lake is famous as a habitat of aquatic birds and a breeding area of migratory ducks from U.S.A. and Canada: Anas Discors, Anas Alypeata, Anas Americana and Aythia affinis. More than 130 species of birds are found in the area. Another indigenous fauna are Crocodile, Iguana and boa etc.

To protect these fauna and flora, a total of 1,880 ha of the lake and its surrounding is designated as a protection area, as shown below.

(Protection Area in Jocotal)

Place	Area(ha)	Land tenure
Casamota & La Pezota	195.6	Not clear
Lake Jocotal	1,877.4	State
San Miguel Volcano	1,200.0	Private

However, human activities have recently brought about many changes in the flora and fauna, as described below.

1) Overdevelopment: The area around the lake has already been developed, and farm and grazing lands adjoin the shore. Forest area has decreased in the surrounding areas.
2) Deterioration of water quality: According to IDEA, an NGO related to the lake, the water quality has been deteriorating since 1970's because of inflow of floodwater from the San Miguel River .

As a result, many species of the fauna have been decreasing and four NGOs are now in activity to improve the situation. IDEA, the largest NGO funded by Canada and consisting of 13 members, is promoting reforestation by bamboo and other trees surrounding the lake and along the right bank of the San Miguel River.

1.2.2 Lake Olomega

Lake Olomega has an area of about 2,000 ha, and about half of its surface is covered by aquatic plants such as water hyacinth because of water pollution.

However, the lake is very important for fishery and the average fish catch in 1993 to 1989 was 232 ton per year, which is equivalent to three times the amount of Lake Jocotal. Main fish species for catch are Guapote, Bagre, Tilapia and Mojarra.

The lake is a habitat for many species of wild birds such as hawk, duck, ibis, heron, owl, etc., also for other vertebrates and invertebrates. However, the number of these animals is decreasing, and most of these species are in danger of extinction.

1.1.3 Erosion

Soil erosion is one of the most serious environmental problem in the country. The National Environmental Strategy is targeted to sustainable use of soil resources by decreasing erosion.

Six reforestation projects, shown in the table below, are under implementation for soil conservation and reconstruction of natural ecosystems in the area. All of these projects are implemented by an NGOs funded by Canada and U.S.A.

(List of Reforestation Project in the Study Area)

Implementation Organization	Municipio	Area (ha)	Tree	Remark
IDEA	El Tránsito Chirilagua	35	Bamboo	Improvement of ecological situation in Lake Jocotal
COMUS	El Tránsito	40	Timber, Fruits	Soil and underground protection in Moropola
FESACORA	San Miguel El Tránsito	40	Casamota Cantora	Protection of farm land of cooperatives
ADCJ	El Tránsito	-	-	
ACELCEI	San Miguel	12	Fruits Conacaste Carreto	Reforestation in La Ceiba Community
SOCORRO LUTERANO	San Miguel	34	Fruits Leucaena Cortez Madrecaca	Reforestation and formation of an environmental committee of Las Gemelitas Cooperative

(Source : MAG)

In the case of the Study Area, the land is already fully developed and forest covers only a small percentage of the total area. However, unarable land, which should be covered by forest because of its steep slope and thin soil layer etc., shares about 52 percent of the Study Area.

From the evaluation of the existing land use, based on the Land Classification Map by MAG, it can be said that grazing land is expanding into the unarable land. This inappropriate land use is prone to induce soil erosion.

Considering this problem, a future land use map based on the classification map is proposed by the Study Team to achieve sustainable use of soil resources. The main concepts of this plan expect the following effects by means of appropriate use of soil in accordance with its potentiality:

1) Improvement of flood prone land use.
2) Improvement of erosion prone land use.
3) Improvement of agriculture productivity.

1.1.4 Water Pollution of San Miguel River

Recently, deterioration of water quality of the San Miguel River is becoming a serious problem since it is affecting the downstream area. The main cause of the pollution is wastewater effluence from urban areas of San Miguel City. According to the San Miguel Municipal Office, 100 % of the wastewater is discharged into the San Miguel River without any treatment.

The values of BOD at Moscoso and Villerias during the dry season in 1981 recorded the high concentrations of 15.2 and 6.6 ppm, respectively. The values of BOD during the wet season were less than 3.0. BOD values in May, 1996 at Moscoso and Urbina were 4.7 and 9.3 ppm respectively.

1.1.5 Mangrove Forest

15,500 ha of mangrove forest expands in the river mouth area of Usulutan Department (Source: Rational Plan for Manglove Management in 1972, MAG) and it consists mainly of 5 spices as follows:

Scientific name	Common name
1) Rhizophora mangle	Mangle
2) Laguncularia racemosa	Sincahuile
3) Avicennia nitida	Istatén
4) Avicenia bicolor	Mangle negro
5) Conocarpus erecta	Botoncillo

Of these species, Mangle is a precious species because it is an endemic species in Central America. The species mainly inhabit in the brackish area.
According to the Forest Legislation, all mangrove forest belongs to the State. However, the area has been decreasing and its main reasons are :

1) Expansion of farm land, saltpan and shrimp pond.
2) Disordered and illegal cutting to produce firewood, charcoal, etc..
3) Change of ecosystem by sedimentation.

2. ENVIRONMENTAL ADMINISTRATION AND LAW

2.1 Environmental Organization

In 1991, the Executive Secretariat for Environment (SEMA) was established as an implementation organization of environmental policy under jurisdiction of the National Environmental Committee and at that time the competent authority belonged to the Ministry of Agriculture and Livestock. The Executive, however, has belonged to the Ministry of Interior since August of 1994 by issue of Decree No. 19. Main functions of SEMA prescribed in the Decree are as follows;

1) To formulate and evaluate the National Environmental Policy.
2) To participate in elaboration of environmental plans and programs for the protection of natural resources.
3) To prepare a quinquennial report on environmental conditions to the Legislative Assembly and the National Environmental Advisory Council for the Sustainable Development.
4) To prepare an annual report on national environmental administration.
5) To promote coordination of related administration and community participation.
6) To support acquisition of funds for environmental protection projects and programs.
7) To participate in forums and international negotiations related with environment.
8) To promote an environmental training program.

As shown in Fig. F.2.1, SEMA consists of 4 units and the role by unit is as follows:

1) Environmental Program/IDB: This Unit's main roles are design and implementation of an institutional system and environmental management inside the public sector including SEMA.
2) Environmental Technical Unit: This Unit's main role is technical aspect for ecological conservation and its function is the center for the environmental management system of the country. Implementation of EIA and monitoring are also important roles of the Unit.
3) Environmental Education and Public Relation Unit: This Unit is responsible for education of importance and conservation of the environment. To extend the education, the Unit promotes coordination of NGOs.
4) Administration Unit: This Unit is in charge of administration works and technical education related to the environment.

However, an administrative function in environment policy is not centralized, the executives as shown in the table below and other organizations related to the environment have been functioning as environmental administration in their own field.

(Organizations Related to Environment)

Field	Organization
•Water	•Ministry of Health, ANDA, Ministry of Public Works, MAG, MIPLAN
•Energy	•CEL
•Minerals	•CEL, Ministry of Public Works
•Landscape	•Salvadoran Institute of Tourism, MAG
•Cultural Heritage	•Ministry of Education
•Natural Heritage	•Ministry of Education
•Forestry and Soil Conservation	•MAG
•Wildlife	•MAG
•Other Natural resource	•MAG, Municipal Office, Ministry of Health

As of March 1997, two draft bills, Environmental Law and Creation of CEMA (Comision Ejectiva del Medio Ambiente), are under discussion in the Assembly. SEMA has belonged to the MICDES (the Ministry of Coordination for Social and Economic Development) since June 1, 1995 and MICDES has not been existed since December 1995. Presently, SEMA's budget comes from the Ministry of Interior and acting independently as a Secretariat until the two bills are agreed and signed in the Assembly.

2.2 Environmental Law and Regulation

Up to now, there is neither environmental law nor regulation in El Salvador. However, a law concerning preservation, development and assessment of the environment is now being elaborated in the Diet.

Therefore, IEE (Initial Environmental Examination) system prepared by JICA is being applied to this Study under agreement between the Study Team and SEMA.

Among other regulations related to environmental assessment, there is a OPAMSS's decree (Planning Office of San Salvador Metropolitan Area), which prohibits an implementation of a project without an Environmental Impact Assessment (EIA) in the 17 Municipalities of the Metropolitan Area.

2.3 International Conventions and Treaties Related to the Environment

International Conventions/Treaties ratified and signed by El Salvador are shown as follows:

1) The Convention on International Trade in Endangered Species of Wild Fauna and Flora. (Ratified May 1986)
2) Convention on Biological Diversity. (Ratified May 1994)
3) Convention on Wildlife, Vegetation and Natural Landscaping Protection for American Countries. (Ratified Jan. 1941)
4) Convention on International Quarantine Protection for Flora. (Signed Feb. 1953)
5) Convention on Central American Bio-diversity Protection. (Signed Jun. 1992)
6) Convention on American Nation's Archeological, Historical and Artistic Heritage Defense. (San Salvador Convention Ratified May 1980)
7) Atmosphere, Underwater, and Space Nuclear Weapons Tests Prohibition Treaty. (Ratified Nov. 1964)
8) Basilea Convention on Cross-Border Movement of Dangerous Waste Materials and Its Elimination. (Ratified June 1991)
9) Cross-Border Regional Treaty Regarding Hazardous Waste Management. -XIII Central America and Panama President's Summit- (Signed Dec. 1992)
10) Vienna Convention for Ozone Layer Protection. (Ratified Oct. 1992)
11) Montreal Protocol Related to Ozone Layer Damaging Substances. (Ratified Dec. 1992)
12) Framework Convention on Climate Change. (Ratified Oct. 1995)
13) United Nations Convention on the Law of the Sea. (Ratified Dec. 1984)
14) Central America Environment and Development Committee, CCAD. (Ratified Nov. 1991)
15) Central American Committee on Inter-Parliamentary Environment and Development: CICAD (Signed Dec. 1990)
16) Convention on Central American Environmental Protection. (Ratified Nov. 1990)

(Source: SEMA, MAG)

The country has not yet ratified or signed the International Convention for Bird Preservation and Convention of Wetlands of International Importance, which are very important for the study area.

3. INITIAL ENVIRONMENTAL EXAMINATION (IEE)

3.1 IEE

In master plan study stage, following projects were studied. Although San Esteban Dam was excluded form the final master plan, IEE was conducted in the process of the study.

(1) Improvement of river channel

The improvement works of river channels are to increase flow capacities of channels by widening, deepening and smoothening the channels. By implementing the improvement works, the floodwater level will become lower and the duration will become shorter during floods.

Decrease in flood frequency will improve the living condition of the communities and enhance the economic activity through agricultural production increase.

(2) Floodwater storage in Lake Olomega

To alleviate flood damage in the lower basin, Lake Olomega will be used as a retarding basin expanding Pelota River as a floodway from San Miguel River to Lake Olomega.

(3) Watershed management

The land use plan based on land potentiality is proposed in the study to achieve sustainable use of land resources. In order to achieve the appropriate land use, watershed management, mainly consisting of reforestation, is proposed in view of run-off control, soil erosion control and water quality improvement. Reforestation area is about 53,000 ha by the target year.

(4) San Esteban Dam

San Esteban multipurpose dam including hydro-electric power generation and irrigation was studied. The reservoir covers about 36 km2, and population in the area is 7,303.

The evaluation of each activity on the environmental element is shown in Table F.3.1.
In conclusion, EIA of the Priority Projects is necessary in the Feasibility Study.

3.2 Water Quality Improvement

As mentioned in Chapter 2, deterioration of water quality of the San Miguel River, Lake Olomega and Lake Jocotal is one of the biggest problems of environment in the area.
According to the water quality analysis, water quality of the San Miguel River, even in the upstream upper stream, was very low. This mean that the cause of the deterioration in the down stream is not only the urban wastewater but also other causes in the upper basin. To improve the situation, following measures are recommended.

(1) Upper stream and Lake Olomega

The causes can be listed as follows:

1) Cattle feces from grazing land
2) Human waste
2) Wastewater from coffee treatment
3) Soap by laundry in the river

However, real cause is not clear at this stage. It is recommend that the cause should be cleared urgently to make up some solutions.

(2) Urban wastewater

Direct inflow of urban wastewater into the river is a heavy load to the river water quality. It restricts the water use in the downstream.
As effective use of water resources is necessary for the further agricultural and economic development in the area, it is recommend that the urban wastewater should be treated.

(3) Jocotal

By implementing the improvement of San Miguel River channel, inflow from river water into the lake would decrease during flood and water quality would be improved. However, the deterioration by washing soap and human waste are also main causes. It is recommend that washing in the lake should be banned to improve the water quality and recover the original ecosystem. To achieve it, water supply system should be distributed around the lake.

4. ENVIRONMENTAL IMPACT ASSESSMENT

To find the important environmental impact of the Priority Project, the use of scoping format by JICA is implemented. The results and the general description of the project are shown in Table F.4.1 and F.4.2, respectively. For these impacts, the main considerations to alleviate them are discuss as follows:

4.1 EIA

4.1.1 Social Environment

a) Resettlement

The project needs land acquisition and resettlement for the river improvement.

To alleviate the impact of the resettlement, the plan has well considered the course of the river. The impact, therefore, is small because the resettlement affects only 20 houses. However, the government should provide compensation for them either as alternative land or as monetary compensation.

Land acquisition is estimated at 450 ha. Most of this area presently suffers from severe flooding or is idle land along the river. Therefore, the project would not affect human activity so much.

b) Economic activities

As mentioned above, the land acquisition area is not used for production purposes because the area is composed of severe flood area or idle land. It will not affect economic activities.

On the other hand, agricultural production in the flood area would be stabilized by implementation of the project because the flood damage will be reduced. As a result, the regional economy would be stimulated.

c) Traffic and public facilities

The project does not affect public facilities because it will not cut off the existing traffic way.

d) Split of community

There are few communities in the area of river improvement. Three bridges were planned across the new river course where there are small passes across the river.

e) Cultural property

There are two cultural heritages in the study area. However, the project does not affect them because they are located far from the river.

f) Water rights

The project proposes that Lake Olomega, where 2,000 fishermen earn a livelihood by fish catch, is used as a retarding basin.

The lake water level has fluctuated every year depending on the basin's rainfall amount and floodwater, and it much affected the fish catch. According to the data on the relationship between fish catch and the lake water level, preferable level for fish catch is between 64 and 65.5 m. Considering this situation, the lake water level is planned to be maintained at the preferable level, between 64.5 m and 65.5 m, to decrease the impact. Therefore, fluctuation of fish catch per year would be alleviated and stabilized by implementation of the project.

In the case of Lake Jocotal, there is no data on correlation between fish catch and the water level. The inflow amount of the floodwater from the river would be decreased by the project, because frequent floods would be discharged without flooding to the lake. The water quality, therefore, is expected to improve because the run-off from the lake catchment originates as spring water and the quality is very high. Therefore, the project would contribute to recover the original ecosystem.

g) Public health condition

The project does not include the works which may cause deterioration of the sanitary conditions such as increasing rubbish, human waste, or outbreak of plagues.

h) Waste

These two projects produce large amount of excavated soil, 6.9 M m3, by the excavation of the

river. Most of the soil is used to construct embankments at the river.

i) Hazard

There is no risk of hazard because the project does not include big construction works.

2) Natural Environment

a) Topography and geology

As mentioned above, most of the areas for the bank construction are flat lands and not used so much. Therefore, the area does not have any valuable topography.

b) Soil and land

The projects include bush deforestation on the areas along the river for the river improvement and bank construction. To prevent erosion of the area, the study recommends slope protection of the bank by protections and sodding. Therefore, only a small amount of soil erosion would be generated.

c) Groundwater

The plan gives consideration on keeping the existing river bed in general, therefore, there would not be any impact on groundwater. In the upper reach in Jocotal area and Olomega Diversion Channel, small effects due to lowering of the river water level on groundwater may occure.

d) Hydrological situation

The water flow in the present river would be affected by construction of the diversion and drainage channels for Lake Olomega. However, the plan proposes construction of diversion facilities to keep the existing discharge during dry season.

e) Coastal zone

Inflow of suspended solid into the marine zone might be increased because most of flood water flow into the zone directly by the river improvement. The solids may affect the marine

ecosystem such as a habitat of coral and fish. However, there are not any precious coral reefs in the sea.
In the master plan, on the other hand, watershed management was proposed to decrease erosion. The plan, therefore, should be implemented to alleviate the impact in the area.

f) Fauna and flora

Lake Jocotal is famous as a habitat of aquatic birds and breeding area of migratory birds from USA, Canada, etc.. More than 130 spices of birds are found in the area. However, most of the species are decreasing and are in danger of extinction because the water quality has been deteriorating since 1970's due to the inflow of floodwater from the river and the overdevelopment of the basin itself. Because of its high S-S (Suspended Solid) contents, the floodwater is of low quality. Implementation of the project would decrease the inflow volume of floodwater. Therefore, the project would contribute to recover the fauna situation through the improvement of the water quality.

Lake Olomega is important as a rerources for fishery resource. In the case of the lake, inflow of flood water from the river would be decreased, accounting for 30 % concerning annual expected amount. It might contribute to improve the water quality of the lake. As mentioned in the water right item, the study is planned to consider the fishing condition to keep it's preferable water level.

15,500 ha of mangrove forest expands in the river mouth area of Usulutan Department (Source: Rational Plan for Manglove Management in 1972, MAG) and it consists of mainly 5 spices as follow:

Scientific name	Common name
1) Rhizophora mangle	Mangle
2) Laguncularia racemosa	Sincahuile
3) Avicennia nitida	Istatén
4) Avicenia bicolor	Mangle negro
5) Conocarpus erecta	Botoncillo

Of these species Mangle is a precious species because it is an endemic species in Central America. The species mainly inhabit in the brackish area. Therefore, the project does not affect the precious species.

g) Meteorology

There are not any large construction works which may have meteorological effects.

h) Landscape

The project affects topographic conditions because of the construction of embankments along the river. It's total length is 61.4 Km. However, the embankment is already constructed and the construction planned in the project is mostly repair work. Therefore, the impact in the landscape is very little.

3) Pollution

a) Air pollution

There are no air pollution sources.

b) Water pollution

The river improvement work may occasionally emit turbid water put its duration is not long.

c) Soil contamination

There are no soil contamination sources.

d) Noise and vibration

Noise and vibration would occur during the works. However, they would not affect human activities because the area is far from any human settlement.

e) Land subsidence

Land subsidence is not expected to occur.

f) Offensive odors

There are no offensive odor sources.

(2) Results

Social and natural environmental impacts of the project are assessed and the implementation of the project will have little impact on it's dweller and natural conditions, because the study has considered the impacts.
On the other hand, the project will stimulate the regional economy through the following:

- Expanding agricultural products by increasing the arable land and decreasing flood damage.
- Stabilizing fish catch of Lake Olomega by keeping it's preferable water level.

Furthermore, the water quality of Lake Jocotal will be improved, because floodwater inflow, will be decreased by the project.

Therefore, the implementation will give a positive impacts on regional economy.

5. RECOMMENDATIONS

5.1 Improvement of river water quality

The existing river water quality is very low and it might affect the following:

- Restriction of water use such as irrigation.
- Decreasing freshwater fish catch in the river and lakes.
- Decreasing wild animals, especially birds in Lake Jocotal.

The main contaminant sources are supposed to be the sewer from San Miguel City and the erosion in the upper basin. The sewer affects BOD of the river water because the value increases in down stream from San Miguel City.
To improve urban environment in San Miguel, a Master Plan including sewage treatment is under study. It is recommended that the results should be well considered for urban planning to improve the river water quality.

5.2 Acceleration of the Watershed Management

Erosion is one of the biggest environmental problems in the study area. It affects not only land fertility loss but also lake and marine ecosystem through the deterioration of the river water quality by inflow of sediment. The following are main impacts of erosion in the area.

- Damage to aquatic life and breeding due to turbidity by floodwater.

In the study area, there are two lakes, Olomega and Jocotal, which are very important for fishery and birds inhabiting. The water quality deterioration of these lakes highly affects them. It was observed that many fishes of the lake died of suffocation by turbidity during flood season.

Many valuable species of local and migrant birds inhabit these lake, however, most of them are in danger. The main causes are excess development around the lake and the deterioration of water quality due to erosion.

- Decrease in land productivity due to the decline of soil fertility.

Fertile soil is an important resource of the area because the main economic sector is agriculture. Erosion will lower the land fertility and finally the area would become a barren land.

- Increase in turbidity in the marine zone

It is well known that the turbid water affect marine aquatic life, of which coral is seriously affected. Fortunately, there is not such habitat in the downstream of the San Miguel River. However, the marine zone is famous for the breeding sites of the aquatic life.

As aforementioned, erosion induces serious impacts on the natural resources and economy. Therefore, reduction of erosion is urgent for the sustainable development of the basin.

The recommended land use, based on land potential and its appropriate use, is proposed in the Mater Plan. The plan considers a sustainable use of land, in other words, it considers preventing soil erosion. It is recommend that the plan should be accelerated to achieve a sustainable development.

5.3 Establishment of fry fish center in Lake Olomega and Jocotal

In the past there has been many conflicts between farmer and fisherman on the lake water level, and the problem is very sensitive.

It is clear that the agricultural sector benefits from the project by reducing flood damage to crops and expanding the arable area. However, the impact on fishery of the lakes is not clear. Therefore consideration should be mode for countermeasures for fishery, which expects clear benefits for them. In this context a fry fish center is recommended.

TABLE F.3.1 SCREENING FOR IEE (I)

No	Environmental Item	Discretion	1	2	3	4	Remarks
Social Environment							
a	Resettlement	Resettlement by land occupation (Transfer of rights of residence, land ownership)	D	B	D	A	(2) Land acquisition for the water way (4) Resettlement of about 7,000 person in the area
b	Economic Activities	Loss of production base (land , etc) and change of economic structure.	D	D	D	B	(4) Loss of farmland
c	Traffic and Public Facilities	Impacts on existing traffic, schools, hospitals, etc. (e g , traffic jam, accidents)	D	D	D	B	(4) School, road in the submerged area
d	Split of Communities	Separation of regional communities by hindrance of regional traffic	D	D	D	B	
e	Cultural Property	Loss or deterioration of cultural properties, such as temples, shrines, archaeological assets, etc.	D	D	D	D	
f	Water Rights and Right of Common	Obstruction of fishing rights, irrigation and water rights	D	B	D	D	(2) Fishing rights of about 2,000 fishermen
g	Public Health Condition	Worsening of health and sanitary condition due to generation of garbage and appearance of harmful insects, increasing of agricultural chemicals	D	D	D	D	
h	Waste	Generation of construction waste, surplus soil, sludge, domestic waste, etc.	A	B	D	A	Generation of debris and soil
i	Hazards(Risk)	Increase in risk of cave-ins, ground failure and accident	D	D	D	D	
Natural Environment							
a	Topography and Geology	Change of valuable topography and geology due to excavation and earthfill	D	D	D	D	
b	Soil and land	Topsoil erosion by rainfall after land reclamation or deforestation, salt accumulation by irrigation, degradation of soil fertility	D	D	D	D	
c	Groundwater	Lowering of groundwater table due to overdraft and turbid water caused by construction work	B	D	D	B	(1) Lowering of groundwater table
d	Hydrological Situation	Change of discharge and water quality due to reclamation and drainage	A	A	D	A	(1),(2) Impact on fishery and change of channel form
e	Fauna and Flora	Interruption of reproduction or extinction of species due to change of habitat condition	D	B	D	D	(2) Affect of water level
f	Meteorology	Change of micro-climate, such as temperature, wind, etc., due to large scale reclamation, and construction	D	D	D	D	
g	Landscape	Deterioration of aesthetic harmony by structures and topographic change by reclamation	B	B	D	A	Damage to landscape due to the construction of dike, waterway and dam
Pollution							
a	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	D	D	D	D	
b	Water Pollution	Water pollution of river and groundwater caused by drilling mud and oil	D	B	D	D	(2) Inflow of sediment into the lake
c	Soil Contamination	Contamination caused by discharge or diffusion of sewage or toxic substances	D	D	D	D	
d	Noise and Vibration	Generation of noise and vibration due to drilling and operation of pumping machines	D	D	D	B	(4) Noise by operation of construction equipment
e	Land Subsidence	Deformation of the land and land subsidence due to lowering of groundwater table	D	D	D	D	
f	Offensive Odor	Generation of offensive odor and exhaust gases	D	D	D	D	
Overall Evaluation :		EIA is necessary for the project implementation					

Activities :
(1) Improvement of river channel
(2) Flood water storage in Lake Olomega
(3) Watershed management
(4) San Esteban Dam

Mark classification : A: Important Impact, B: Some impact, C: Unknown , D: No Impact

Table F.4.1 GENERAL DESCRIPTION OF THE PROJECT

Name of the project	:	Comprehensive Flood Control for the Rio Grande de San Miguel
Background	:	Agricultural area with fertile soil in the middle and lower basin of the San Miguel River Basin has been flooded frequently and it has damaged the agricultural products and residents' properties.
Objectives	:	To alleviate flood damage.
Executive Agency	:	Ministry of Agriculture and Livestock
Beneficiaries	:	Approximately a population of 32,700 inhabitants (7,600 households) in 1992.
Project component	:	1) River improvement of the middle reach of the San Miguel River. 2) River improvement of the lower reach of the San Miguel River. 3) Floodwater storage in Lake Olomega
Project description	:	1) River improvement : Dike 29.7 km, Channel excavation 21.9 km, Excavation 2.6 M m3 Olomega diversion and retarding : Storage volume 29 M m3, Weir 65 m, Control gate 20 m 2) River improvement : Dike 31.7 km, Channel excavation 47.9 km, Excavation 4.3 M m3
Location	:	1) Dike : Pelota R. - Aramuaca, Channel excavation : El Delirio - Aramuaca, Lake Olomega 2) Dike : Santa Rita R. - Vado Marine, Channel excavation : Santa Rita R. - La Canoa
Project cost	:	1) 376 Million Colon 2) 314 Million Colon

TABLE F.4.2 SCREENING FOR EIA

No.	Environmental Item	Discretion	Evaluation 1	Evaluation 2	Remarks
Social Environment					
a	Resettlement	Resettlement by land occupation (Transfer of rights of residence, land ownership)	B	B	1), 2) Land acquisition area for the river improvement is 450 ha 2) Resettlement of 20 houses.
b	Economic Activities	Loss of production base (land , etc) and change of economic structure.	D	D	Most of land aquisition area is severe flood area and idle land.
c	Traffic and Public Facilities	Impacts on existing traffic, schools, hospitals, etc (e g , traffic jam, accidents)	D	D	
d	Split of Communities	Separation of regional communities by hindrance of regional traffic	D	D	
e	Cultural Property	Loss or deterioration of cultural properties, such as temples, shrines, archaeological assets, etc.	D	D	
f	Water Rights and Right of Common	Obstruction of fishing rights, irrigation and water rights	B	D	1) Fishing rights of about 2,000 fishermen
g	Public Health Condition	Worsening of health and sanitary condition due to generation of garbage and appearance of harmful insects, increasing of agricultural chemicals	D	D	
h	Waste	Generation of construction waste, surplus soil, sludge, domestic waste, etc.	B	B	1), 2) Generation of debris and soil
i	Hazards(Risk)	Increase in risk of cave-ins, ground failure and accident	D	D	
Natural Environment					
a	Topography and Geology	Change of valuable topography and geology due to excavation and earthfill	D	D	
b	Soil and land	Topsoil erosion by rainfall after land reclamation or deforestation, salt accumulation by irrigation, degradation of soil fertility	C	C	1), 2) Soil erosion be dike construction.
c	Groundwater	Lowering of groundwater table due to overdraft and turbid water caused by construction work	D	D	
d	Hydrological Situation	Change of discharge and water quality due to reclamation and drainage	B	B	1), 2) Impact on fishery and change of channel form.
e	Coastal Zone	Coastal erosion and change of vegetation due to coastal reclamation and coastal changes	B	B	1), 2) Increase of turbidity in the marine zone.
f	Fauna and Flora	Interruption of reproduction or extinction of species due to change of habitat condition	B	C	1), 2) Impact of the water level and the water quality.
g	Meteorology	Change of micro-climate, such as temperature, wind, etc., due to large scale reclamation, and construction	D	D	
h	Landscape	Deterioration of aesthetic harmony by structures and topographic change by reclamation	B	B	1), 2) Impact on landscape due to the construction of dike.
Pollution					
a	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	D	D	
b	Water Pollution	Water pollution of river and groundwater caused by drilling mud and oil	D	D	
c	Soil Contamination	Contamination caused by discharge or diffusion of sewage or toxic substances	D	D	
d	Noise and Vibration	Generation of noise and vibration due to drilling and operation of pumping machines	D	D	
e	Land Subsidence	Deformation of the land and land subsidence due to lowering of groundwater table	D	D	
f	Offensive Odor	Generation of offensive odor and exhaust gases	D	D	

Mark classification : A: Important Impact, B: Some impact, C: Unknown , D: No Impact

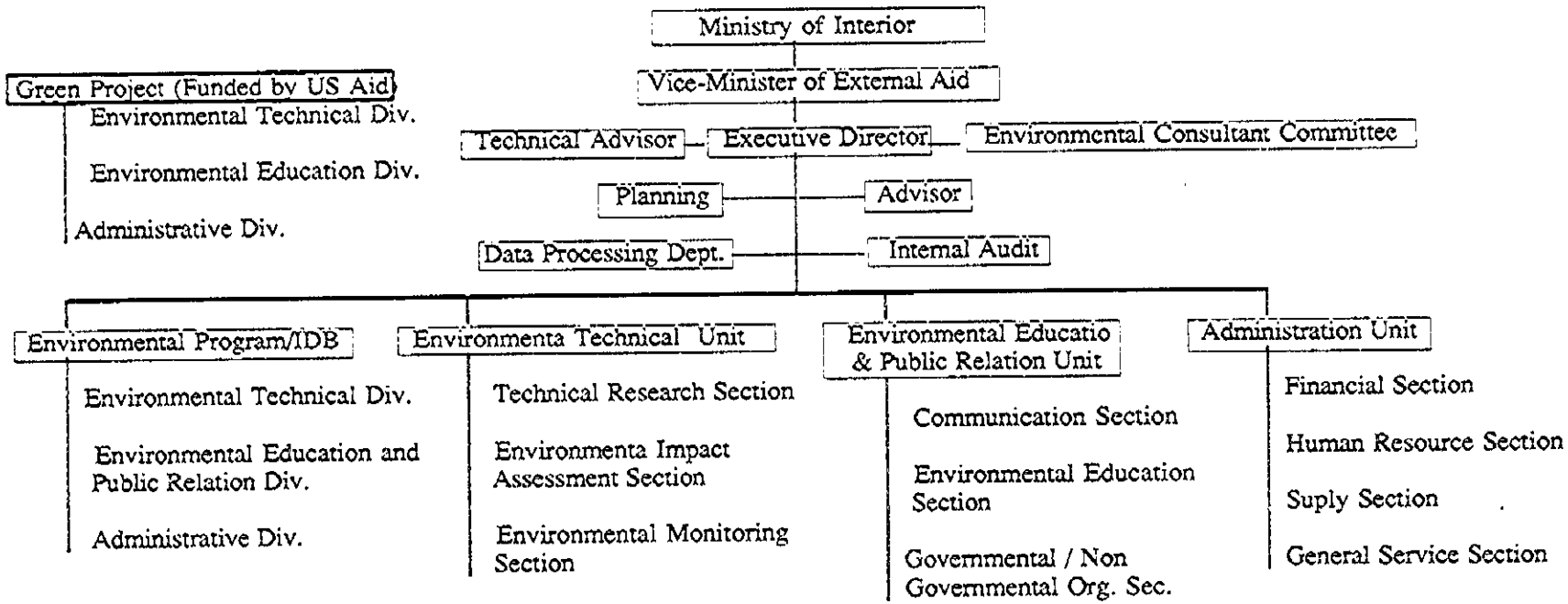

Figure F.2.1 ORGANIZATION CHART OF SEMA

SUPPORTING REPORT

G : ORGANIZATION AND INSTITUTION

Supporting Report G: Organization and Institution

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List of Tables and Figures in Supporting Report G

G ORGANIZATION AND INSTITUTION

1. GENERAL

In this report the related organizations and their general functions have been studied, and required organizations and functions for implementation of the Master Plan and the Priority Projects have been studied. The proposed flood mitigation measures in the master plan are summarized as follows:

(Structural measures)

- River improvement works for the middle and lower reaches of the Rio Grande de San Miguel.
- Flood storage works for the Lake Olomega.

(Non-structural measures)

- Flood plain management for Olomega, Jocotal and San Miguel city areas.
- Watershed management for the river basin.

2. RELATED ORGANIZATION

2.1 General

The organizations related to flood control or watershed management activities are as follows:

1) Ministry of Agriculture and Livestock (Ministerio de Agricultura y Ganaderia: MAG)

2) Ministry of Public Works (Ministerio de Obras Publicas: MOP)

3) Ministry of Internal Affairs (Ministerio de Interior: MOI)

4) National Administration of Water Supply and Sewerage (Administracion Nacional de Acuaductos y alcantarillado: ANDA)

5) Executive Secretariat of Environment (Secretaria Ejectiva del Medio Ambiente: SEMA).

Their functions and jurisdictions are mainly based on the Forest Law, the Water Law, the Irrigation and Drainage Law. As for national emergency activities against natural disasters,

including inundation and tornado, the Government has established a national committee "Comite de Emergencia Nacional (COEN)" based on the National Emergency System (Sistema Nacional de Emergencia: SISNAE).

According to the Water Legislation (Decree No. 886 of the Junta Revolucionaria de Gobierno, Dec. 2, 1981), the Ministry of Planning, Coordination of Economic and Social Development (MIPLAN) had been the responsible entity for the comprehensive water resource management, cooperating with the related ministries, but MIPLAN ceased to exist in 1996.

Now there is neither comprehensive water resources control and management law nor responsible organization, but there are efforts toward such ends. In order to improve the situation a draft of the General Law of Water (Anteproyecto de la Ley General de Agua) has been prepared and under discussion.

MAG is in charge of watershed management in the country and has been assigned to the leading implementation organization for this Study.

2.2 RELATED ORGANIZATION

2.2.1 MAG

(1) Institutional Structure

The responsibilities for all the activities related to the field of forest under the Legislative Decree No. 268 of February 8, 1973. Also under the Irrigation and Drainage Law, it is granted the primary responsibility for the country's irrigation and drainage related issues. Also MAG's function extends over other environmental sectors, such as soil, vegetation, wild life, and environmental contamination.

The institutional structure of MAG consists of five levels as shown in Fig. 6.1.

They are listed as follows:

1) Policy decision level:

- Minister and Vice-minister,
- National Council of Environment (Consejo Nacional del Medio Ambiente: CONAMA),

- Consultative Council of Agricultural Sector (Consejo Consultivo Agrario Sectoral: COAS), and
- Council of Technical Advice (Consejo Tecnico Asesor: CTA),

2) Policy advisory level:

- Sector Office of Agricultural Planning (Oficina Sectorial de Planificacion Agraria: OSPA),
- Agricultural Policy Analysis Unit (Unidad de Analisis de Politicas Agrarias: OAPA),
- Officer of Legal Advice (Oficina de Asesoria Juridica: OAJ) and
- Office of Internal Audit (Oficina de Auditoria Interna: OAI),

3) Support level:

- General Office of Administration (Oficina de General de Administracion: OGA),
- Office of Project Coordination (Oficina Coordinadora de Proyectos: OCP) and
- General Office of Communications (Oficina General de Comunicaciones: OGDC),

4) Centralized service level:

- General Direction of Agricultural Economy (Direccion General de Economia Agraria: DGEA),
- General Direction of Vegetal and Animal Health (Direccion General de Sanidad Vegetal y Animal: DGSVA),
- General Direction of Fishery Development (Direccion General de Desarrollo Pesquero: DIGEPESCA) and
- General Direction of Renewable Natural Resources (Direccion General de Recursos Naturales Renovables: DGRNR),

5) Decentralized service level:

- National Agricultural School (Escuela Nacional de Agricultura: ENA),
- National Center of Agriculture, Stock breeding and Forestry Technology (Centro Nacional de Tecnologia Forestal:CENTA),
- Institute of Agricultural Transformation in El Salvador (Instituto Salvadoreno de Transformacion Agraria: ISTA),
- Bank of Agricultural Lands (Banco de Tierras: BDT) and
- Bank of Promotion of Agriculture and Stock breeding (Banco de Fomento Agropecuario: BFA).

For this Study, MAG has assigned OSPA from the policy advisory level and DGRNR from the centralized service level respectively.

(2) Sector Office of Agricultural Planning (Oficina Sectorial de Planificacion Agraria: OSPA),

OSPA was created in 1973. Its main purpose is to make the planning process more efficient for the agricultural sector in order to standardize and guide the comprehensive development of the agricultural and livestock sector.

The general functions are summarized as follows:

- To carry out advisory and coordination activities for the elaboration of the institutional plans, budget programs and investment projects for technical cooperation.
- To manage, coordinate and canalize the international technical cooperation to support the investment of the Agricultural and Livestock public sector.
- To advise and coordinate to conduct studies for the administrative and institutional modernization of the Ministry, as well as the development and evaluation of them.
- To plan, direct and control the actions of follow up and evaluation on the execution of programs and projects for investment and technical cooperation.

- To manage all the data base in the Ministry and provide technical assistance on this regard to all its branches.

(3) Recursos Naturales Renovables: DGRNR)

(a) General function

DGRNR is to regulate, control and focus the conservation, restoration and development of the natural renewable resources in the country. The general functions are summarized as follows:

- To carry out actions focused in the management of the natural renewable resources,
- To carry out the study on the atmospheric and weather conditions in order to provide the country with timely advises to the people about the benefits or dangers of the natural phenomena,
- To formulate the integrated renewable natural resources policy and to collaborate with the proposals of alternatives for the solution of the problems,
- To participate in execution and control of the national policies, environmental strategies, laws, guidelines, plans and projects related to the natural renewable resources,
- To generate and transfer the irrigation and drainage technology for the purposes of sustainable use of soil and water resources,
- To plan strategically the safeguard and conservation of the nature protection area.

DGRNR consists of the five levels i.e., directive, advisory, support operative and decentralization levels, as shown in Figure. G.2.

The support operative level is divided into three divisions. The general functions of each division are stated as follows:

1) Natural Resources Division:

- Watershed management and soil conservation fields,
- All functions and activities of the Forest field,

- National park and fauna / wild life.

2) Meteorology and Hydrology Division:

- Meteorology field,
- Hydrology field,
- Laboratory services of environmental field,
- Facilities maintenance.

3) Irrigation and Drainage Division:

- Water management field,
- Projects,
- Technology transfer field.

(b) Human resources

The DGRNR personnel in operation were planned for 1997 (1996) as follows:

DGRNR Personnel

	By law	By Contract	By daily Base	Total
Executive	0(0)	5(3)	0(0)	5(3)
Technical	70(70)	79(57)	67(0)	216(127)
Administrative	43(43)	24(21)	54(0)	121(64)
Service	2(2)	2(2)	25(0)	29(4)
Labor	0(0)	0(0)	95(234)	95(234)
Total	115(115)	110(82)	241(234)	466(432)

Note: Data from 'Diario Oficial 22 Diciembre de 1995

1) Natural Resources Division

Section	Number of Personnel	
- National park:	145	(university graduate level: 7, technical level: ?)
- Forest:	160	(university graduate level: 8, technical level: ?)
- Basin:	14	(university graduate level: 5, technical level: ?)
Total	319	

2) Hydrology Division

Section	Number of Personnel			
- Hydrology:	(university graduate level:	6, technical level:	35)
- Meteorology:	(university graduate level:	4, technical level:	5)
- Laboratory:	(university graduate level:	3, advanced level:	0)
- maintenance:	(university graduate level:	0, technical level:	3)

3) Irrigation and Drainage Division

Section	Number of Personnel	
- Water management:	(university graduate level:	4, technical level: 4)
- Project:	(university graduate level:	5, technical level: 1)
- Technology transfer:	(university graduate level:	3, technical level: 2)

Note: no structure engineer

(c) Budget

The annual budget of MAG and DGRNR for 1995-1997 are as follows:

Annual Budget of MAG and DGRNR for 1995-1997(unit: Colon)

	1995	1996	1997
MAG	218,593,260	352,766,070	314,397,010
DGRNR	22,567,930	17,090,625	19,370,845

(d) Major activities for 1966

According to the annual operation plan for 1996, the major activities consist of institutional activities, projects and supporting activities. The major projects are listed as follows:

(Projects related to watershed)

-1 Protection and restoration of natural resources renewable in priority areas (Lago Coatepeque),

-2 Environmental program of the Salvador, PAES,

-3 Protection of environment : PROMESA,

-4 Agricultural development of the Rio Jiboa Basin (JICA),

-5 Study on Integrated Flood Control in the Rio Grande de San Miguel (JICA),

(Projects related to Irrigation water)

-1 National program of irrigation and drainage,
-2 Development of irrigation and drainage No. 3 area, Lempa-Acahuapa (BID 802/SF-ES),
-3 Zapotitan No. 1 (JICA)

2.2.2 Others

(1) MOP

The entity controls design, construction, and supervision of streets, roads, bridges etc.. The ministry is composed of three viceministries:

1) Viceministry of Human and Urban Development (Viceministerio de Vivienda y desarrollo Urbano)

- Financial Administrative Directorate
- Urban and Regional Development Directorate
- Inhabitation-Promotion Directorate

2) Vice ministry of Public Works (Viceministerio de Obras Publicas)

- General Directorate of Road
- Directorate Urbanism and architecture
- Administration of Machinery and Equipment
- Center of Geotechnic Investigation

The National Geographic Institute was currently moved under the Ministry of Justice.

3) Viceministery of Transportation (Viceministerio de Transporte)

- General Directorate of Land Transportation,

- General Directorate of Aviation
- General Directorate of Navigation
- General Directorate of Transit

(2) MOI

It assumes a responsibility in such activities as resettlement of the displaced population. MOI is expected to share the responsibilities with COEN in the case of national emergency resulting from natural disaster.

(3) ANDA

Under the Water Legislation, ANDA is assume an authority to plan, finance, execute, operate, maintain, manage and exploit any works required to provide the services of drinking water and sewer system to citizens.

(4) Executive Commission for the Lempa River Commission (Hydroelectric del Rio Lempa: CEL)

It has the function to develop, conserve, manage and utilize the energy resources of the country, including flood preventive activities for the Rio Lempa basin under COEN.

(5) SEMA

SEMA was appointed by the Ministry of Foreign Affairs and the Ministry of Justice, and established in July 1991. SEMA is in charge of coordinating and administering the compliance of environment and natural resources protection policies: also the entity was responsible for preparation of Environmental Impact Assessment Law (EIA).

2.3 National Emergency System (Sistema Nacional de Emergencia: SISNAE)

The general policy of SISNAE is summarized as follows:

1) To conduct a permanent activity in order to prevent and mitigate the effects of disaster situations.

2) To develop continuous and sustainable actions in order to monitor the threats and reduce the vulnerability.

3) The main organization in charge of all the implemented actions in the disaster cycle is the Emergency National Committee (CONAE now COEN).

4) To promote the effective development of the Departmental, Municipal and local committees.

5) To promote training on disasters on all the Educational levels.

6) To promote institutional participation on the execution of the Sector Plans

The organization is as follows:

1)	National level:	COEN consists of Executive Secretary (SECRETARIA EJECTIVA) and the ministries of MOI, MAG, MOD, MOPH, MOP
2)	Departmental level:	COED :Comites de Emergencia Departamentales,
3)	Municipal level:	COEM: Comites de Emergencia Municipales,
4)	Local level:	COEL: Comites de Emergencia Barrios, Colonias, Escuelas, Comunidades, Caserios,

(1) National Emergency Committee (Comite de Emergencia Nacional: COEN)

In 1994, COEN was founded as the entity managing all the disaster-related activities to be implemented. It is an independent entity which assumes a leading role in the case of national emergency and coordinate the actions taken by various organizations. COEN's activities by means of SISNAE are based on the committees of national, regional, departmental, municipal and local levels as shown in Figure. G.3.

As for emergency activities against flood disasters, COEN is to issue flood forecasts, warnings for the endangered population and take actions for evacuation of the endangered population.

COEN is to develop preventive activities to cope with the periodical natural disasters, but preventive activities against flood disasters are still in an initial stage and require supporting measures such as technical cooperation.

(2) MAG's role in the preventive activities

Among the COEN's preventive activities against natural disasters such as floods, tropical storms and forest fires, MAG is expected to take a role partly or solely to conduct the followings:

(Against floods)

- Permanent preventive measures,
- Watershed management,
- Risk area assessment,
- Prohibition of human settlements in risk areas,
- Risk map preparation,
- Conservation programs,
- Flood dike construction,
- Check canals.

(Against tropical storms)

- Preventive measures
- Identification of safe places for evacuation,
- live barrier to prevent landslides,
- Reforestation of mangrove and reforestation on river bank
- Establishment of on time warning system,
- Rainfall measurement,
- Monitoring of strong rainfall, strong wind, high tide
- Protective measures for the harvest of crops,
- Urgent recovery of damage areas

(Against volcanic eruption)

- Reforestation of damaged areas,

(Against forest fires)

- Fireproof belt

(For Water Resources)

- Watershed management
- Reforestation

MAG is in charge of providing to COEN with flood risk maps and adequate meteorological flood forecast systems for the flood endangered river basins except the Rio Lempa which is covered by CEL. MAG has assigned eight staff of DGRNR to conduct the tasks. Now they are preparing flood risk maps.

As for the Lempa River, currently DGRNR, CEL and UCA University have conducted the project " Mathematical Modeling for the Forecast and Control of Flooding on Real Time at the Basin of the Lempa River" managed by CEPREDANAC (National Disasters Prevention Center on Central America Area) financed by the Danish Agency for International Development (DANIDA).

According to the important role of MAG in the natural disaster preventive activities, it is suggested that MAG should reinforce DGRNR to meet with the role for preventive activities against natural disasters.

3. REQUIRED ORGANIZATION AND INSTITUTION

3.1 Basic Concept

The Watershed Management activities in the Rio Grande de San Miguel consist of the followings:

- Disaster preventive measures to stabilize the watersheds by flood mitigation measures such as river improvement works and dikes, renovation of natural conditions such as reforestation, erosion control and land use regulation.
- Environmental improvement measures such as treatment of urban wastes, control of industrial wastes.
- Promotion of sustainable development measures for the watershed, including water resources development.

Their implementation stages are considered as follows:

(Short term)

- Flood mitigation measures,
- Treatment of urban wastes.

(Long term)

- Erosion control,
- Reforestation
- Water resources development

This project would be a pilot for watershed management in the country. It is expected that through implementation of the project, a lot of staff who are experienced to apply the basic technologies for watershed management, will be provided to the country. They might be assigned for conducting watershed management works of the other basins such as Rio Paz, Rio Jiboa, Rio Lempa and Rio Goascoran.

In order to carry out the proposed structural and non-structural flood mitigation measures effectively, MAG should take the leading role and establish an optimum implementation organization for execution of the proposed measures. It is suggested that an implementation organization shall be established based on the following ideas:

1) To strengthen DGRNR from watershed management aspects to enable to carry out the measures proposed in the Study.

2) To procure international consultants through an international tender to assist DGRNR for implementation of the project.

3) To prepare detailed designs and the tender documents for execution of major structural measures proposed in the Study by assistance of international consultants.

4) To carry out major construction works by general contractors selected through international tenders under the supervision of DGRNR assisted by international consultants.

5) To carry out the flood plain management by local governments under guidance of DGRNR.

6) To prepare a flood forecast and flood warning system by assistance of consultants and to issue warnings to the endangered people through COEN. Also evacuation of the people in the endangered places shall be conducted by COEN.

7) To activate the existing forest protection (or nursery) systems such as Salvador Protected Areas System, State Nursery System / Community Nursery System and Agroforestry System, for supporting watershed management activities.

There are fourteen state nurseries under the management of DGRNR in the whole country and lots of nurseries established according to the community Nursery System guided by the government forest policy, where rural people produce seedlings by themselves.

8) To apply the result of research of CENTA , due to the forest policy, water management for irrigation and soil. It has established seed research in order to guarantee the genetic material of forest species.

9) To enhance local people in participation both in recovering the deforested area and in routine O&M activities of the project.

3.2 Implementation Organization and Functions

The implementation organization shall be developed due to the following three stages:

(1) Preparation stage (From 1997 through 1998)

In order to execute the project smoothly, MAG should assign a group of staff and start the activities immediately after the JICA Study in order to realize the results of the Study.

The staff shall be selected from OSPA and DGRNR. Some of the counterpart personnel shall be involved in the group. OSPA shall take the initiative in implementing the project together with DGRNR. The major tasks shall be conducted as follows:

	OSPA	DGRNR
- Implementationprogram for priority measures	+	+
- Budget arrangement, including loan	+	
- Implementation organization	+	+

Also during this period the following tasks are recommended to be started:

- Improvement of hydrological observation systems
- Agricultural (or regional) development plan

(2) Implementation stage (From 1999)

The implementation organization shall be established due to the implementation program prepared in the preparation stage. The implementation organization, consisting of one central office in San Salvador and one site office in San Miguel. The central office shall have coordinating and management functions, and the site office shall have executing functions such as project management and supervision of construction works.

Key staff shall be selected from MAG or some other ministries, if necessary. The other staff might be employed on temporary bases. The central office shall have functions to carry out planning and designing of facilities related the watershed management. The site office shall have functions to conduct project management and supervising of civil works.

Functions & Activities	Central Office	Site Office
- Employment of consultants	+	
- Detailed designs and tender documents	+	
- Land acquisition & compensation	+	
- Tender procedures for construction works	+	
- Supervision of the construction works		+
- Detailed design of remedial works		+
- O&M program.	+	+
- Guidance for flood plain management	+	
- Guidance for watershed management,	+	

The site office consist of the following staff:

Project Manager
Administrative Officer
River Engineer
Design Engineer
Hydrologist
Quality Control Personnel

(3) O&M stage

Operation and maintenance of the flood control facilities, after construction, will be conducted by MAG as described below:

- Operation and maintenance of the facilities, such as river banks, dikes, revetments, diversion structures, gauging stations, will be carried out by MAG.
- The Project Office in San Miguel will carry out the management of the facilities.
- For maintenance and management of facilities, ten personnel will be required in the Project Office.
- For maintenance and operation of facilities at Lake Olomega, five personnel will be required in the Olomega Site Office.

Management of the non-structural measures will be conducted by MAG and COEN as follows;

- Emergency activities during the flood will be made by COEN.
- Watershed management including reforestation and erosion control will be carried out by MAG. SENTA in Morazan will be involved in execution of the field work of the project. Five more personnel would be required for the activities such as research, education, nursery, etc.
- For watershed management, five personnel will be required in the Project Office in San Miguel. Close contact with SENTA in Morazan will be required.
- For Floodplain Management, the same personnel for Structural Measures will also hold the post of Floodplain Management in the Project Office in San Miguel and in the Olomega Site Office.

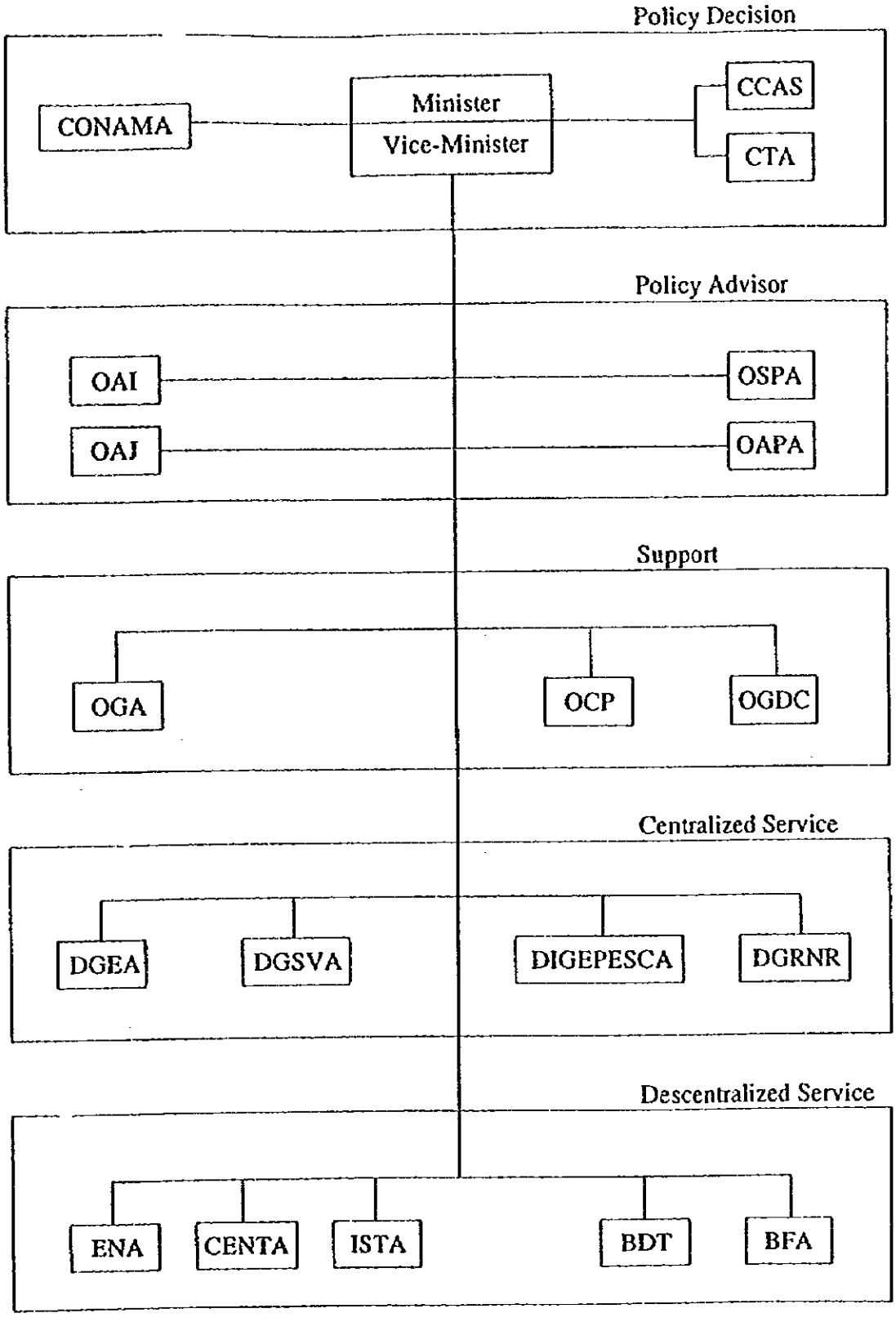

Figure G.1 ORGANIZATION CHART OF MAG

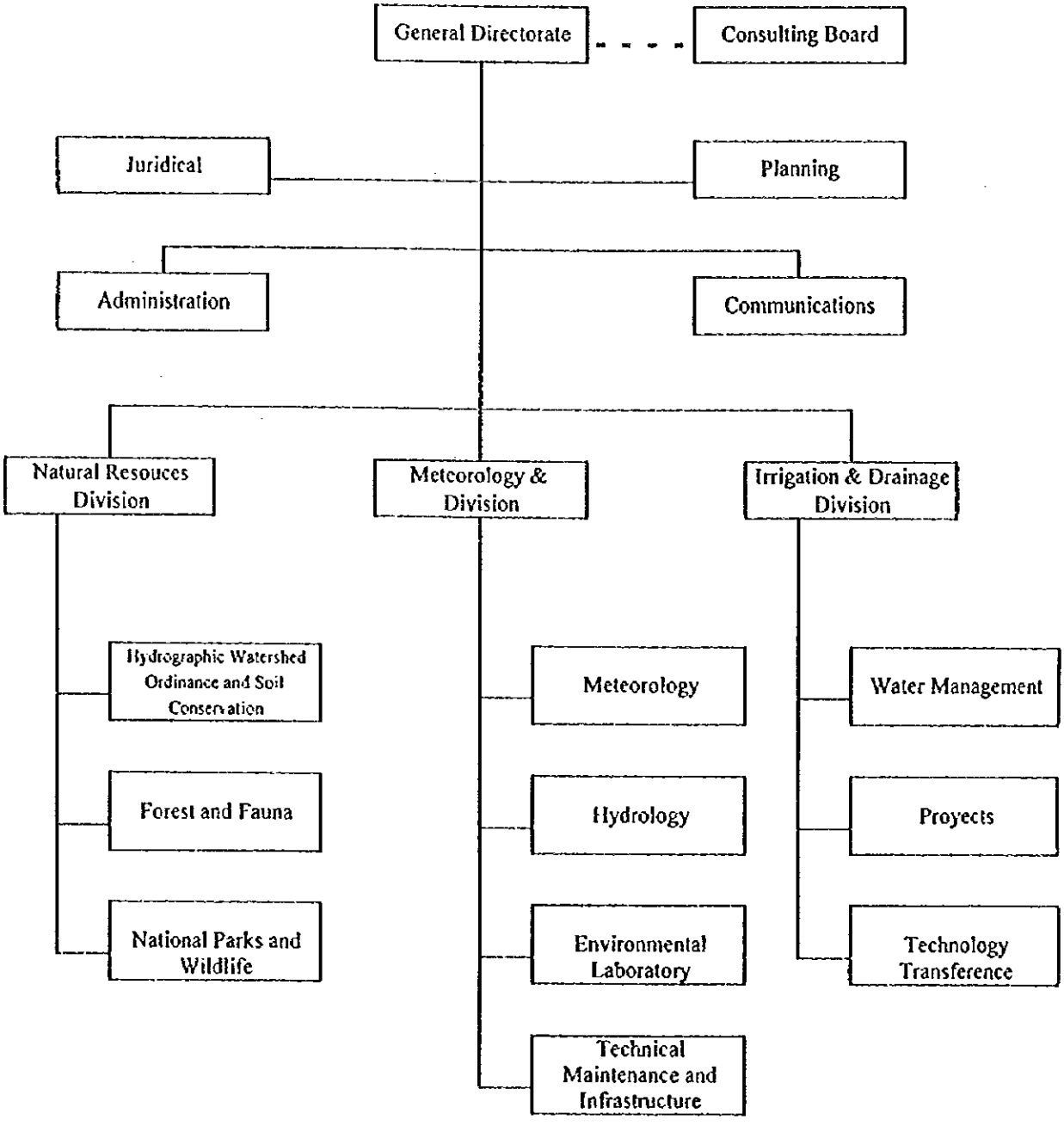

Figure G.2 ORGANIZATION CHART OF DGRNR

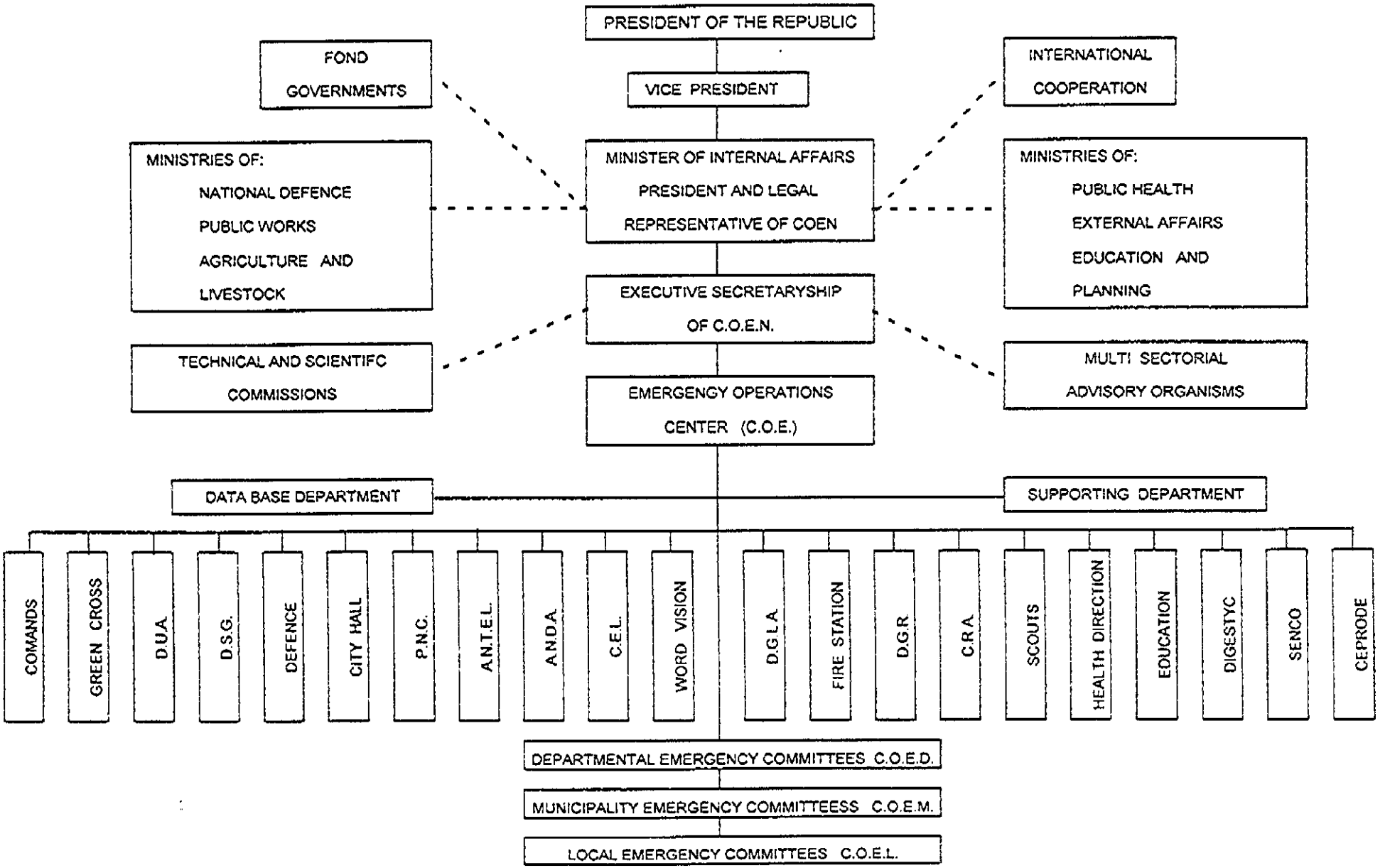

Figure G.3 **ORGANIZATION CHART OF COEN**

SUPPORTING REPORT

H: WATER RESOURCES DEVELOPMENT

Supporting Report H: Water Resources Development

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List of Tables and Figures in Supporting Report H

H. WATER RESOURCES DEVELOPMENT

1. STREAMFLOW DISCHARGE

1.1 Stream Flow Record at Villerias and Moscoso

Villerias and Moscoso are the only places where a long term stream flow records are available in the upper and middle basin of San Miguel River. For these two stations, comparatively complete data is available between 1971 and 1980 and were used for water resources development study.

The daily stream flow records at Villerias (1970-1978) and Moscoso (1979 and 1980) are shown in DATA BOOK: 10.

The tables show that the minimum monthly discharges of the year at Villerias generally occur in March and the average value varies between 1 m^3/s and $3m^3/s$. The maximum monthly discharge of the year occur in September or October but the average value varies greatly ranging from 13 m^3/s to 66 m^3/s.

1.2 Estimated Stream Flow Discharge at San Esteban Dam Site

As there is no stream flow data available at the dam site of San Esteban (C.A.=825km^2), it was estimated by using specific discharge at Villerias (C.A.=910km^2) or Moscoso (C.A=1,074km^2). The ratio of catchment area of San Esteban Dam site to those of Villerias and Moscoso are 0.907 and 0.768 respectively.

The estimated daily discharges at the San Esteban Dam site are shown in DATA BOOK: 10.

2. PRESENT WATER DEMAND

2.1 Domestic Use

Water use for domestic purpose in the Study Area mainly depend upon groundwater. The present domestic water demand and supply in the Department of San Miguel and the Department of Usulutan in March 1996, are shown in Table H.2.1.

The table shows that the total demand in the two departments is 29,000 m³/day, while the total supply is 24,000 m³/day, making the ratio of supply to demand 85%. Among the municipalities, San Miguel City is making a big deficit , while Usulutan has surplus of water supply.

Another related water problem of San Miguel City is continuous lowering of groundwater surface as shown in Table H.2.2. The rate of lowering is 0.05 m/year to 1 m/year depending upon the location. Observing the arrangement of wells and Table H.2.2, main cause of the problem might be the concentration of wells in small area.

2.2 Agricultural Use

Presently, agricultural water use of San Miguel River is scarce. Only one pumping station is located on the main river and the total intake of water is less than 0.2 m³/s estimated from the diameter of the pump installed.

In the upper basin of the river, many small scaled irrigation systems are taking water from small streams. Table H.2.3 shows all registered water rights presently. The total amount of registered water rights is 1m³/s, and used mainly for grazing.

2.3 Hydropower Generation

There used to be the San Esteban Hydropower Station but it was abandoned in 1991. There is no hydropower station in the Study Area at present.

3. FUTURE WATER DEMAND

3.1 Domestic Use

According to the population projection of the Study Area, it will increase by 92 % from 1992 to 2010. By extrapolating this trend, the population in the study area in 2020 was estimated. If the specific water consumption remains as estimated at present, the total water demand for domestic use will increase to 46,000 m³/day in 2020. Thus, the increment of demand is 17,000m³/day (0.2m³/s), which should be supplied by new water source. (Table H.2.1)

3.2 Agricultural Use

There are various irrigation projects in the area and the most ambitious one is " Usulutan-San Miguel Irrigation Project" prepared in 1977. The study covers the middle and the lower basin and the total target irrigation area is 28,900ha. Table H.3.1 and Table H.3.2 show the overall irrigation water demand in the area calculated in the Usulutan San Miguel Irrigation Project. The total demand is 376 million cubic meters annually, among which 126 million cubic meter is from groundwater.

Other small irrigation projects prepared by MAG are listed in Table H.3.3. The total demand of all the projects is 2 m³/s.

Both the large and the small scale projects were taken into account in water resources development study here.

3.3 Hydropower Generation

CEL has a long term projection of electricity demand in the country. Table H.3.4 shows the demand projection and hydropower plan by CEL. Between the year 1995 and 2010, the total amount of electricity demand will increase by 600 MW, requiring new power plants or import from other countries.

If the present share of hydropower continues, which is half of the total power supply, 300MW of electricity should be generated by hydropower plants in these 15 years.

4. BASIC CONCEPT OF WATER RESOURCES DEVELOPMENT

4.1 Water Supply for Domestic Use

ANDA East Region Office is studying water supply scheme to meet the present deficit and future demand increase in the area. According to their plan, groundwater is more preferable than surface water, considering the water quality and the available amount of water.

The problem of groundwater lowering will be solved by diversifying the well locations toward south where a large groundwater potential is expected. However, in order to make a quantitative study of the plan, it is necessary to acquire data by test borings and pumping tests.

In this study, water intake from the San Miguel River for domestic use was not counted.

4.2 Irrigation

As the water quality requirement is low and required quantity is huge in irrigation, a large scale surface water development is necessary to meet the total demand of irrigation schemes by MAG. In Usulutan and San Miguel Irrigation Project, the San Esteban Dam is an essential water source.

In this study also, San Esteban project was reviewed and considered as an alternative measure.

For the purpose of irrigation water supply, an idea of a group of small dams is also studied roughly in Chapter 7.

4.3 Hydro-power

As CEL made a study of San Esteban Dam in 1995, the concept was applied in this study.

5. WATER RESOURCES DEVELOPMENT BY SAN ESTEBAN DAM

5.1 General

San Esteban Dam site was selected by both the irrigation sector and the power sector. Considering the large catchment area (825 km^2), the site is also appropriate for flood control purpose.

Therefore, San Esteban Dam was studied as a multi-purpose project including flood control, irrigation and hydropower generation. As it is necessary to determine the cost allocation policy among multiple users, all dams with each single purpose were also planned independently.

5.2 Existing Studies

Study by MAG.

In 1977, MAG made a feasibility study of Usulutan-San Miguel Irrigation Project, in which San Esteban Dam was selected as an important water source. The total amount of water

supplied by the reservoir is 172 million cubic meters annually. The features of the MAG plan are shown in Table H.5.1.

Study of CEL

In 1995, CEL made a preliminary study of San Esteban Hydropower plant. The maximum electricity generated by the scheme is 8.5MW and the average annual output is 30GWH. The feature of the CEL scheme are shown in Table H.5.2.

5.3 Selection of Dam Site

By using topographic maps of scale 1/50,000 the whole basin was studied to locate appropriate dam sites. Thus listed are the dam sites shown in Table H.5.3.

The upper basin of the San Mguel River is classified into two areas; one part is steep mountain area and the other is comparatively flat valley. Therefore, a group of dams situated in the steep mountain area have small reservoirs. Those small dams have only limited catchement area and they have nil effect on flood control downstream and excluded in selection of multi-purpose dam site.

On the other hand, the ones in the flat valley area are large in their reservoir volumes.
San Esteban Dam Site is a representative of the latter case and it is unique in a sense that both the catchment and the lake area are very large. Other dam sites in the flat valley were not selected because they are less effective than San Esteban Dam and still generate a large number of resettlement population. Therefore, if the flood control purpose is included, San Esteban Dam is the most appropriate selection of dam site.

5.4 Topography/Geology

In the study by MAG in 1977, geological investigation including borings was carried out and a geological section of the site was estimated. In this Study, review of previous studies and surface investigation were combined to make geotechnical survey of the dam site.

The results are shown in Fig. H.5.1 and Fig. H.5.2 as Schematic Geological Map and Geological Profile respectively.

Foundation rock is composed of various volcanic rocks such as vitric tuff, tuff(fine to sandy),

basaltic lava, and volcanic breccia that are covered by unconsolidated talus deposit, river deposit and terrace deposit.

Hard and fine lava is fit for dam foundation and construction materials, however, polus rock and/or aglomelatic rock are troublesome for dam foundation due to its heterogeneous soundness and high permeability.

Recommendable maximum dam height is estimated about 155 meters above mean sea level from the topographical point of view. The width of right ridge is not so big and leakage shall checked in terms of distribution of permeable lava.

Groundwater table in the left bank is low. Judging from this hydrogeological condition, permeability of foundation rock may be high in general. Consequently, length of curtain grouting line and depth of grouting may be large.

Core and filter materials may be obtained near the dam site in the reservoir. But, rock materials especially rip-rap material shall be from the far site besides the Pan Ameriacan Highway.

5.5 Sedimentation

Sedimentation is one of the critical factors to govern the reservoir allocation planning. Most practical way to estimate the sediment yield rate is to apply the reservoir resurvey data of existing reservoirs in the vicinityof the dam site.

As there is no existing reservoirs in the same catchment, resurvey data from those artificial reservoirs on Lempa River were referred. This method is justified as the land use map of the whole country shows similarity between Lempa River Basin and San Miguel River Basin.

Table H.5.4 shows the resurvey data of four reservoirs on Lempa River. The calculated average sediment yield rate is 948 m^3/year/km^2.

On the other hand, the whole basin was studied from the viewpoint of erosion estimation. Areal photograph analysis and field investigation revealed no serious erosion except the mud flow deposit area surrounding Usulutan Volcano, which is different from the catchments of those dams studied here.

Sediment discharge surveys were conducted in this study, in forms of water quality survey and sedimentation survey. As all specimen taken in this study are at small discharge, it tends to underestimate the total annual sediment discharge.

Finally, taking into account the above mentioned points, the planned sediment yield rate is 1,000 m^3/km^2/year. In 100 years, the total sediment yield is calculated as 85 million cubic meters. The corresponding reservoir water elevation is 115 m.

5.6 Water Supply Scheme for Irrigation

Water supply scheme for irrigation is planned based on the following basis.

-Streamflow Discharge:	Monthly Discharge in 1971-1980
-Water Demand:	Water Demand in Usulutan-San Miguel Irrigation Project (San Miguel Sector) including monthly pattern

Fig. H.5.3 shows the series of mass curve between the year 1971 and 1980. It shows that in 1978, the required reservoir volume is the largest. The reservoir volume is 124 million cubic meters as calculated in Table H.5.5. Considering the sedimentation volume underneath, corresponding reservoir water level is EL 122.5m.

5.7 Hydro-power Generation Scheme

The facilities planned in CEL study were utilized and the operation rule of irrigation water supply was assumed to be adopted for power generation plan, too. It means that the power generation sector shall depend upon the operation rule of irrigation during the irrigation season. This is an arbitrary assumption for the study and the real operation rule of the reservoir should be discussed among the parties concerned in feasibility stage of the project.

The stream flow data used in this analysis are average monthly discharge between 1963 and 1992 which were prepared by CEL. The maximum generating capacity is 4.8MW and the annual output is 30GWH. Table H.5.6 shows the power generation scheme in this study.

The reservoir volume for hydropower generation is 228 MCM and the corresponding water level is EL 127m.

5.8 Flood Control Scheme

For flood control scheme, following procedure was applied.

(1) plan of design flood for dam safety
(2) plan of spillway structure to cope with the dam design flood
(3) plan of flood control by utilizing the above spillway

It is a Japanese practice in decision of dam design flood, to take the largest of the following three values.

a. maximum possible flood considering meteorological and topographical features of the basin (not available in this study)
b. recorded maximum flood (978m³/s , 1975: converted from Villerias record)
c. flood with a return period of 200 years (1,703m³/s: simulated)

Thus the dam design flood was determined as 1,703 m³/s .

The plan of spillway was made as follows;

(1) The spillway width was determined as 50 meters so that become similar size as the downstream channel
(2) The normal water level during flood season was determined for each purpose of the dam.
(3) The design flood level was determined by calculating dam design flood inflow and outflow of the reservoir.
(4) Design outflow discharge from the dam of 250 m³/s was determined, considering the capacity of downstream river channel.
(5) For flood control dam, crest gates were planned to attain the design outflow discharge, while for multi-purpose dam no gates were needed because of the large retention surface and volume.

Thus, reservoir allocation for each purpose of the dam was made and for flood control was determined.

5.9 Reservoir Allocation

As determined above, the reservoir allocation becomes as follows;

(1) Single Purpose Dam for Flood Control

Storage Volume for Sedimentation	: 85MCM, EL115m
Storage Volume for Flood Control/Dam Safety	: 57MCM, EL119m
Total Storage Volume	:142MCM, EL119m

(2) Single Purpose Dam for Irrigation

Storage Volume for Sedimentation	: 85MCM, EL115m
Storage Volume for Irrigation Water Supply	:123MCM, EL122.5m
Storage Volume for Dam Safety	: 69MCM, EL125.9m
Total Storage Volume	:277MCM, EL125.9m

(3) Single Purpose Dam for Power Generation

Storage Volume for Sedimentation	: 85MCM, EL115m
Storage Volume for Hydropower Generation	:228MCM, EL127m
Storage Volume for Dam Safety	: 81MCM, EL129.9m
Total Storage Volume	:394MCM, EL129.9m

(4) Multi-purpose Dam for Flood Control, Irrigation and Power Generation

Storage Volume for Sedimentation	: 85MCM, EL115m
Storage Volume for Irrigation/Hydropower Generation	:228MCM, EL127m
Storage Volume for Dam Safety	: 81MCM, EL129.9m
Total Storage Volume	:394MCM, EL129.9m

Fig.H.5.4 and Fig.H.5.5 show inflow and outflow hydrograph of dam design flood (return period is 200 years) and 10 year flood respectively, in the case of multi-purpose dam. The peak outflow discharge during 10 year flood is 250 m³/s and the value was applied for river improvement plan downstream.

Fig. H.5.6 shows the reservoir allocation curve in the case of multi-purpose dam.

5.10 Preliminary Plan of Dam

(1) Type of Dam

Considering the geology and the height of the dam, a zoned rock-fill type is appropriate.

(2) Height of Dam

The height of the dam was determined from the dam design flood level, wind wave height, seismic wave height and free board. Thus the heights of dams were determined as shown Table H.5.7.

(3) Configuration of Spillway

There are two alternatives, one is a separate spillway type and another is a combined spillway type. The two alternative were studied as shown in Fig.H.5.7 and Fig.H.5.8. The costs of two types were compared and result showed advantage in the combined type. The cost of separate type attributes to large diversion tunnels to divert large floods.

In combined type, the temporary diversion tunnel with a small capacity shall be installed inside the spillway concrete and larger floods would overflow the concrete under construction.

5.11 Seismic Consideration

Seismic consideration is one of the key factors in dam design because frequent earthquake are recorded all around the country.

They have a good record of earthquake in Geotechnical Research Center, where they provide a complete list of historical seismic activities. For seismic study, all earthquake records which recorded since 1783 within 50 km from the San Esteban Dam site were collected and analyzed. Table H.5.8 shows the seismic data and their analysis on acceleration expectation at the dam site. Fig. H.5.9 shows the probability study of all the large earthquakes data arranged in descending order of the calculated acceleration at the dam site.

The equation used here is Okamoto's Formula commonly used in Japan.

$$k = 0.6 \times a$$

$$\log_{10}(a/640) = (x+40)/100 \times (-7.640+1.7244M-0.1036M^2)$$

Here, k= maximum acceleration acting on the dam body(gal)
a= maximum acceleration of the ground (gal)
M= magnitude at epicenter
x= distance from the epicenter to the dam site (km)

In seismic consideration of dam planning, a horizontal acceleration with the magnitude of 0.12G and 0.15G were applied to rockfill part and concrete part(spillway section) respectively. These values are common in Japanese Standard of seismic deign. Judging from Fig 5.9, corresponding return period is over 300.

5.12 Resettlement and Relocation of Public Facilities

Dam crest elevation, lake area and resettlement/relocation for each purpose are shown in Table H.5.9.

In counting the number of households affected, community maps prepared by municipal social workers were used and checked by MAG engineers at the site so that the number can be counted according to the elevation.

The length of road relocation was calculated from topographical maps with scale of 1/25,000. The land acquisition and compensation cost for each height of dam are also summarized in Table H.5.9.

In case of September 15 Dam, several newly created communities were constructed by CEL to resettle the people, where all public facilities including water supply and electricity were provided by CEL. Here in this study such kind of community creation was not included in the cost. The cost of resettlement was counted as money value for each house compensation, which was taken from a reference of CEL.

5.13 Construction Plan and Cost Estimate

5.13.1 Construction Plan

Basic idea of construction plan can be summarized as follows

(1) Diversion of stream flow is made over spillway taking the design discharge of 1,000m³/s (return period is 20 years)
(2) Core material is taken from upstream of the site
(3) Filter material will be blend of river bed sand and weathered rock
(4) Rock materials and concrete aggregate will be taken from the quarry near the High Way No.1

5.13.2 Cost Estimate

Cost estimate of the dam was based on the actual construction cost of September 15 Dam , which has a similar structural features as San Esteban Dam. CEL revised the cost of September 15 Dam in 1996 and updated the price according to the price escalation.

For unit cost analysis of the dam, the total cost was divided into the following components

----- embankment (including excavation and foundation treatment)
----- spillway and power house concrete
----- power plant(turbine, motors, generators etc.)
----- land acquisition

Table H.5.10 shows the total cost, amount of work and unit cost of above components of September 15 dam.

All these costs were applied to the cost estimate of San Esteban Dam. Table H.5.11 shows the cost of each purpose dam and the cost allocation of the multi-purpose dam.

5.14 Environment

There is no report on historical remains or precious species in the reservoir area. The most serious problem is a large scale resettlement.

5.15 Economic Evaluation

5.15.1 General

In this study, multi-purpose San Esteban Dam was evaluated from two different points of views;

(1) One alternative in flood control master plan

In this case, the dam is evaluated in comparison with other flood control measures, that is river improvement. The cost borne by flood control sector was calculated by a cost allocation concept. The benefit is the flood damage reduction by the project.

(2) A multi-purpose dam project itself

In this case, the dam is not evaluated alone but together with the all related structures to fulfill all the purposes. Benefit of the whole project, which include flood control, irrigation and power generation were all counted.

5.15.2 Benefit of Multi-purpose San Esteban Dam Project

(1) Benefit of Flood Control

The benefit is calculated by counting the flood damage reduction by implementing the project.

(2) Benefit of Irrigation

The benefit of the project is expressed by increase in income minus increase in cost, which was estimated based on the study by MAG in 1977.

(3) Benefit in Power Generation

The benefit of the project is estimated by the cost of an alternative thermal power plant including both investment cost and running cost.

5.15.3 Cost of Multi-purpose San Esteban Dam Project

(1) Cost of Flood Control Project

The cost for exclusive facilities for flood control is river improvement cost to cope with 10-year flood together with the dam.

(2) Cost of Irriation Project

The cost of intake facility and irrigation channel for distribution was estimated based upon the cost estimate by MAG in 1991.

(3) Cost of Power Generation

The cost for exclusive facilities for power include power generation unit and sub-station, which was estimated by a sample of September 15 Dam.

5.15.4 Economic Evaluation

(1) Evaluation in Flood Contorl Master Plan

It is already stated in the flood control master plan. Alternatives including San Esteban Dam are case-3 and case-4, both of which were not selected as the final master plan as the project cost is large to give the same benefit.

(2) Evaluation as a Multi-purpose Dam

The EIRR of the multi-purpose dam is 10.3 % as stated in Supporting Report O.12. The value shows that the project is not feasible. However, it is necessary to study further on this project from the view point of water resources development.

6. WATER RESOURCES DEVELOPMENT BY A GROUP OF SMALL DAMS

6.1 Existing Studies

MAG already studied several small irrigation projects in the Study Area. Those are shown in Table H.3.3. These projects were included in selection of dam site in the following section.

6.2 Selection of Dam Sites

By using topographical maps of 1/50,000, all possible sites for small dams were studied.
The relationships between dam height and reservoir volume were obtained by using a map of 1/50,000 in scale. Fig. H.6.1 shows the location of dam sites studied.

6.3 Sedimentation

Sediment volume in 100 years was calculated by using sediment yield rate, 1,000 $m^3/km^2/year$.

6.4 Water Supply Scheme

By using specific discharge, the stream flow record at the site was generated. Through mass curve analysis, maximum required reservoir volume and water developed at the site was obtained.

6.5 Reservoir Allocation

By using data of sedimentation and water supply, reservoir allocation was planned.

6.6 Preliminary Plan of Dams

After examining the reservoir allocation and the topographical feature of the site, the height of the dam was determined. The rough height and the crest length of the dam was determined.

6.7 Resettlement and Relocation of Public Facilities

As there is no data other than the topographic map of 1/50,000, the number of houses were counted and multiplied by specific number of the people per house which was verified in counting the number of resettlement in San Esteban.

6.8 Estimate of Dam Volume

Assuming that the crest length and the dam height, the volume of each dam was estimated.

6.9 Evaluation

As is shown in Table H.6.1, the group of dams combined can not replace the functions of San Esteban Dam as the reservoir volume is small and the corresponding catchment is also small. Therefore, it is difficult to replace San Esteban Dam by a group of small dams while maintaining the ambitious Usulutan-San Miguel Irrigation Project.

In other words, a group of small dams are appropriate only for small scale irrigation. It is one option to revise all the irrigation scheme studied in Usulutan-San Miguel Irrigation Project and reduce the irrigation target area or target water supply to meet the total capacity of the small reservoirs.

Among the small dams studied, Taisihuat Dam is the most effective in a sense that it has a considerable catchment area (80km^2) and the topography at the site is preferable. It is recommended to study Taisihuat Dam further, seeking the most appropriate height of the dam taking into account the number of resettlement and the irrigation target area.

Table H.2.1 WATER DEMAND AND SUPPLY FOR DOMESTIC USE (MARCH 1996)

Department	Municipality	System	Population	Demand (l/p/d)	Demand (m3/d)	Supply (m3/d)	S/D (%)	Population Projection 2020	Demand Projection 2020 (m^3/d)
San Miguel	San Miguel	El Sitio	186,267	250	46,567	32,225	69	298,027	74,507
	Chinameca	El Liano	15,000	150	2,250	376	17	24,000	3,600
	Moncagua	Los Nacimientos	4,100	125	513	433	84	6,560	820
	Quelepa	Los Nacimien	3,900	125	488	279	57	6,240	780
	Lototique	La Piscina	4,000	125	500	482	96	6,400	800
	San Rafael Ote	El Almendro	7,000	150	1,050	505	48	11,200	1,680
	San Jorge	El Almendro	4,500	125	563	86	15	7,200	900
	El Transito	El Maranon	10,441	175	1,827	1,626	89	16,706	2,923
	San Gerardo	Antigua-Tacot	3,133	125	392	89	23	5,013	627
	Chirilagua	Zapatagua	6,000	150	900	576	64	9,600	1,440
	Guasori	Guanaste	3,765	125	471	103	22	6,024	753
	C/El Liano El A.	San Matias	2,887	125	361	432	120	4,619	577
	Carolina	Miracapa	4,610	125	576	612	106	7,376	922
	Uluazapa	La Palma	4,000	125	500	230	46	6,400	800
	Sub-total		259,603		56,956	38,054	67	415,365	91,129
Usultan	Usultan	El Molino	35,000	200	7,000	8,245	118	56,000	11,200
	Jucuapa	La Cruz	16,000	150	2,400	2,016	84	25,600	3,840
	San Buenaventura	Pila del Cura	3,000	125	375	289	77	4,800	600
	Nusva Grumada	Rio Umana	4,000	125	500	99	20	6,400	800
	C/Jocotillo	Rio Umana	1,900	100	190	95	50	3,040	304
	Mercedes Umare	Sante Anita II	4,000	125	500	860	172	6,400	800
	Villa El Tfo.	Baltazar Orell	6,200	150	930	2,160	232	9,920	1,488
	Estanuelas	El Aceituno	7,150	150	1,073	504	47	11,440	1,716
	Jiquilisco	Los Cactus	12,564	175	2,199	817	37	20,102	3,518
	Santa Elana	Los Mangos	8,814	150	1,322	828	63	14,102	2,115
	Sgo de Maria	El Milagso	20,000	250	5,000	2,930	59	32,000	8,000
	Berlin	Pierdona	7,878	150	1,182	1,224	104	12,605	1,891
	California	Tetraloffa	3,000	125	375	10	3	4,800	600
	alegffa	Palmara	3,500	125	438	1,260	288	5,600	700
	Santa Marfa	El Pozo	7,362	125	920	172	19	11,779	1,472
	Concep. Batres	El Tempisque	2,000	125	250	33	13	3,200	400
	Ozatlan	La Poza	6,500	150	975	145	15	10,400	1,560
	Oucuaran	El Since	3,500	125	438	44	10	5,600	700
	Puerto El Triun	El Tercio	12,481	175	2,184	2,432	111	19,970	3,495
	C/El Pozon	Tetzalogia	1,000	100	100	58	58	1,600	160
	C/El Jicaro	Tetralogia	1,000	100	100	58	58	1,600	160
	Tecapan	Terralogia	2,500	125	313	58	19	4,000	500
	Sub-total		169,349		28,762	24,337	85	270,958	46,019

Table H.2.2 WELLS IN SAN MIGUEL CITY

Location Name	WELL NO.	Dia	Production in 1996	WATER TABLE lOWERING		GROUNDWATER DEPTH(m)											
						1958	1966	1970	1972	1973	1982	1985	1989	1992	1994	1995	1996
		(inchi)	(m3/d)	(m)	(m/year)												
La Paz	1	12	1,003	8.30	0.38					10.92						19.22	
	2	16		0.91	0.04			15.25								16.17	
	3	12	1,144	15.71	0.79				13.73					29.43			
	4	10	1,458	1.53	0.51									11.29		12.81	
Hillerman	1	16	4,320	8.08	0.38					13.27		13.27			21.35		
	2	14		6.10	0.29					13.73		13.54			19.83		
	3	16	4,320	0.00	0.00					20.44					20.44		
Belen	1	16	1,116	1.53	0.05		9.76					9.75					11.29
	2	16	725	2.75	0.11			13.73				26.80					16.47
	3	16		2.14	0.10					9.76		10.58				11.90	
El Molino	1	10	1,496	11.47	0.88						2.26					13.73	
El Sitio	1	12	6,034	0.61	0.15									23.79			24.40
	2																
Jalacatal	1	16/18	3,456	1.53	0.04	30.50											32.03
	2																
Brigada	1	8		3.05	0.44								11.44				14.49
Moncagua	1		379														
Tlaloc	1																
San Carlos	1		774														

Table H.2.3 WATER RIGHT REGISTERED IN THE STUDY AREA

NO.	NO.	WATER SOURCE	CANTON	IR. AREA (MZ)	CROP	AMOUNT (L/SEC)	HOUR	DAY	MUNICIPIO
583	1	CHAPELTIQUE RIVER	SAN PEDRO	5	GRASS	40	12	8	SAN MIGUEL
578	2	CHAPELTIQUE RIVER	HUALAMD	3	GRASS	30.3	24	10	SAN MIGUEL
752	3	CHAPELTIQUE RIVER	HUALAMD	3.5	GRASS	35.35	24	10	SAN MIGUEL
819	4	CHAPELTIQUE RIVER	LA TRINIDAD	4	GRASS	40.4	24	10	SAN MIGUEL
821	5	CHAPELTIQUE RIVER	SAN PEDRO	5	GRASS	50.5	24	10	SAN MIGUEL
825	6	CHAPELTIQUE RIVER	HUALAMA	1	GRASS	16.16	12	8	SAN MIGUEL
845	7	CHAPELTIQUE RIVER	LA TRINIDAD	3	GRASS	30.3	24	10	SAN MIGUEL
820	8	CHAPELTIQUE RIVER	SUBURBIOL	1	GRASS	20.2	12	10	SAN MIGUEL
815	9	CHAPELTIQUE RIVER	SAN PEDRO	2	GRASS	16.2	12	8	SAN MIGUEL
816	10	CHAPELTIQUE RIVER	SAN PEDRO	1	GRASS	16.2	12	8	SAN MIGUEL
1019	11	CHAPELTIQUE RIVER	SANTO TOMAS	3	GRASS	24.3	24	8	SAN MIGUEL
1021	12	CHAPELTIQUE RIVER	SAN PEDRO	5	GRASS	24.3	24	8	SAN MIGUEL
1022	13	CHAPELTIQUE RIVER	HUALAMA	5	GRASS	31.59	24	8	SAN MIGUEL
1027	14	CHAPELTIQUE RIVER	SAN PEDOR	2	GRASS	24.3	24	8	SAN MIGUEL
1026	15	SANTO TOMAS	SAN GERONIMO	6	MAIZ AND RICE	20.17	12	8	CHAPELTIQUE
822	1	CHAPELTIQUE RIVER	SAN PEDRO	2	GRASS	40.4	12	10	CHAPELTIQUE
823	2	CHAPELTIQUE RIVER	SAN PEDRO	2	GRASS	40.4	12	10	CHAPELTIQUE
824	3	CHAPELTIQUE RIVER	SAN PEDRO	3	GRASS	60.6	12	10	CHAPELTIQUE
821	4	CHAPELTIQUE RIVER	SAN PEDRO	5	GRASS	50.5	24	10	CHAPELTIQUE
578	5	CHAPELTIQUE RIVER	HUALAMA	3	GRASS	30.3	24	10	CHAPELTIQUE
752	6	CHAPELTIQUE RIVER	HUALAMA	3.5	GRASS	35.35	24	10	CHAPELTIQUE
919	7	CHAPELTIQUE RIVER	LA TRINIDAD	4	GRASS	40.4	24	10	CHAPELTIQUE
	1	SANTO TOMAS	SAN GERONIMO	4	GRASS	40.4	24	10	CHAPELTIQUE
953	1	GUAYABAL RIVER	LAUO GRANDE	3	MAIZ	30.61	24	8	YAMNABAL
954	2	GUAYABAL RIVER	SAN BARTALON	3	GRASS	24.44	24	8	GUATJIAGUA
955	3	GUAYABAL RIVER	EL JACARAL	10	GRASS	81	14	8	GUATJIAGUA
982	4	LOS AMATES	PAJIAGUA	10	RICE	16	24	8	GUATJIAGUA
983	5	LOS AMATES	GOYADE	3.5	RICE	47	24	8	GUATJIAGUA
1018	6	GUAYABAL	GUAYAABAL	2	GRASS	32	12	8	GUATJIAGUA
1028	7	RAS CANAS	SAN BARTALO	6	GRASS/MAIZ	61.23	24	8	GUATJIAGUA
TOTAL				113.5	(79.5ha)	1,051 .05m³/s)			

Table H.3.1 OUTLINE OF USULUTAN-SAN MIGUEL IRRIGATION PROJECT

Sector	Irrigation Area	Required Water	Intake Site	Available Water	Cost(million US$), Price in 1990				
					Dam	Canal	Irrigation	Other	Total
	(ha)	(million m3)							
San Dioniso	2,261	29.2	San Dionisio	San Miguel River(7-14.5 m3/s), Lake Olomega(65MCM/year)	0.20	2.56	0.34	1.12	4.22
Jocotal	3,954	49.5	El Delirio, Jocotal pump	San Miguel River(2.5-9.1 m3/s), Lake Jocotal(1.2m3/s),Lake Olomega(65MCM/year)	0.55	6.59	0.94	2.09	10.17
San Miguel	10,749	171.7	San Esteban	San Esteban Reservior(Reservoir Voluem 105 MCM)	15.27	16.86	5.60	6.49	44.22
Aguas Subterraneas	11,952	125.6	(wells)	Groundwater(240MCM/year)	0.00	3.98	2.09	17.99	24.06
Total	28,916			376.0					82.67

H.T.4

Table H.3.2 IRRIGATION REQUIREMENT(U/S IRRIGATION PROJECT)

	Irrigation Requirement														
Sector	San Dinonisio			Jocotal			Jocotal(pumped water)			San Miguel			Aguas Subterraneas		
	(m3/s)	(m3/day)	(m3/month)	(m3/s)	(m3/day)	(m3/month)	(m3/s)	(m3/day)	(m3/month)	(m3/s)	(m3/day)	(m3/month)	(m3/s)	(m3/day)	(m3/month)
Jan	1.69	146,016	4,526,496	2.46	212,544	6,588,864	0.84	72,576	2,249,856	10.32	891,648	27,641,088	7.46	644,544	19,980,864
Feb	2.02	174,528	4,886,784	2.87	247,968	6,943,104	0.98	84,672	2,370,816	11.56	998,784	27,965,952	8.72	753,408	21,095,424
Mar	1.89	163,296	5,062,176	2.87	247,968	7,687,008	0.98	84,672	2,624,832	11.35	980,640	30,399,840	10.67	921,888	28,578,528
Apr	1.00	86,400	2,592,000	1.58	136,512	4,095,360	0.54	46,656	1,399,680	7.64	660,096	19,802,880	5.85	505,440	15,163,200
May	0.41	35,424	1,098,144	0.35	30,240	937,440	0.12	10,368	321,408	2.79	241,056	7,472,736	0.11	9,504	294,624
Jun	0.02	1,728	51,840	0.00	0	0	0.00	0	0	0.1	8,640	259,200	0.11	9,504	285,120
Jul	1.17	101,088	3,133,728	0.79	68,256	2,115,936	0.27	23,328	723,168	3.51	303,264	9,401,184	1.15	99,360	3,080,160
Aug	0.28	24,192	749,952	0.18	15,552	482,112	0.06	5,184	160,704	1.03	88,992	2,758,752	0.11	9,504	294,624
Sep	0.00	0	0	0.00	0	0	0.00	0	0	0	0	0	0	0	0
Oct	0.00	0	0	0.00	0	0	0.00	0	0	0	0	0	0	0	0
Nov	1.41	121,824	3,654,720	1.41	121,824	3,654,720	0.78	67,392	2,021,760	8.67	749,088	22,472,640	7.23	624,672	18,740,160
Dec	1.28	110,592	3,428,352	1.28	110,592	3,428,352	0.66	57,024	1,767,744	8.77	757,728	23,489,568	6.77	584,928	18,132,768
Total			29,184,192			35,932,896			13,639,968			171,663,840			125,645,472

Table H.3.3 IRRIGATION PROJECTS BY MAG

Name of Project	Name of Sector	Name of Sub-sector	Irrigation Area (ha)	Max. Water (m3/s)	Source	CATCHMENT (km2)	Reservoir Structure Name	Reservoir Structure Volume (MCM)	Reservoir Structure Height (m)	Intake Structure Name	Intake Structure Height (m)	Intake Structure Crest El (EL m.)
San Fransisco Gotera	San Francisco-Gotera	(Presa Chilanga)	162	0.204(Feb)	Rio San Chilanga	30.5	Chilanga	3.0	23.0	Chilanga	23	323
		(Presa Chaguite)	138	0.168(Feb)	Rio San Chaguite	19.1	Chaguite	2.2	18.0	Chaguite	18	313
	Yamabal		400	0.744(Mar)	Rio Yamabal	32.8	Sensembra	2.3	23.0	Sensembra	23	283
	San Carlos-Rio Seco		150	0.174(Mar)	Rio Gotera		-	-	-	San Carlos		
Quelepa	Quelepa		1,780	0.693(Feb)	Rio San Esteban		-	-	7.3	El Obrajuelo	7.3	171.3
	(SUB TOTAL)				1,983							
Usultan-San Miguel	San Dionisio		2,261	2.02(Feb)	San Miguel, Olomega		Olomega	9.46+27.32	-	San Dionisio	3.5	65.3
	Jocotal		3,954	2.87(Feb)	San Miguel, Olomega, Jocotal		Olomega	9.46+27.32	-	El Delirio	7.2	36.2
	Aguas Subterraneas		11,952	10.67(Mar)	groundwater		-	-	-			
	San Miguel		10,749	12.41(Mar)	San Miguel	825	San Esteban	120.0	40.0	San Esteban	40	130

Table H.3.4 ELECTRICITY DEMAND AND SUPPLY PLAN BY CEL

WATER DEMAND PROJECTION

DEMAND IN 2010	1,277 MW
DEMAND IN 1995	676 MW
DEMAND INCREASE	601 MW

HYDRO POWER PLAN

	CAPACITY (MW)	COST/POWER (US$/KWH)	COST/POWER RATIO(%)	NOTE
EL TIGER	351	0.047	100%	
PASO DEL OSO ALTO	77	0.066	140%	DD STAGE
ZAPOLITLO C	104	0.07	149%	DD STAGE
SAN MARCOS	56	0.144	306%	
SAN ESTEBAN	8	0.284	604%	
TOTAL	596			

PRESENT SHARE OF SOURCE

	CAPACITY(MW)	RATIO
HYDROELECTRICITY	388	47%
GEOTHERMAL	105	13%
THERMAL	325	40%
TOTAL	818	100%

Table II.5.1 SAN ESTEBAN DAM PLAN BY MAG

		Unit	Value
DAM	Crest Elevation	EL m	130
	River Bed Elevation	EL m	87
	Dam Height	m	43
	Crest Length	m	1183
	Volume	MCM	2.77
RESERVOIR	High Water Level	EL m	127
	Normal Water Level	EL m	123.5
	Maximum Operating Lev	EL m	120
	Sediment Capacity	MCM	55
	Effective Capacity	MCM	105
	Normal Capacity	MCM	160
	Flood Retention Capacit	MCM	80
	Maximum Capacity	MCM	360

Table II.5.2 SAN ESTEBAN DAM PLAN BY CEL (1995)

		Unit	Value
DAM	Crest Elevation	EL m	132
	River Bed Elevation	EL m	87
	Dam Height	m	45
	Crest Length	m	1100
RESERVOIR	Maximum Operating Level	EL m	127
	Maximum Operating Level	EL m	120
	Maximum Storage Volume	MCM	314
	Minimum Storage Volume	MCM	157
	Active Storage volume	MCM	157
	Maximum Flood Water Level	EL m	128.7
	Flood Retention Capacity	MCM	56
	Maximum Capacity	MCM	360
Power Plant	Maximum Generating Capacity	MW	8.5
	Maximum Annual Energy Output	GWH	39.8
	Total Design Discharge	m^3/s	30

Table H.5.3 DAMS STUDIED

DAM NAME	BASIN AREA (km2)	IRRIGATION AREA (ha)	DAM HEIGHT (m)	CREST LENGTH (m)	DAM VOLUME (m.c.m.)	RESERVOIR AREA (km2)
SAN ESTEBAN	825.0	11,000	43	1,100	2.90	35.38
(UPSTREAM FROM SAN ESTEBAN)						
ARAUTE	12.5	227	34	400	0.84	0.40
YOLOAIQUIN	32.5	567	26	500	0.81	0.95
CHAGUITE	19.0	337	37	200	0.46	0.72
TORONIO	22.9	410	41	300	0.76	0.43
NAJADA	34.2	602	33	200	0.41	1.74
SAN SEBASTIAN	15.8	288	37	200	0.46	0.38
CHAPELTIQUE	28.1	498	60	600	2.23	0.4
LOS AMATES	11.6	210	44	300	0.82	0.21
PUEBLO	10.1	175	49	300	0.91	0.19
GUALAVO	18.4	323	46	700	2.00	0.35
YAMABAL	30.7	550	70	500	2.17	0.43
SAN DIEGO	26.1	462	29	400	0.72	0.91
TOTAL	261.9	4,649			12.59	7.11
(DOWNSTREAM FROM SAN ESTEBAN)						
TAISIHUAT	82.4	1,423	36	150	0.33	3.95
EL PASTOR	18.4	320	46	200	0.57	1.42
TOTAL	100.8	1,743			0.91	5.37

Table H.5.4 RESURVEY IN EXISTING RESEROVIRS ON LEMPA RIVER

RESERVOIR NAME	CATCHMENT AREA (km^2)	RESIDUAL CATCHMENT (km^2)	INITIAL YEAR	INITIAL VOLUME (M.C.M.)	VOLUME IN 1994 (M.C.M.)	ANNUAL SEDIMENT (M.C.M.)	SPECIFIC SEDIMENT (m^3/year/km^2)
GUIJA	2,768	2,768	1963	560	508.7	1.65	598
CERRON GRANDE	8,584	5,816	1976	2,180	2,026.2	8.54	1,469
5 DE NOVIEMBRE	9,863	1,279	1974	65	40.7	1.19	930
15 DE SEPTIEMBRE	17,524	7,661	1983	393	335.5	5.23	682
WEIGHTED AVERAGE							948

Source; CEL

Table H.5.5 MASS CURVE ANALYSIS (1977)

YEAR	MONTH	Qi (m^3/s)	Qi-Qm (m^3/s)	(Qi-Qm)*d (m^3/s*day	SUM(Q-Qm (m^3/s*day)	Qd (m^3/s)	Qd-Qm (m^3/s)	(Qd-Qm)* (m^3/s*day)	SUM(Qd-Qm (m^3/s*day)	Required V (MCM)
1976	OCT	17.55	3.02	93.72	0.00	0.00	-14.53	-450.33	0.00	0.00
1976	NOV	3.73	10.80	-323.90	-323.90	8.67	-5.86	-175.70	-175.70	12.80
1976	DEC	2.05	12.48	-386.78	-710.68	8.77	-5.76	-178.46	-354.16	30.80
1977	JAN	1.49	13.04	-365.03	-1075.71	10.32	-4.21	-117.79	-471.95	52.16
1977	FEB	1.33	13.20	-409.10	-1484.81	11.56	-2.97	-91.97	-563.92	79.56
1977	MAR	1.19	13.34	-413.44	-1898.25	11.35	-3.18	-98.48	-662.40	106.78
1977	APR	1.06	13.47	-404.00	-2302.25	7.64	-6.89	-206.60	-869.00	123.83
1977	MAY	5.35	-9.18	-284.48	-2586.73	2.79	-11.74	-363.84	-1232.84	116.98
1977	JUN	22.20	7.67	230.20	-2356.54	0.10	-14.43	-432.80	-1665.65	59.69
1977	JUL	2.49	12.04	-373.14	-2729.68	3.51	-11.02	-341.52	-2007.17	62.42
1977	AUG	9.36	-5.17	-160.17	-2889.84	1.03	-13.50	-418.40	-2425.56	40.11
1977	SEP	12.63	-1.90	-56.90	-2946.75	0.00	-14.53	-435.80	-2861.37	7.38

Qi= monthly inflow
Qm=(average inflow) 14.53 m^3/s
Qd= monthly irrigation demand
d= number of days of the month

Table H.5.6 SAN ESTEBAN DAM CPERATION SCHEME(IRRIGATION +POWER)

MONTH	INFLOW m3/s *	OUTFLOW m3/s	Res.V.Increase m.c.m.	Res. VOLUME m.c.m.	Res. EL m	POWER(MW)	POWER(GWH)
NOV	7.3	8.67	-3.55	313.36	127.00	2.3	1.6
DEC	2.4	8.77	-16.51	309.81	126.87	2.3	1.7
JAN	1.9	10.32	-21.82	293.30	126.27	2.7	1.9
FEB	1.8	11.56	-25.30	271.48	125.47	2.9	2.1
MAR	1.3	11.35	-26.05	246.18	124.39	2.8	2.0
APR	1.3	7.64	-16.43	220.13	123.12	1.8	1.3
MAY	5.5	21.29	-40.93	203.70	122.31	4.8	3.5
JUN	22.2	18.62	9.29	162.77	120.31	3.9	2.8
JUL	20.7	22.025	-3.43	172.06	120.76	4.7	3.4
AUG	29.3	19.555	25.26	168.63	120.59	4.2	3.0
SEP	50.6	18.525	83.14	193.89	121.83	4.1	3.0
OCT	35.0	18.525	42.70	277.02	125.67	4.7	3.4
NOV				319.73	127.23		
TOTAL	5471.5	5394.1	6.36				29.6
AVERAGE	14.99	14.78			MAX	4.8	

* average 30 years(1963-1992)

Table H.5.7 FEATURES OF SAN ESTEBAN DAM OF EACH PURPOSE

PURPOSE	DAM DESIGN FLOO ELEVATION (EL m)	WAVE HEIGHT (m)	FREE BOARD FOR FILL DAM (m)	TOTAL (El m)	CREST ELEVATION (EL m)
FLOOD	119	1.7	1	121.7	122
IRRIGATION	125.9	1.7	1	128.6	129
POWER	125.9	1.7	1	132.6	133
MULTI-PURPOS	129.9	1.7	1	132.6	133

wind velocity: 30m/s
reservoir length: 10km
U/S slope of fill: 1 to 3
surface condition: rough

Table II.5.8 SEISMIC ANALYSIS AT SAN ESTEBAN DAM SITE

DATA DURATION 279 YEARS
LATITUDE 13.5288 DEGREE N
LONGITUD 88.1837 DEGREE W

1/180*3.1415926535897= 0.017453

NO.	YEAR	MONTH	DAY	MAGNITUDE	LONGITUDE (DEGREE)	LATITUDE (DEGREE)	DISTANCE (KM)	ACC. MAX (GAL)	ACC. DAM (G)
1	1783	11	29	6.6	13.632	88.783	67.56	94.64	0.058
2	1859	8	25	7.1	12.850	88.000	76.26	121.97	0.075
3	1899			5.7	13.651	88.796	69.34	33.06	0.020
4	1934	3	7	6.25	13.250	87.750	56.87	84.19	0.052
5	1939	12	26	6	13.250	88.250	31.04	120.03	0.073
6	1940			5	13.300	88.800	72.85	9.81	0.006
7	1940			5	13.300	88.800	72.85	9.81	0.006
8	1941			5.7	13.250	88.500	46.32	61.70	0.038
9	1951	5	6	6.25	13.500	88.420	26.46	159.17	0.097
10	1951	5	6	6.2	13.517	88.400	24.08	162.00	0.099
11	1951	5	7	6	13.483	88.450	30.02	122.96	0.075
12	1951	8	2	6	13.000	87.500	95.14	26.51	0.016
13	1951			5.3	13.000	87.500	95.14	7.94	0.005
14	1951	8	3	6	13.000	87.500	95.14	26.51	0.016
15	1951			5.5	13.000	87.500	95.14	11.57	0.007
16	1951			5.5	13.000	8.750	8140.99	0.00	0.000
17	1958	6	27	6	13.000	88.500	67.16	51.25	0.031
18	1959			5.4	13.000	87.500	95.14	9.61	0.006
19	1961			5.88	13.330	88.800	71.81	39.44	0.024
20	1961			6.3	12.830	87.500	107.24	31.51	0.019
21	1961			5.6	13.000	87.500	95.14	13.83	0.008
22	1962	11	24	6.5	13.000	87.500	95.14	51.71	0.032
23	1964			5.6	13.000	87.500	95.14	13.83	0.008
24	1964			5.2	13.650	88.580	45.97	34.57	0.021
25	1966			5.4	13.300	88.800	72.85	19.21	0.012
26	1968			5.1	13.960	88.690	73.05	11.61	0.007
27	1970			5.1	13.160	87.790	59.22	18.96	0.012
28	1971			5.2	13.562	88.795	68.06	16.33	0.010
29	1971			5.3	13.271	88.506	45.40	39.93	0.024
30	1972			5.4	13.124	88.598	63.56	25.64	0.016
31	1972			5.6	13.004	88.572	71.33	27.18	0.017
32	1973			5	12.972	88.423	65.87	12.70	0.008
33	1974			5.3	13.194	88.472	48.36	36.27	0.022
34	1976			5.1	13.024	88.472	63.33	16.39	0.010
35	1976			5.3	12.990	87.742	76.23	14.67	0.009
36	1976			5.1	12.839	88.116	75.05	10.82	0.007
37	1977			5	12.972	88.536	71.87	10.17	0.006
38	1977			5	13.210	88.073	36.61	37.52	0.023
39	1978			5.1	12.919	88.345	68.39	13.70	0.008
40	1980			5.1	13.021	88.421	60.95	17.84	0.011
41	1980			5.2	13.005	88.725	82.67	9.94	0.006
42	1981			5.2	12.946	87.578	92.26	7.18	0.004
43	1982			5.5	12.920	88.780	93.47	12.16	0.007
44	1982	1	12	6.2	13.158	87.589	77.33	51.72	0.032
45	1982			5.4	13.470	88.480	33.55	65.14	0.040
46	1984			5	13.264	87.703	60.63	15.42	0.009
47	1985			5	12.956	88.685	83.36	6.65	0.004
48	1985			5	13.088	88.690	73.78	9.48	0.006
49	1986			5.4	13.073	88.806	84.96	13.19	0.008
50	1994			5.5	13.096	87.668	74.03	21.66	0.013
51	1995			5.4	13.037	87.995	57.20	31.24	0.019

Table H.5.9 LAND ACQUISITION AND COMPENSATION FOR SAN ESTEBAN DAM

	UNIT	FLOOD	IRRIGATION	POWER	MULTI PURPOSE
RESERVOIR VOLUME	MCM	142	277	394	394
DAM CREST ELEVATION	EL m	122	129	133	133
RESERVOIR AREA	km2	19.82	29.55	35.38	35.38
COMPENSATION ITEMS					
PEOPLE	person	3,859	5,445	7,303	7,303
POPULATION PER AREA	p/km2	195	184	206	206
HOUSE	house	905	1,233	1,647	1,647
CANTON	number	8	15	20	20
LAND(CULTIVATED)	km2	9.91	14.78	17.69	17.69
LAND(PASTURE)	km2	9.91	14.78	17.69	17.69
PUBLIC INSTITUTION	number	8	15	20	20
ROAD					
CA7	km	0.34	1.52	2.50	2.50
WITHOUT PAVEMENT	km	3.76	7.53	9.91	9.91
DRIVE ONLY DRY SEASON	km	26.63	34.81	41.19	41.19
HORSE PATH	km	40.46	62.55	79.74	79.74

Table H.5.10 UNIT COST OF SEPTEMBER 15 DAM

ITEM	COLON	US $(8.72C)	
LAND AQUISITION	36,996,223	4,242,686	a
OUSING AND DEVELOPMENT(POWER HOUSE ET	364,925,826	41,849,292	b
CIVIL WORKS	1,023,410,864	117,363,631	c
TURBIN,MOTERS,GENERATERS	178,841,978	20,509,401	d
ELECTRIC CONTROL UNIT	19,884,701	2,280,356	e
EQUIPMENT	29,386,894	3,370,057	f
SUBSTATIONS	87,234,443	10,003,950	g
TOTAL	1,740,680,929	199,619,373	

	US$	related amount	unit	value	unit cost	
COST OF LANDAQUISITION(a)	4,242,686	RESERVOIR AREA	km^2	35.75	118,677	US$/km2
COST OF DAM AND POWERHOUSE(b+c)	159,212,923	ROCK FILL*	m^3	2,848,000	31.63	US$/m3
		CONCRETE*	m^3	333,700	207.17	US$/m3
COST OF POWER GENERATION RELATED(d+e+f+g	36,163,763	MAX CAPACITY	MW	170	212,728	US$/MW
TOTAL	199,619,373					

* cost ratio of concrete to rock fill was assumed to be 6.55 by CEL data

Table H.5.11 COST OF SAN ESTEBAN DAM AND COST ALLOCATION

PURPOSE	HEIGHT (m)	DAM (US$)	SPILLWAY (US$)	GATE (US$)	COMPENSATION (US$)	TOTAL (US$)	COST RATIO	LOCATION	ALOCATED COST	PURPOSE
ULTI PURPOS	43	87,527,877	34,812,470	0	18,462,085	140,802,432	100%			
POWER	43	87,527,877	34,812,470	0	18,462,085	140,802,432	100%	44.41%	62,524,217	POWER
IRRIGATION	39	66,508,302	27,178,830	0	15,003,207	108,690,339	77%	34.28%	48,264,637	IRRIGATION
FLOOD ONLY	32	40,105,611	17,030,440	274,250	10,179,267	67,589,568	48%	21.32%	30,013,578	FLOOD
								140,802,432		

Table H.6.1 FEATURES OF SMALL DAMS PLANNED

DAM NAME	BASIN AREA	AVE. DIS.	RESERVOIR V.			IRRI AREA	MAX W.D.	DAM HEIGHT	CREST LENGTH	DAM VOLUME	CREST EL	RES. AREA	RESETTLEMENT
			SEDI	IRRI	TOTAL								
	(km2)	(m3/s)	(MCM)	(MCM)	(MCM)	(ha)	(m)	(m)	(m)	(MCM)	(m)	(km2)	(person)
ARAUTE	12.50	0.08	1.25	2.6	3.85	227	29	34	400	0.84	304	0.4	200
YOLOAIQUIN	32.50	0.21	3.25	6.5	9.75	567	21	26	500	0.81	316	0.95	720
CHAGUITE	19.00	0.12	1.90	3.86	5.76	337	32	37	200	0.46	327	0.72	80
TORONIO	22.90	0.15	2.29	4.7	6.99	410	36	41	300	0.76	291	0.43	120
NAJADA	34.20	0.22	3.42	6.9	10.32	602	28	33	200	0.41	203	1.74	40
SAN SEBASTIAN	15.80	0.10	1.58	3.3	4.88	288	32	37	200	0.46	307	0.38	240
CHAPELTIQUE	28.10	0.18	2.81	5.7	8.51	498	55	60	600	2.23	310	0.4	0
LOS AMATES	11.60	0.07	1.16	2.4	3.56	210	39	44	300	0.82	294	0.21	0
PUEBLO	10.10	0.06	1.01	2	3.01	175	44	49	300	0.91	279	0.19	160
GUALAVO	18.40	0.12	1.84	3.7	5.54	323	41	46	700	2.00	316	0.35	0
YAMABAL	30.70	0.20	3.07	6.3	9.37	550	65	70	500	2.17	340	0.43	160
SAN DIEGO	26.10	0.17	2.61	5.29	7.90	462	24	29	400	0.72	199	0.91	0
TAISIHUAT	82.43	0.53	8.24	16.3	24.54	1423	31	36	150	0.33	166	3.95	825
EL PASTOR	18.40	0.12	1.84	3.66	5.50	320	41	46	200	0.57	156	1.42	525
TOTAL	362.73				109.48	6391				13.49		12.48	3070

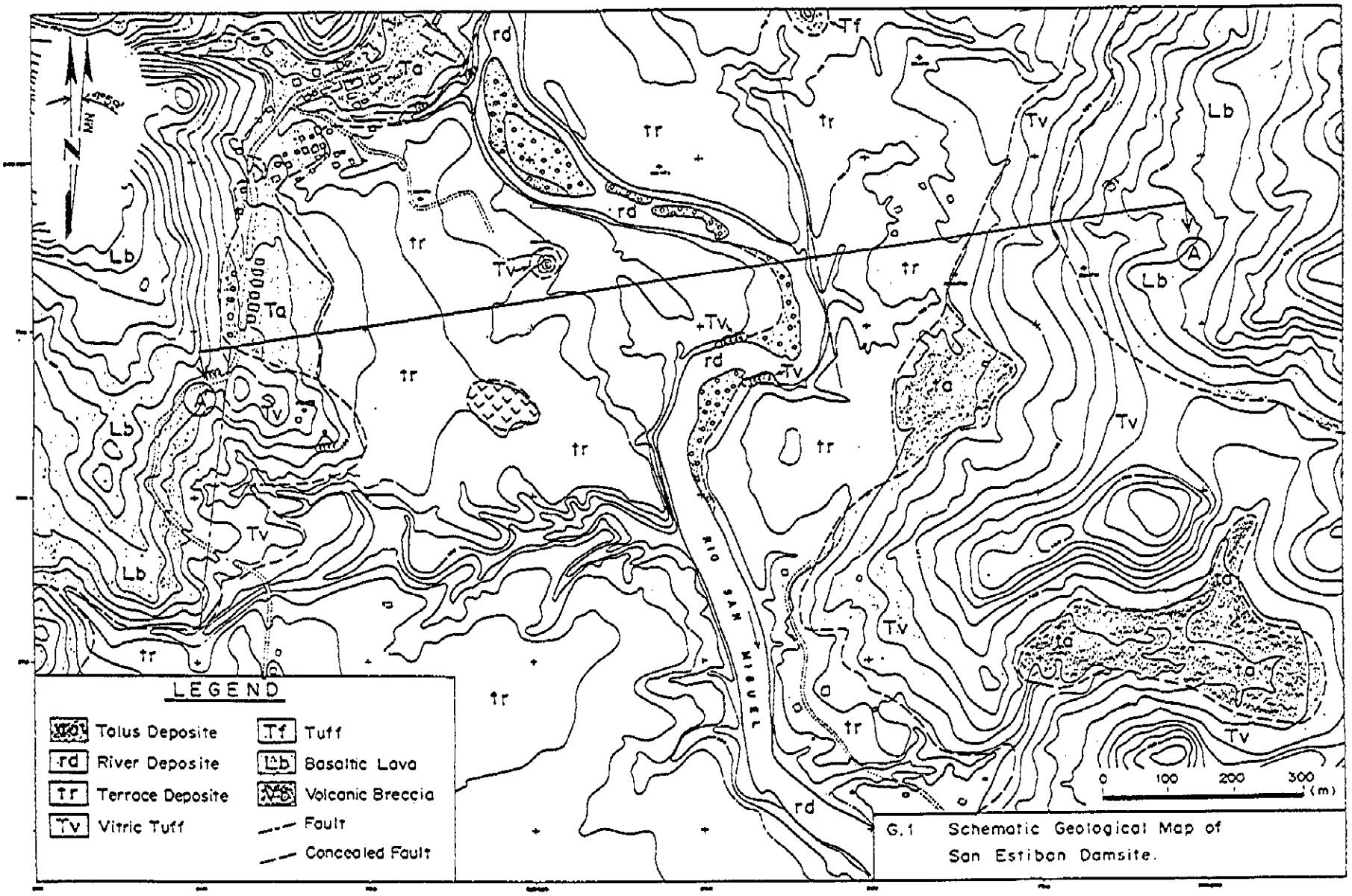

Figure H.5.1 SCHEMATIC GEOGRAPHIC MAP OF SAN ESTEBAN DAMSITE

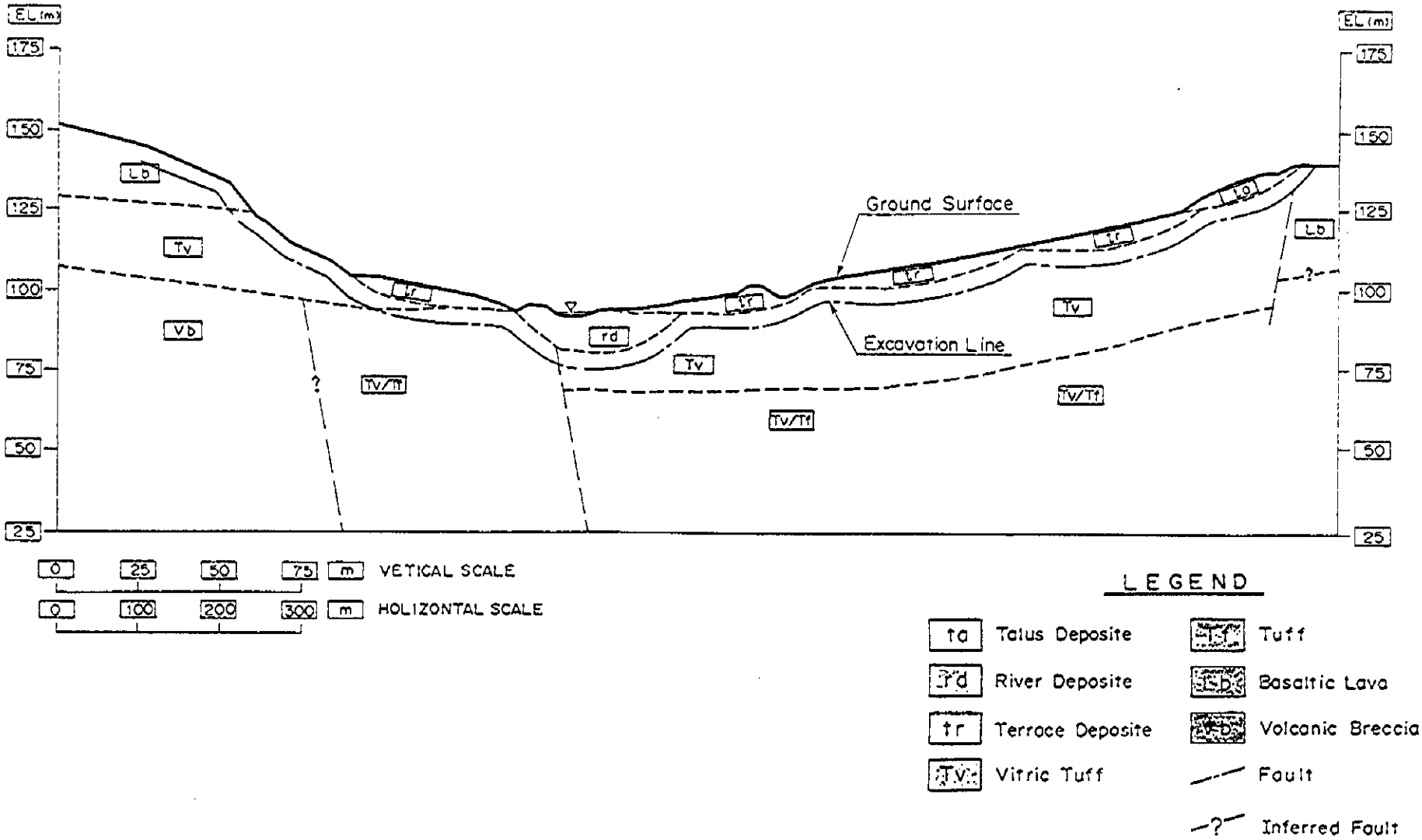

Figure H.5.2 GEOLOGICAL PROFILE OF SAN ESTEBAN DAM AXIS

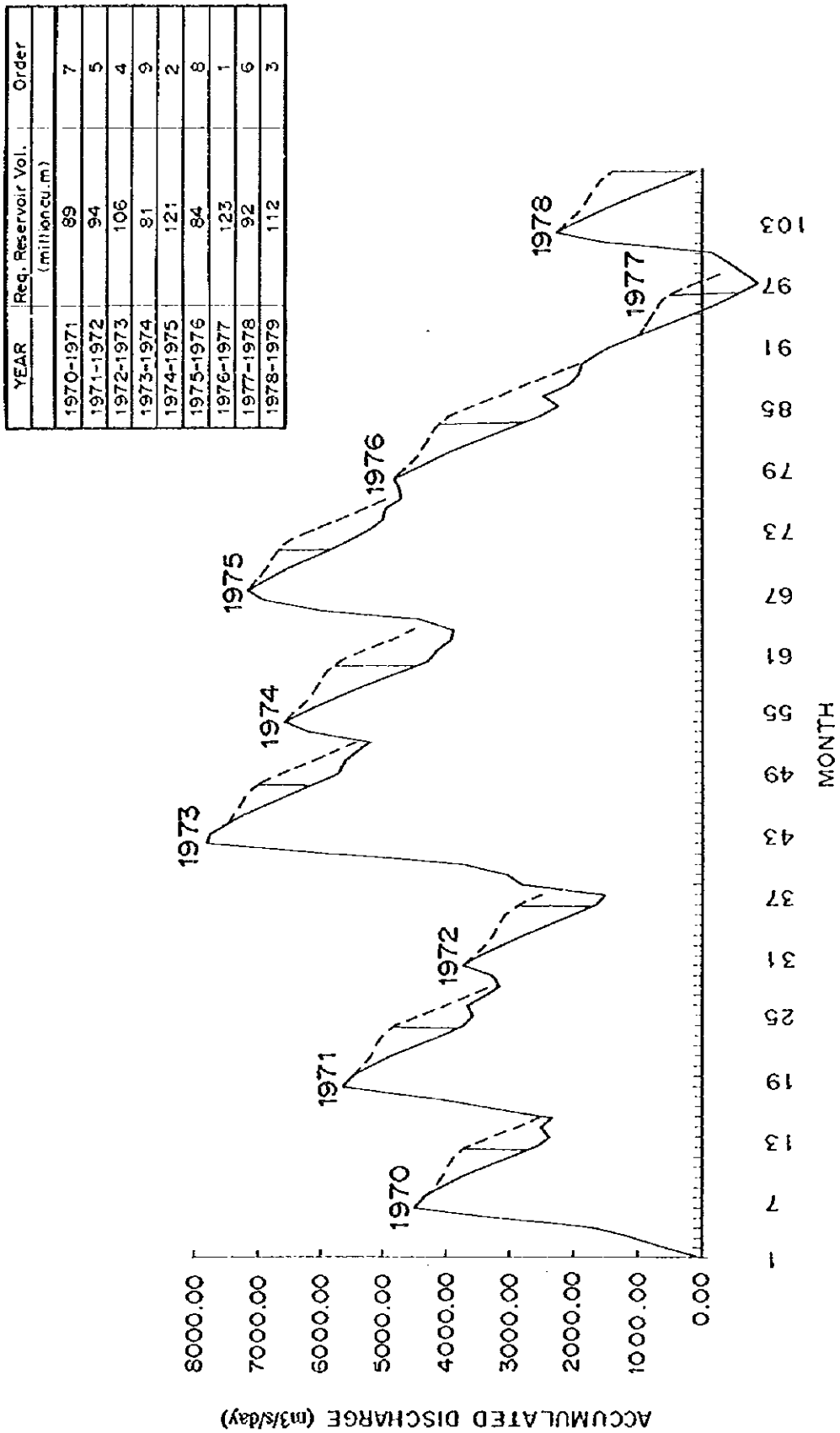

Figure H.5.3 MASS CURVE ANALYSIS AT SAN ESTEBAN DAM (1970 - 1980)

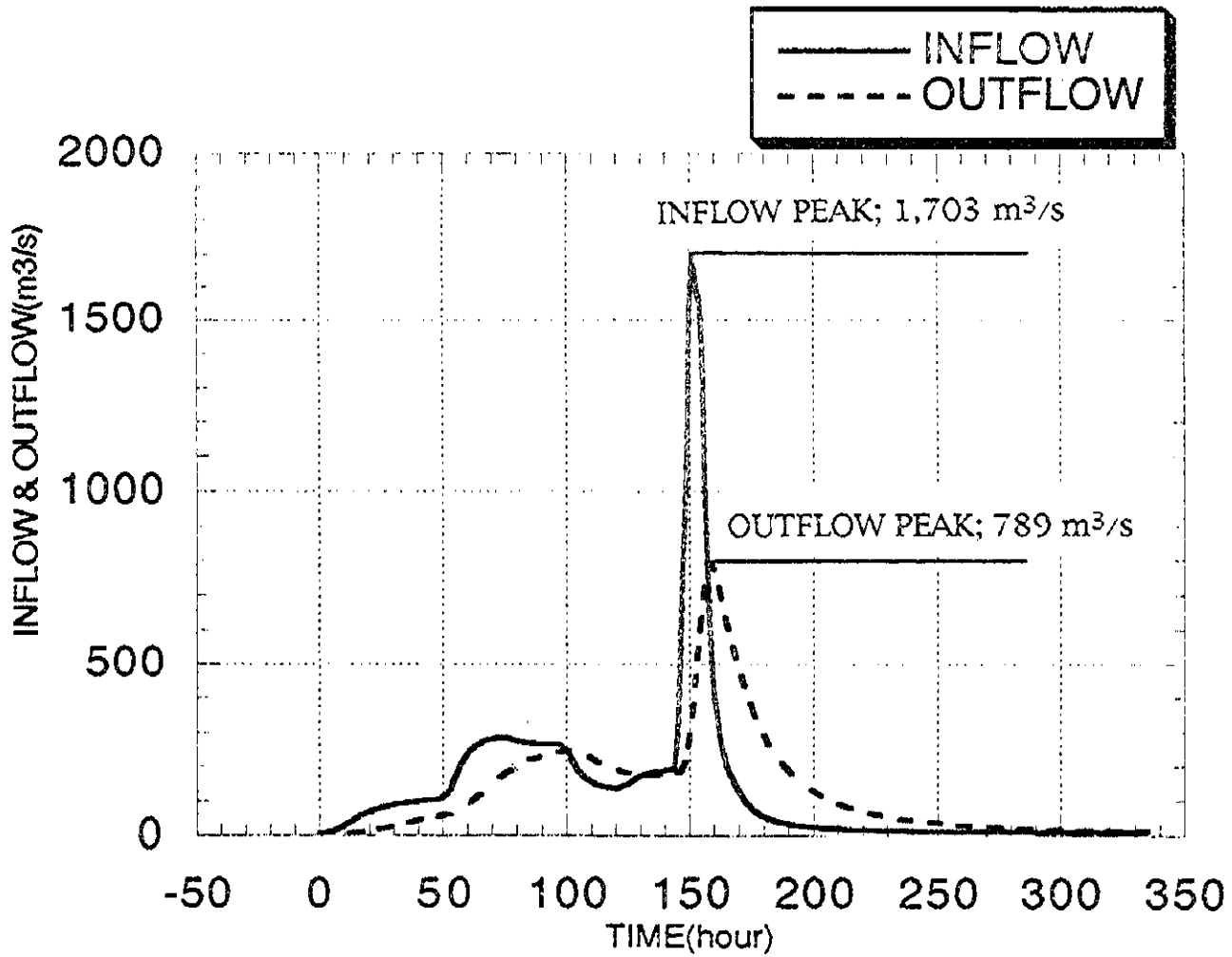

Figure H.5.4 INFLOW AND OUTFLOW HYDROGRAPH OF SAN ESTEBAN DAM (DAM DESIGN FLOOD)

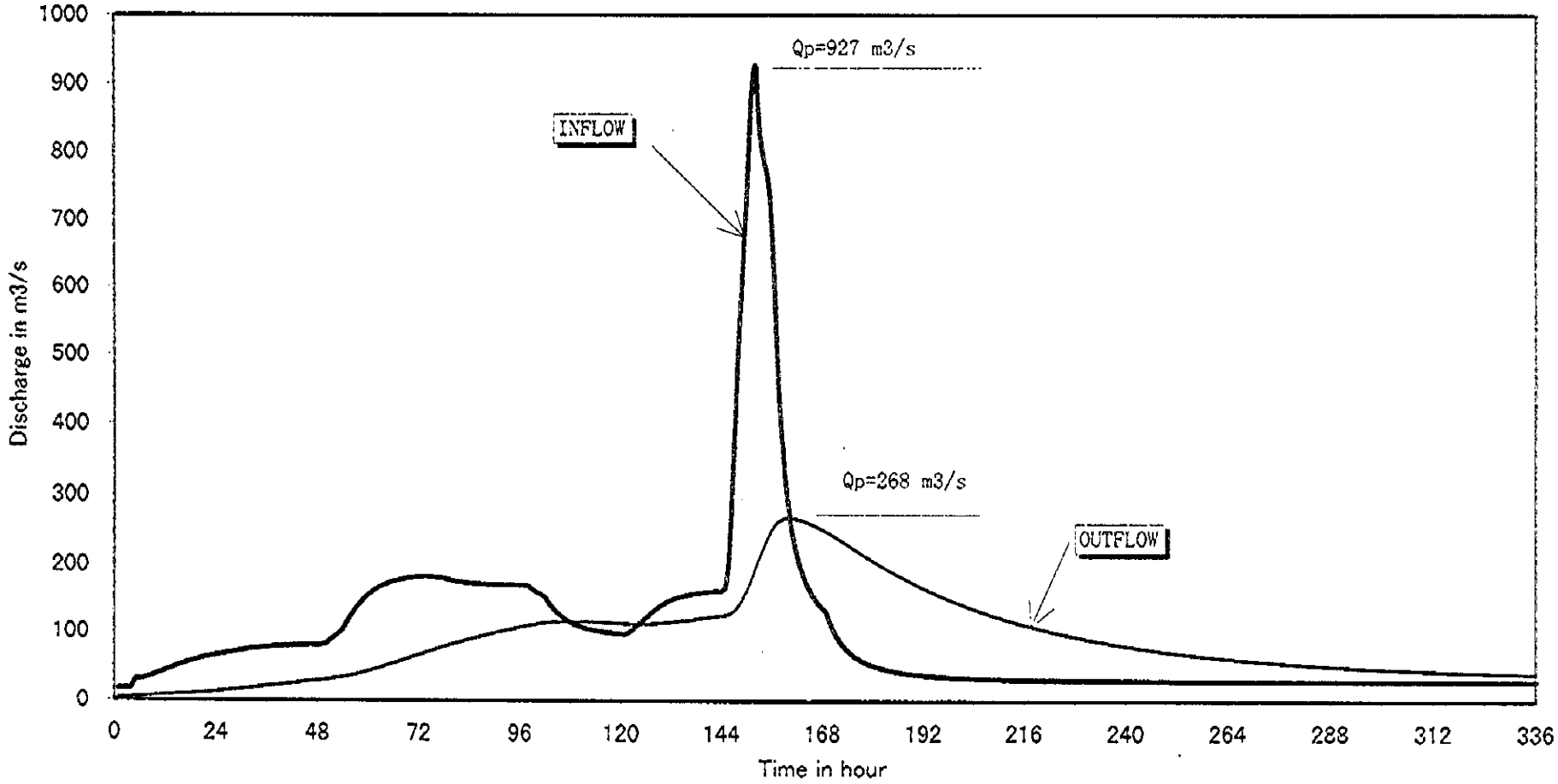

Figure H.5.5 MULTI-PURPOSE DAM HYDROGRAPH OF 10-YEAR FLOOD

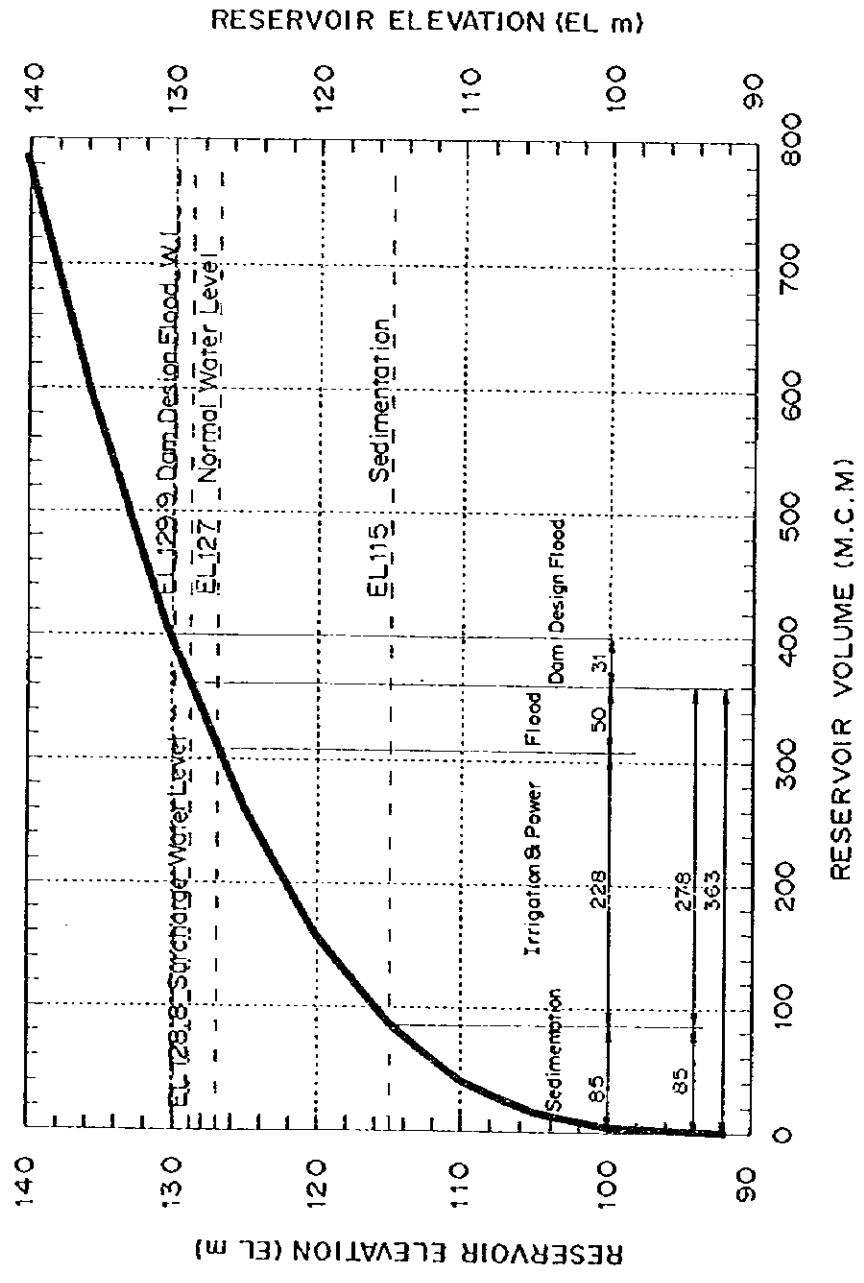

Figure H.5.6 SAN ESTEBAN MULTI-PURPOSE DAM RESERVOIR VOLUME ALLOCATION

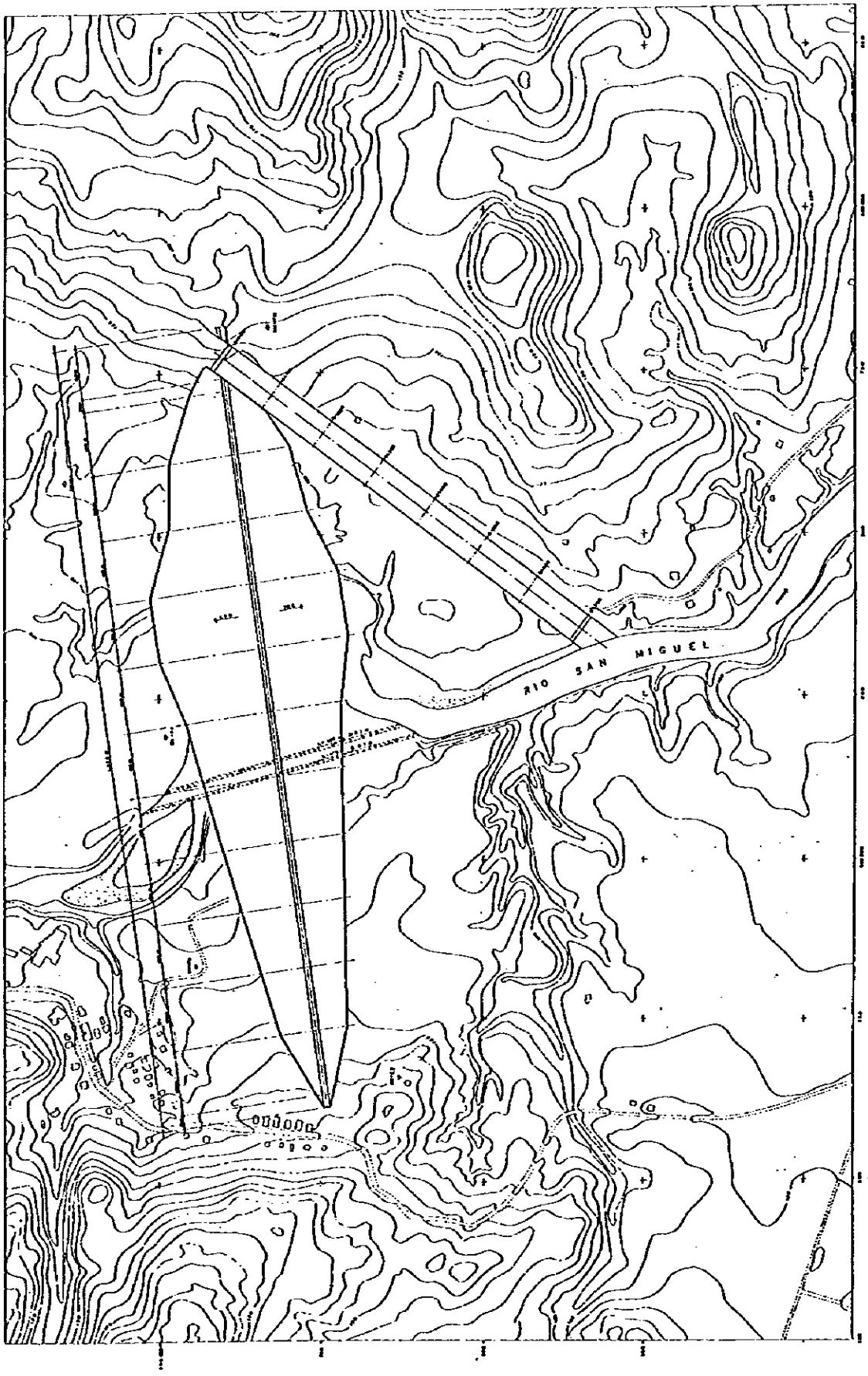

Figure H.5.7 SEPARATE TYPE OF SPILLWAY

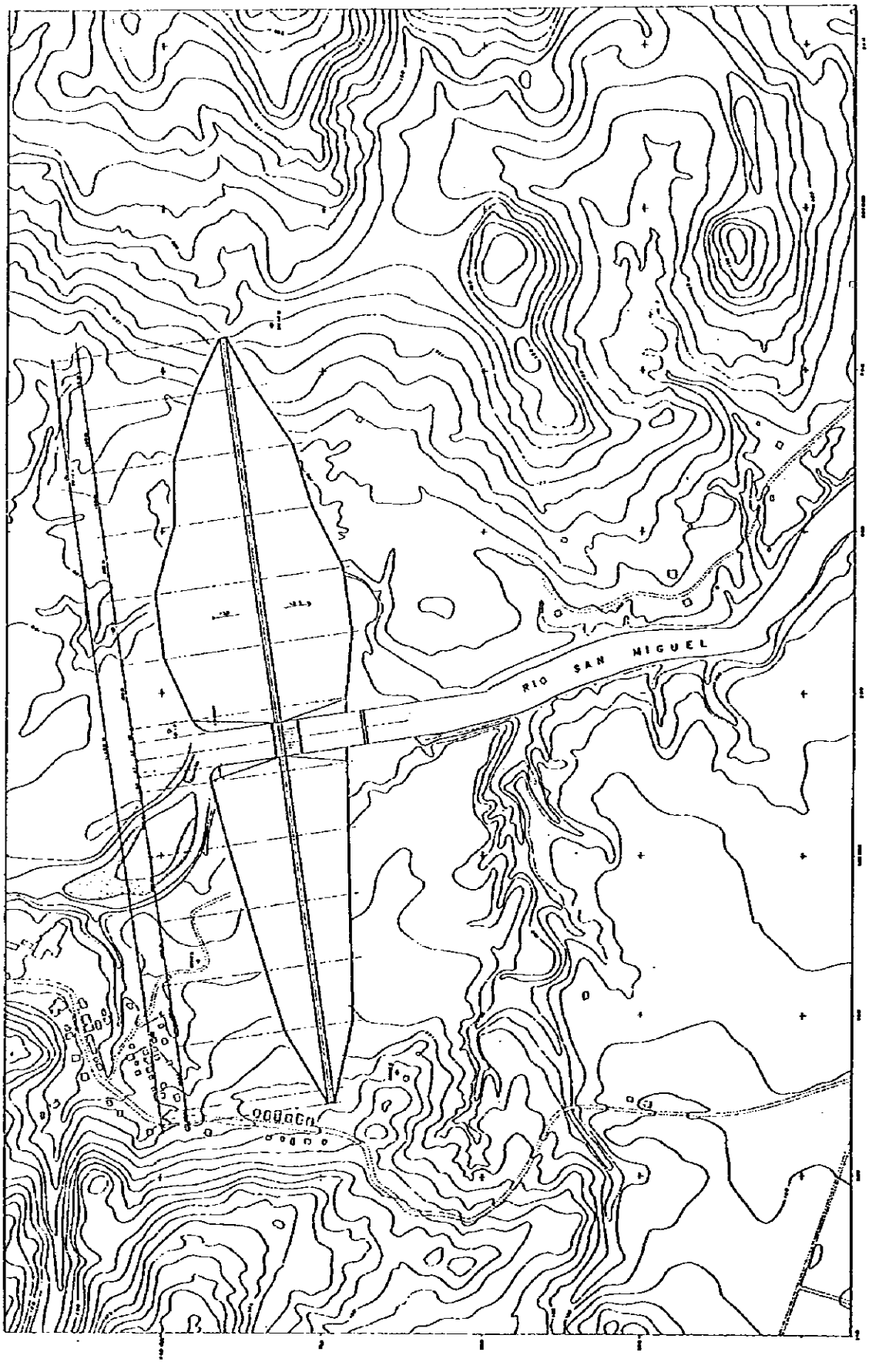

Figure H.5.8 COMBINED TYPE OF SPILLWAY

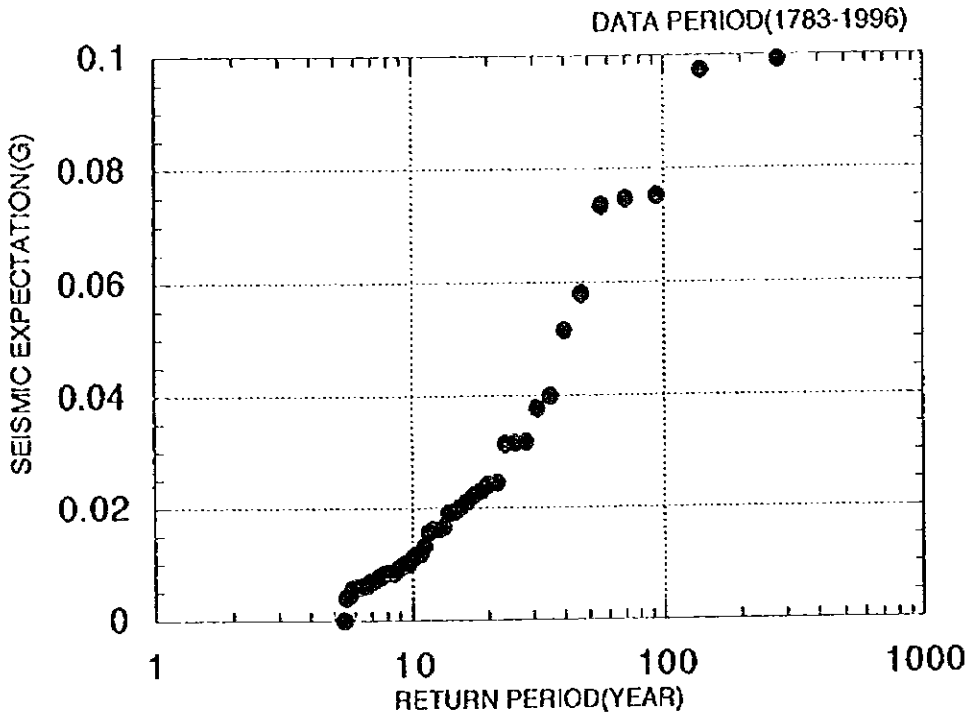

Figure H.5.9(1/2) SEISMIC EXPECTATION AT SAN ESTEBAN DAM SITE

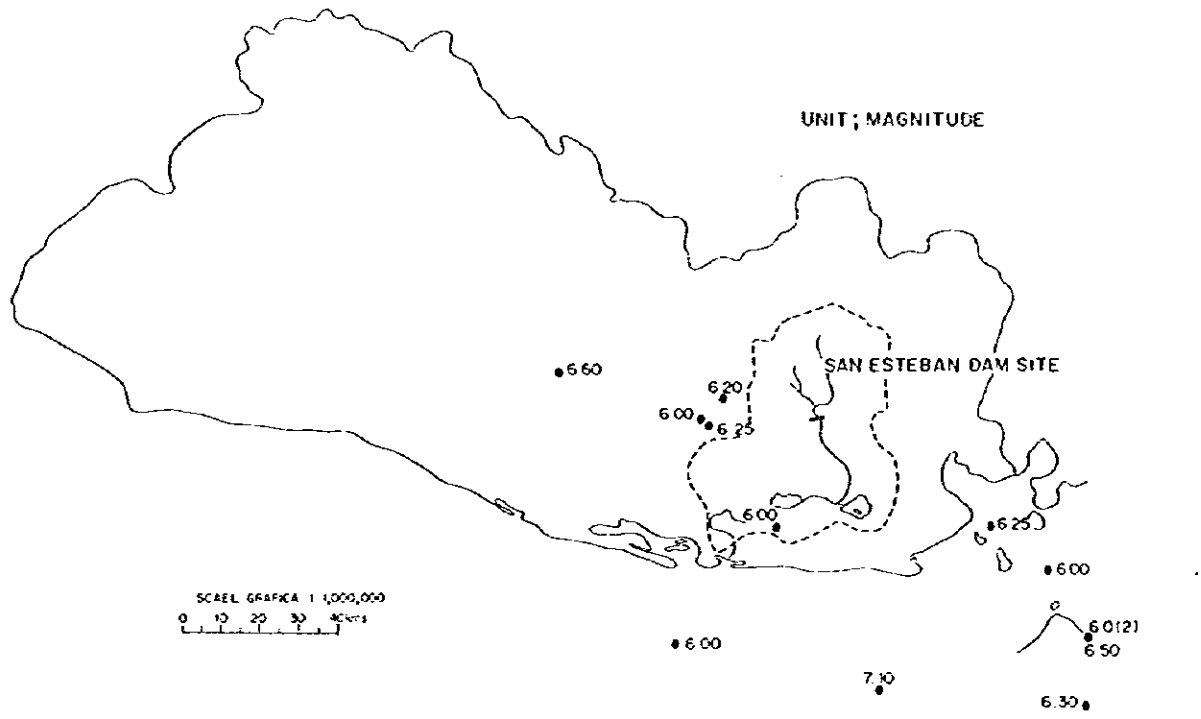

Figure H.5.9(2/2) LOCATION OF EPICENTERS OF LARGE EARTHQUAKES NEAR SAN ESTEBAN DAM SITE

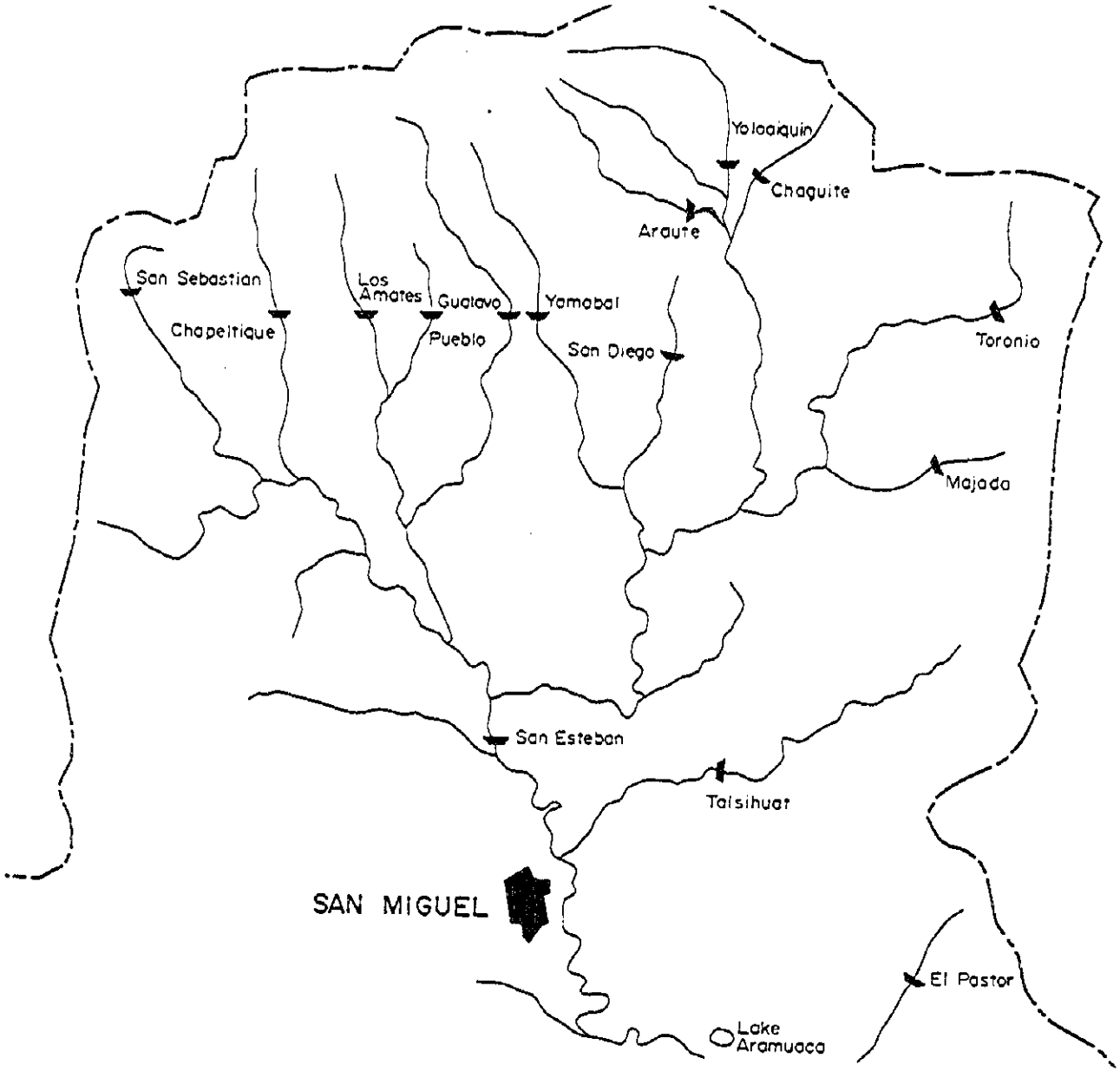

Figure H.6.1 LOCATION OF DAMSITE STUDIED