CHAPTER 3

PRESENT CONDITIONS OF THE STUDY ARERA

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3.1 Natural Condition

3.1.1 Geomorphology, Geology, and Groundwater

(1) Geomorphology

The Jiboa River basin is divided into a mountainous/hilly area in the northern side and a flat plain in the southern side downstream by a contour line of 100 m in elevation.

Figure 3.1.1.1 shows a topographic map contoured using 1 km x 1 km nodal elevations read from 1:50,000 scale topographic maps. The contour lines are drawn by interpolating the nodal elevation every 500 m using the Kriging method. The map may be referred to as a summit surface map as it does not delineate minor ridges and valleys.

From the map, the upstream area in the basin can be subdivided into the outer ring mountains surrounding Ilopango caldera, the foothill of the southern outer ring mountains, the foot of San Vicente Volcano, and the hilly areas on the left side of El Desague River and the upstream area of the Jiboa River.

Figure 3.1.1.2 shows three-dimensional topographic images made from the above interpolated data. The geomorphologic features obtained from Figures 3.1.1.1 and 3.1.1.2 can be summarized as follows:

1) The scale of erosion along Jiboa River is the biggest from the view point of geomorphology. The second may be the area along which the Comalapa River flows down to the west of the study area. The erosional scale of Rio Sepaquiapa is bigger than that of Rio Tilapa.
2) A clear topographic boundary line can be recognized from El Desague River to the east through Jiboa River. This coincides with the geological tectonic line indicated in the geological maps of the Republic of El Salvador (1978). The area south of the tectonic line is presumed to have been downthrown.
3) Gentle slopes at elevations between 600 to 700 m can be seen in the upper basin areas of Candelaria, San Ramon, and San Cristobal based on the 1 km interval elevation data. This indicates that the scale of present erosive topography is less than 1 km in size. It also indicates that the primitive topography of the area before erosion occurred was almost flat.

The distribution of groundwater levels is generally in agreement with the rough topography. In the study area, as described in a later chapter, groundwater resources are deeply imbedded on the ridges of mountainous/hilly areas and the groundwater table gently slopes compared with the topographic slope in higher elevation areas. However, it is predicted that the groundwater table in the study area is generally as high as the river bed elevations.

From the aerial photos of the downstream area, 1 to 2 m high terraces are found on both sides of the Jiboa River. The aerial photos also showed the old river courses.

(2) Geology

1) Stratigraphy

The study area is mainly underlain by volcanic sediments of the Tertiary to Quaternary age. According to references such as "Mapa Geologico de la Republica de El Salvador" (1978) , the geology of the study area consists of the BALSAMO Formation (Miocene to Pliocene), CUSCATLAN Formation (Pliocene to Pleistocene), and SAN SALVADOR Formation (Pleistocene to Holocene) in the ascending order.

2) Geologic structures

The geologic structures in the study area are characterized by Ilopango caldera, E-W fault zone along the northern foot of San Vicente Volcano, NE-SW fault system along the midstream area of Jiboa River, and NW-SE fault systems in the middle to upper basin areas.

a) Ilopango caldera

Ilopango is a caldera that is said to have been formed in 260 AD. Ash from this explosive eruption covered much of central El Salvador. Lake Ilopango fills part of the caldera. Islas Quemadas, a volcanic dome, was formed within the caldera in 1879-1880.

The average water level of Ilopango Lake is 440.30 m; the water level ranges from 439.45 m to 441.15 m. The central part of the lake exceeds a depth of 200m. The island of Quemadas stands at 220 m to 230 m from the lake bottom.

b) E-W fault zone along the northern foot of San Vicente Volcano

The fault starts from the eastern part of Ilopango lake to San Vicente city along the El Desague River, dividing the area into hills to the north and the foot of San Vicente Volcano to the south. To the north of Verapaz, the difference in elevation along the fault is about 150 m, gradually expanding eastwards. There are several natural springs along the fault, indicating that the groundwater flow in the area is controlled by the fault.

c) NE-SW fault system along the midstream Jiboa river

The geologic map shows the existence of a fault extending from the intersection of El Desague and the Jiboa rivers to the intersection of the Jiboa and Chinuapa rivers. This fault can be traced from the northeast up to the area around San Sebastian, being displaced by the E-W fault mentioned above.

d) NW-SE fault systems in the middle to upper basin

The geologic maps show many faults as well as estimated faults in the areas from Cojutepeque to San Pedro Masahuat. Meanwhile a NNW-SSE fault system can be seen in the areas of San Antonio Masahuat, San Pedro Masahuat, and Tapalhuaca. As expected, these numerous faults strongly influence and control the surface drainage patterns and groundwater. The rocks and sediments in these areas are well fractured as a result of the high density in faults.

(3) Groundwater

The resistivity sounding and the collection and interpretation of data on existing wells were carried out to better understand subsurface geologic structures and the groundwater system.

1) Resistivity sounding

Resistivity sounding using the Wenner electrode array was carried out at 31 locations in and around the study area. The sounding locations are shown in Figure 3. The maximum distance between the outer electrodes extends up to 396 m. The apparent resistivity values were read 31 times at fixed electrode intervals and shown in the data sheets attached in the Annex. The theoretical depth of the resistivity sounding is 132 m (396 m / 3 = 132 m). Table 3.1.1.1 shows the list of resistivity soundings with the apparent resistivity curve types.

There are two methods of interpretation: the traditional graphical method using two layer standard curves with supplemental curves, and the method using inversion techniques. In this study, the traditional method was employed in the field to obtain the initial values for the inversion model, which are to be introduced in the inversion interpretation program called "RINVERT".

Table 3.1.1.2 summarizes the results of the inversion analysis (top and bottom elevations of each resistivity layer and the resistivity). All data sheets and apparent resistivity curves along with the results of the inversion model analysis are presented in the Annex. (See Figure 3.1.1.4-5)

Analysis and interpretation of resistivity data show that K and Q type curves are common in the downstream area (E-07, 08, 11, 12, 21, 22, 23), indicating that resistivity values decrease with depth. In the coastal plain area, the geology consists primarily of recent fluvial sediments which are unconsolidated to moderately consolidated. Typically, the resistivity value decreases by a magnitude of order within the first few meters. This generally corresponds with the river water levels and the shallow groundwater levels measured in nearby shallow wells. The continued decrease in resistivity values indicates that the sediments are either fine-grained or more compact. In many of the resistivity sounding records a thin zone of very low resistivity is encountered. This is probably a layer of clay or volcanic ash that, in some areas, will separate groundwater zones or create perched water tables of limited capacity.

Also, (E-23) the resistivity value near the coast is very low and is seen to further decrease. This relationship is typically associated with the presence of saline water. It is quite likely that there is a salt-water zone extending inland a short distance from the ocean. However, the extent of such a zone is difficult to verify without additional data.

To the north, in the area near San Pedro Masahuat and San Antonio Masahuat (E-02, 18), is a thin zone of sharply higher resistivity. Considering the geology of the area and proximity to Ilopango caldera, this is interpreted to be a thin lava layer or similar volcanic deposits.

In the upstream areas, the resistivity data is commonly represented by A and H type curves (E-09,10, 15, 24, 25, 27), indicating that resistivity increases with depth. This relationship is a result of the widespread distribution of andesitic and basaltic lavas underlying the sediments in this area. Typically, lava flows have a weathered surface, which is clayey, and are overlain by consolidated sediments of the Cuscatlan Formation. Usually there is a shallow water table perched on the weathered surface, which is not very productive but yields water in the wet season. The deeper water table in the confined aquifer is generally a favorable water resource, but is difficult to access due to depth. Also, since many wells are constructed without the aid of modern drilling machinery, hard rocks are relatively impermeable for manual well construction methods.

2) Collection and interpretation of existing well data

The study team collected data on 54 wells in and around the study area, which are tabulated in Table 3.1.1.3. Most of these wells were drilled by ANDA and PLANSAVAR, and the location of the existing wells are shown in Figure 3.1.1.6. The existing wells are distributed in the downstream area and the northern area from Ilopango lake. There are also a few wells in the upstream area of Jiboa River, but no well data are available in the midstream hilly area.

Although the distribution of well data is not uniform in the study area, a specific capacity map is prepared to understand aquifer characteristics in the study area (Figure 3.1.1.6). The values of specific capacity can be easily obtained from pumping tests or well production test using the equation: (Specific capacity) = (Discharge rate) / (Drawdown)

It can be said that aquifer productivity increases with increasing specific capacity. According to Figure 3.1.1.7, the areas having more than 500 m^2/day in specific capacity can be seen near Rosario, the northern part of Ilopango lake, and the foot of San Vicente Volcano. There are no well data in the upstream area of San Pedro Masahuat and San Antonio Masahuat, although, it is estimated that these areas may have 250 to 500 m^2/day in specific capacity based on the results of resistivity sounding and the geologic conditions.

On the other hand, the area having less than 100 m^2/day in specific capacity due to relatively poor aquifer productivity extends from the northwestern part of the international airport to the west side of the Jiboa River bank. The aquifer productivity at the coastal area is average with a specific capacity ranging from 100 to 200 m^2/day.

The areas of San Ramon and Santo Domingo have relatively small specific capacity ranging from 50 to 100 m^2/day.

Figure 3.1.1.8 shows the relationship between transmissivity obtained from pumping tests at existing wells and specific capacity, in which the existing wells are classified into three areas; the upstream area, Rosario in the midstream area, and the downstream area. The relation between transmissivity (T) and specific capacity (Sc) in the upstream area can be expressed as:

$T = 1.234\ Sc$

In Rosario, both T and Sc are higher than those in other areas: $T = 1.165\ Sc$
And the relation in the downstream area is obtained as: $T = 1.189\ Sc$

The following empirical equation presented by Logan (1964) is commonly used to express the relation between transmissivity and specific capacity: $T = 1.22\ Sc$

In comparison, the above calculated average T-Sc relations are almost the same as the Logan's equation. As a result of the above mentioned investigation and analysis, the aquifer productivity in the Jiboa River basin can be summarized as follows:

a) Relatively high productivity (500 m^2/day <= Sc): Rosario area, northern area of Ilopango lake, and foot of San Vicente Volcano
b) Moderately productive area (100 m^2/day <= Sc < 500 m^2/day): hilly area in the mid-Jiboa basin and coastal area downstream
c) Relatively poor productivity (Sc < 100 m^2/day): right side area of upper Jiboa river, near international airport downstream

The results of groundwater level measurements by the existing wells and by our field surveys show that the depth to groundwater level from ground surface in the downstream area mostly ranges from 2 to 5 m. However, groundwater on the hills in the midstream and upstream areas is 20 to 30 m below the ground surface. Figure 3.1.1.9 shows the distribution of groundwater levels in the study area.
Groundwater in the upstream to midstream areas occurs as perched water and unconfined water, whereas downstream it is unconfined water and confined water. For example, water gushing from the spring made of pumice tuff on the side of the road in San Cristobal, originates from the perched water within the tuff layer. In western Rosario, there are two aquifer systems: one is shallow unconfined aquifer with a groundwater level

of about 2 to 3 m from ground surface, and the other is deep confined aquifer having more than 20 m in depth to the piezometric surface.

3) Relations and interactions between groundwater and surface water

a) Groundwater

Figure 3.1.1.10 shows that major ions in the groundwater samples are clustered and generally within the expected range for groundwater. Samples taken during October 1996 have higher concentrations of carbonate ion (CO_3), approaching 100%, and indicate that major ion distribution does not vary significantly during the year.

Concentrations of arsenic (As) and boron (B) are quite high in samples taken from wells. In most of the wells sampled, As concentrations exceeded the WHO guidelines for drinking water and in 3 cases exceeded the FAO guidelines for agricultural irrigation water. Concentrations of B also exceeded the WHO guidelines for drinking water in 3 cases and the FAO guidelines in 1 case.

High concentrations of As are relatively common in areas with rocks and soils of volcanic origin. High concentrations of B are commonly associated with those of As, however, the source and mechanism are unclear.

b) Rivers

River water quality analysis was conducted 4 times in 1996. Figure 3.1.1.11 shows the distribution of major ions for samples taken during October of 1996. Generally, the data are clustered near the middle of the diagram, and the values detected were slightly higher than the expected ion concentrations. Sites R-1, 3, 4, 8, 9, and 10 are clustered near the 60% level for SO_4+Cl and the others are scattered around the 50% level for Ca+Mg. One exception is R-7, which has higher levels (70%, 50%) of both ion groups. These data trends are no doubt influenced by the various industrial and domestic pollutants discharged into the rivers.

As and B concentrations were quite high in the samples taken in February. Upon presentation of the data results from October samples, we will be able to establish trends prevailing between the wet and dry seasons.

c) Ilopango Lake

The results of the major ion analyses for samples taken in October 1996 are shown in Figure 3.1.1.12. As can be expected in a large homogeneous body of water, the data are clustered very closely and do not change significantly during the course of the year. This is good as it indicates constant circulation in the lake and that stratification is not significant. The concentration of SO_4+Cl is relatively high at 70-80% and the concentration of Na+K is quite high at 80%.

As and B concentrations were high in the February samples and most likely so during the

October sampling period. More details will be provided after the results of the data analysis are obtained.

d) Relations and interactions between groundwater and surface water

Figures 3.1.1.13 and 3.1.1.14 show Stiff diagrams of the water quality data obtained during February and October of 1996. These diagrams show major ion concentrations for all sampled sites. It can be seen that during February, the dry season, the concentrations of ions in lake water cannot be traced downstream. This is because most of the rivers are in baseflow or low flow conditions, deriving water largely from groundwater. However, the results of the October sampling show a distinct trend and influence from Ilopango lake water. The same Stiff pattern (high Na) can be seen in El Desague River and further downstream in the Jiboa River due to higher runoff from the lake during the wet season. Further, downstream concentrations of major ions increase, starting from El Rosario due in part to increased runoff associated with the wet season.

Trends and patterns with As and B concentrations will be described after the results from the samples have been obtained.

During the dry season, baseflow conditions exist and groundwater influences the water quality of rivers and streams. In this period, the influence of Ilopango lake water is insignificant. During the wet season, Ilopango lake water is seen to have a strong influence on the major ion concentrations and distributions in rivers and streams. At the same time, concentrations in groundwater decrease, probably due to the infiltration of and dilution from precipitation.

4) Recommendations

Through the course of data collection and analyses, the following are the several deficiencies and problems encountered and observed:

a) Lack of data and incomplete records

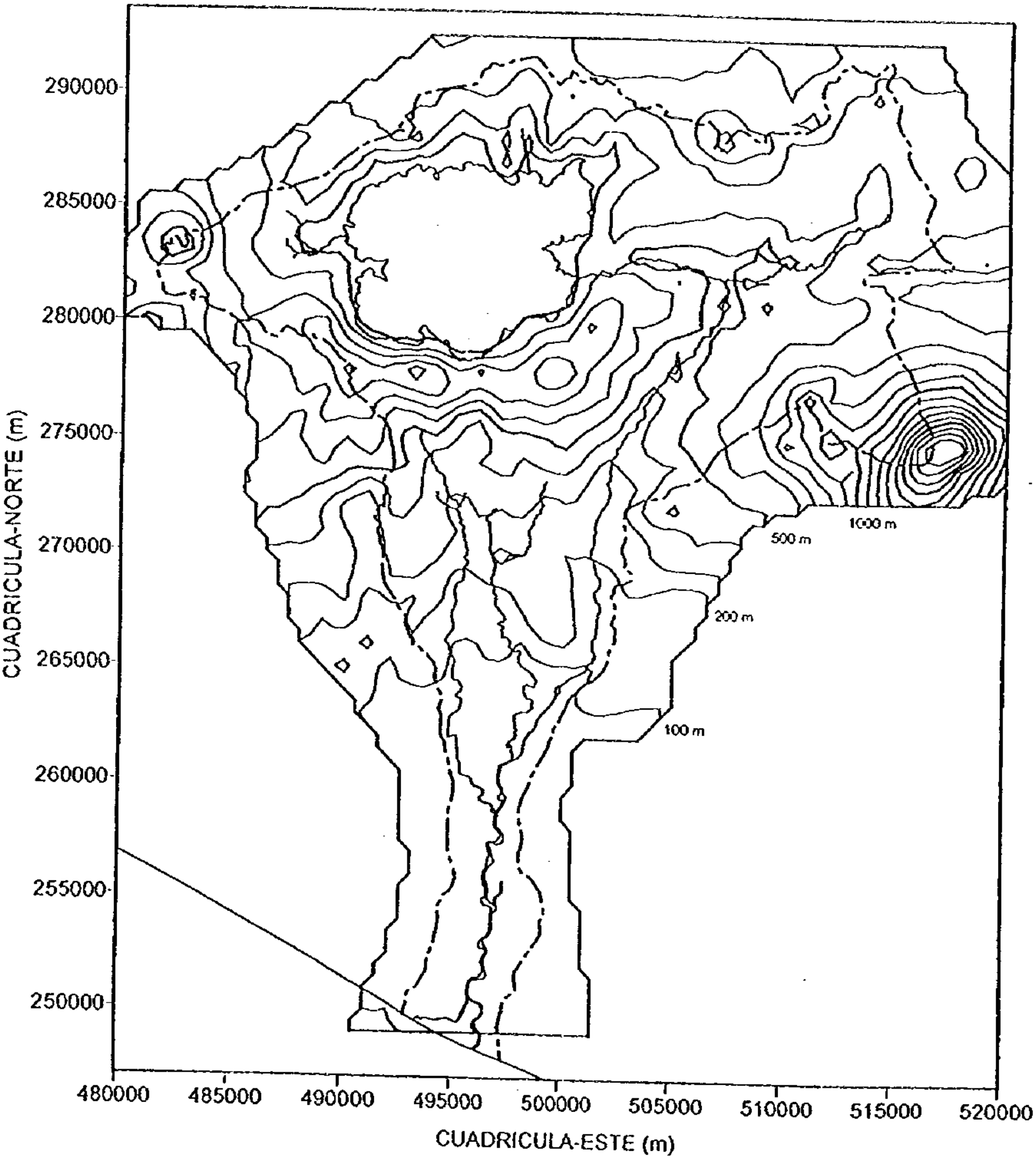
During the course of data collection, particularly well records and logs, it was discovered that the records are kept at many different agencies. In some cases, the records were organized and easy to access, but in most cases they were difficult to find, unorganized, and incomplete. Previous reports were also difficult to find and verify. It is suggested that one government agency be responsible for the collection and classification of previous records. This agency would also be responsible for issuing well construction permits and ensuring that a minimum set of data are recorded for new wells.

b) Absence of time series or long term data for analysis

No record of long term measurements was found during the course of this study. In order to plan for future development of water resources, a consistent record of time series data, such as water levels and water quality, should be utilized to evaluate long term trends and the impact of development. A simple network of carefully selected well and stream sites to be measured at regular intervals would be sufficient to initiate a long term data record. By properly documenting the location, reference point, and details of the method and type of measurement, personnel can easily duplicate the measurements at regular time intervals such as weekly or monthly. With additional resources it may be possible to install recording devices at selected sites to automate part of the data collection.

c) Acute need for improvement and development of water resources

Many problems in water quality and supply were observed throughout the study area. Access to sufficient quantities of potable water are essential to public health. It was clear that many areas do not have easily accessible sufficient quantities of water, thereby impelling many people to use water from rivers and streams, which are usually polluted with sewage, garbage, and industrial effluent. Accordingly, a comprehensive plan should be designed and implemented. Part of the plan would prioritize the need for water in the various towns and villages, then provide detailed hydrogeologic investigations, followed by well and pump installation or spring development. Another part of the plan would be to establish a proper disposal system and clean up rivers and streams. Attention to water supply and quantity will improve public health and extend the life span of the people.

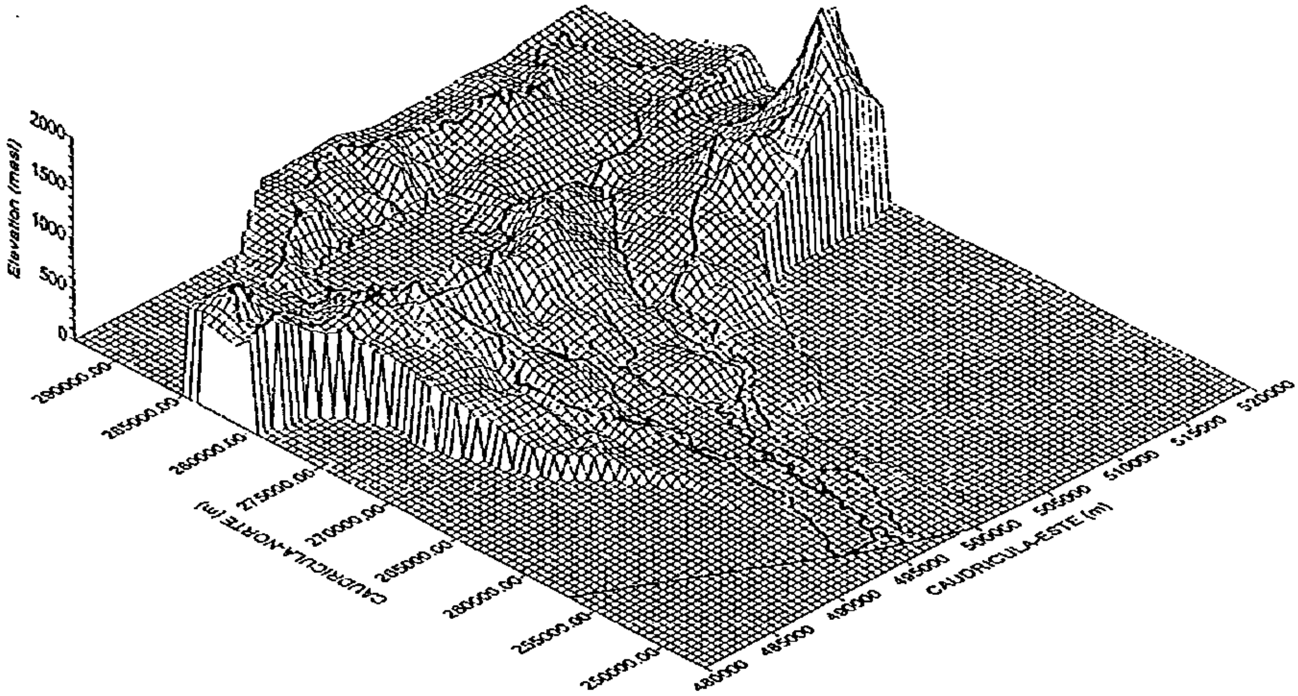


Counter line interval : 100 m

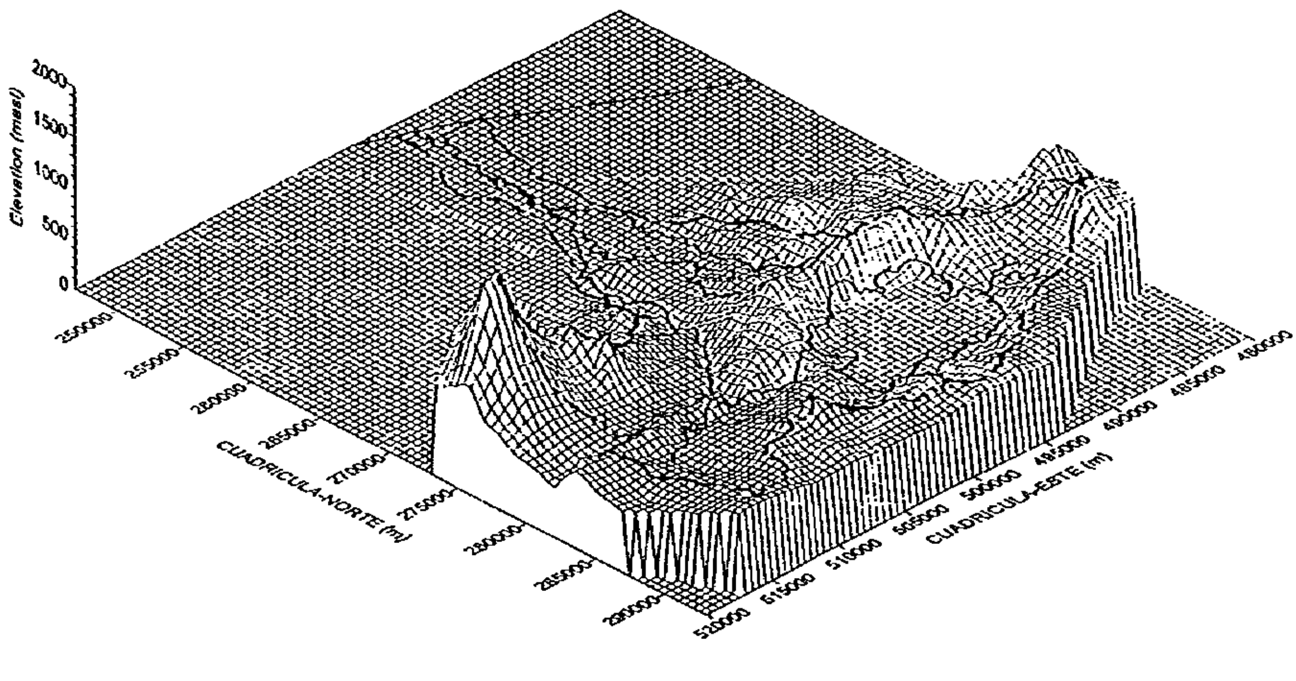
Thick counter line interval : 500 m

Counter lines are drawn by the Kringing's interpolation methos.

Fig.3.1.1.1	TOPOGRAPHIC COUNTER MAP BASED ON 1km GRID NODAL DATA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)	



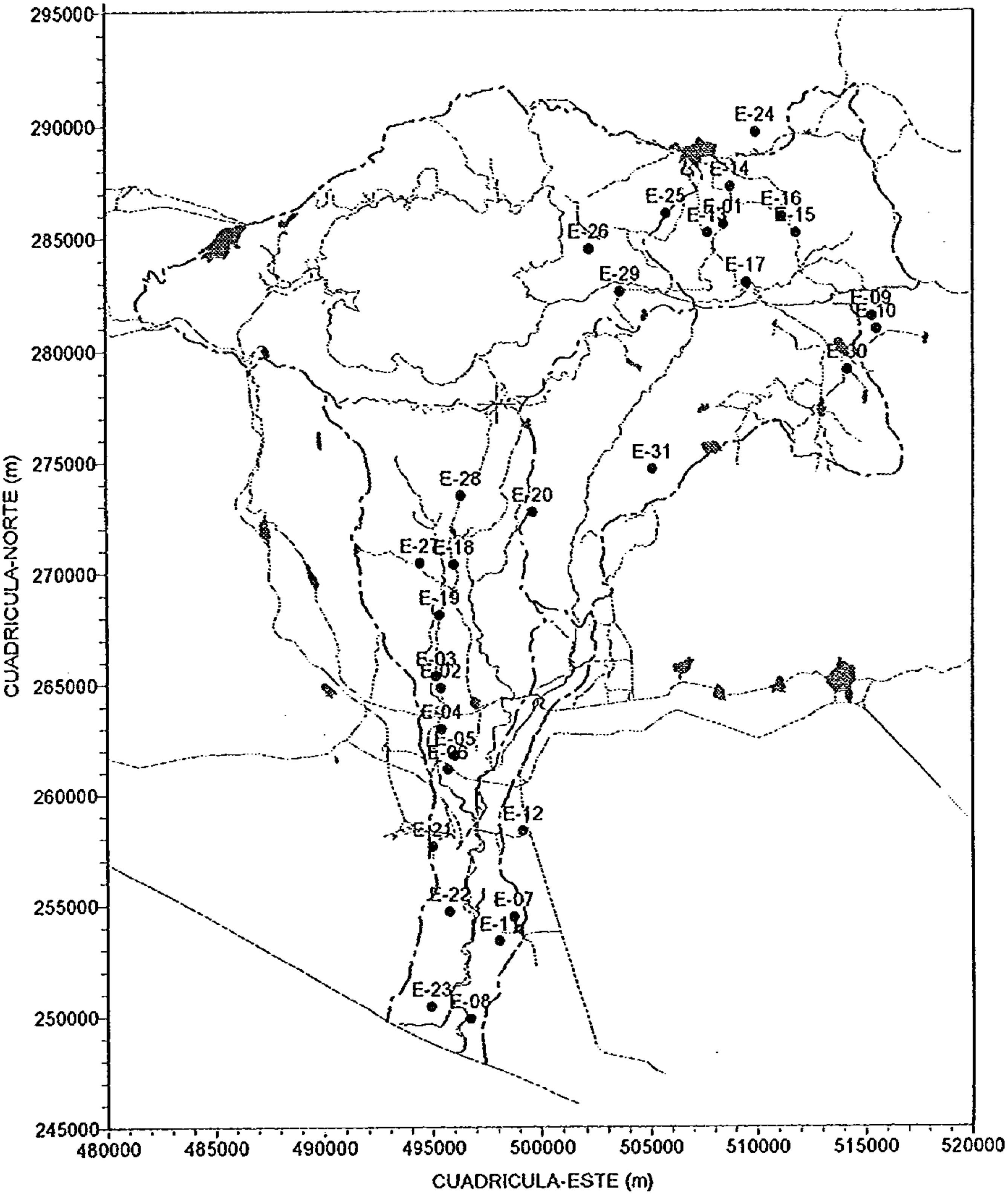
a) SW View



b) NE View

500 m nodal values are computed using the Kringing's interpolation method based on 1km x 1 km elevation data.

Fig 3.1.1.2	3-D ORTHOGRAPHIC VIEW OF THE STUDY AREA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)	



E-01
● Location of resistivity sounding with No.

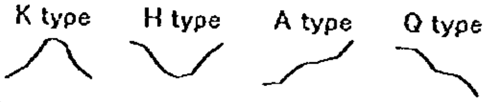
Fig.3.1.1.3	LOCATION OF RESISTIVITY SOUNDING
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)	

Table.3.1.1.1 LIST OF RESISTIVITY SOUNDING

No.	E (m)	N (m)	Elev (m)	Curve type	Location
E-01	508412.5	285575	633	H	Cton. San Pablo, San Ramon
E-02	495350	264812.5	82	K	Cton. El Carmen, San Pedro Masahuat
E-03	495137.5	265350	88	Q	Cton. El Carmen, San Pedro Masahuat
E-04	495400	262962.5	69	HQ	Hda. Las Flores, San Pedro masahuat
E-05	496000	261750	56	Q	Hda. San Mauricio, San Pedro Masahuat
E-06	495675	261125	46	QQ	Ctom. Las Flores, San Pedro Masahuat
E-07	498725	254450	21	Q	Cton. Las Isletas, San Pedro Masahuat
E-08	496700	249875	6	Q	Hda. La Zorra, San Pedro Masahuat
E-09	515300	281550	602	HQ	Benef. Molineros, Tepetitan
E-10	515520	280950	610	H	Benef. Molineros, Tepetitan
E-11	498050	253362.5	17	Q	Hda. Santa Emilia, San Pedro Masahuat
E-12	499150	258325	34	Q	Desvio Las Tres Puertas, San Pedro Masahuat
E-13	507650	285200	633	A	San Ramon
E-14	508737.5	287250	775	K	Cton. San Pablo, San Ramon
E-15	511762.5	285175	635	KA	Cton. San Antonio, San Cristobal
E-16	511125	285912.5	641	KA	Cton. Santa Cruz, San Cristobal
E-17	509475	282975	495	K	Cton. Santa Anita, San Cristobal
E-18	495962.5	270350	232	K	Finca El Cocal, San Pedro Masahuat
E-19	495287.5	268100	170	Q	Barrio San Jose, San Pedro Masahuat
E-20	499600	272700	287	HQ	Cton. Belen, San Antonio Masahuat
E-21	494975	257625	24	HQ	Camp. El Cacao, San Pedro Masahuat
E-22	495763	254700	16	K	Camp. San Jose Luna, San Pedro Masahuat
E-23	494925	250425	5	K	Cton. Las Hojas, San Pedro Masahuat
E-24	509912.5	289850	772	H	Cton. Concepcion, El Carmen
E-25	505687.5	286075	667	K	El Llano, Candelaria
E-26	502125	284487.5	645	K	Cton. El Rosario, Candelaria
E-27	494375	270425	352	A	Cton. Buena Vista, Tapalhuaca
E-28	496275	273462.5	381	A	Cton. El Socorro, San Antonio Masahuat
E-29	503537.5	282612.5	520	K	El Planon, Santa Cruz Analquito
E-30	514190	279150	672	K	Cton. San Antonio Los Ranchos, Guadalupe
E-31	505050	274662.5	505	KA	Cton. La Comunidad, San Pedro Nonualco

Curve Type:

K type H type A type Q type



$(\rho_1<\rho_2>\rho_3)$ $(\rho_1>\rho_2<\rho_3)$ $(\rho_1<\rho_2<\rho_3)$ $(\rho_1>\rho_2>\rho_3)$

Table.3.1.1.2 LIST OF RESISTIVITY SOUNDING

Sounding	Coordinates		Ground	Layre-1			Layre-2			Layre-3			Layre-4			Layre-5			Layre-6			Layre-7		
No.	E (m)	N (m)	Elev (m)	from(m)	to(m)	ρ(Ω-m)	from(m)	to(m)	ρ(Ω-m)	from(m)	to(m)	ρ(Ω-m)	from(m)	to(m)	ρ(Ω-m)	from(m)	to(m)	ρ(Ω-m)	from(m)	to(m)	ρ(Ω-m)	from(m)	to(m)	ρ(Ω-m)
E-01	308412.5	285575	633	0	1.96	90.33	1.96	18.86	15.33	18.86	52.96	34.13	52.96	INFINITY	93.75									
E-02	495350	264812.5	82	0	2.2	126.1	2.2	3.29	702.9	3.29	155.99	35.34	155.99	INFINITY	Low									
E-03	495137.5	265350	88	0	4.27	357.1	4.27	6.8	15.58	6.8	29.77	55.47	29.77	76.05	63.6	76.05	INFINITY	Low						
E-04	495400	262962.5	69	0	1.94	127.7	1.94	10.97	33.67	10.97	39.46	14.14	39.46	85.95	75.85	85.95	INFINITY	Low						
E-05	496000	261750	56	0	1.8	397.8	1.8	20.94	183.9	20.94	24.37	4.71	24.37	67.79	108.3	67.79	74.46	22.07	74.46	78.13	12.46	78.13	INFINITY	Low
E-06	495675	261125	46	0	2.98	202.8	2.98	38.64	56.99	38.64	41.98	Low	41.98	168.88	247.5	168.88	INFINITY	106.8						
E-07	498725	254450	21	0	0.09	10.2	0.09	1.22	209.6	1.22	3.73	31.97	3.73	8.25	223.6	8.25	INFINITY	18.28						
E-08	496700	249875	6	0	0.02	9.26	0.02	0.64	950.9	0.64	2.83	19.59	2.83	18.53	66.68	18.53	INFINITY	13.91						
E-09	515300	281550	602	0	1.42	95.08	1.42	2.09	14.62	2.09	8.04	339.2	8.04	9.47	8.89	9.47	64.93	235.8	64.93	INFINITY	Low			
E-10	515520	280950	610	0	0.82	264.6	0.82	9.45	78.59	9.45	198.98	255.4	198.98	INFINITY	Low									
E-11	498050	253362.5	17	0	3.06	636.2	3.06	30.83	47.42	30.83	INFINITY	12.4												
E-12	499150	258325	34	0	2.68	491	2.68	18.57	96.21	18.57	INFINITY	29.6												
E-13	507650	285200	633	0	3.55	17.95	3.55	4.38	3.05	4.38	15.67	301.4	15.67	20.85	22.38	20.85	87.92	84.16	87.92	INFINITY	11.47			
E-14	508737.5	287250	775	0	0.24	1051	0.24	8.68	84.52	8.68	40.8	210.5	40.8	INFINITY	8.94									
E-15	511762.5	285175	635	0	0.74	43.4	0.74	3.25	95.31	3.25	7.13	176.7	7.13	7.75	1.43	7.75	INFINITY	695.2						
E-16	511125	285912.5	641	0	0.03	1.57	0.03	5.56	57.49	5.56	10.89	209.2	10.89	15.51	1.92	15.51	41.71	402.6	41.71	INFINITY	Low			
E-17	509475	282975	495	0	1.52	24.98	1.52	8.15	947.2	8.15	99.05	147.1	99.05	INFINITY	Low									
E-18	495962.5	270350	232	0	1.33	36.57	1.33	9.58	85.89	9.58	11.53	10.25	11.53	18.09	High	18.09	47.34	Low	47.34	INFINITY	520.4			
E-19	495287.5	268100	170	0	0.53	307	0.53	7.69	93.62	7.69	8.77	2.21	8.77	19.91	161.8	19.91	INFINITY	33.5						
E-20	499600	272700	287	0	0.77	124.9	0.77	8.19	66.07	8.19	14.41	162.9	14.41	95.28	35.43	95.28	INFINITY	351.1						
E-21	494975	257625	24	0	0.45	636.2	0.45	17.61	93.19	17.61	26.76	4.75	26.76	41.33	170.5	41.33	INFINITY	19.3						
E-22	495763	254700	16	0	3.09	14.98	3.09	5.12	143.1	5.12	23.64	37.77	23.64	INFINITY	14.82									
E-23	494925	250425	5	0	0.66	11.9	0.66	32.92	43.38	32.92	INFINITY	7.06												
E-24	509912.5	289650	772	0	1.27	62.26	1.27	1.6	4.05	1.6	13.37	30.45	13.37	39.59	81.78	39.59	42.01	1.71	42.01	INFINITY	68.76			
E-25	505687.5	286075	667	0	2.59	43.57	2.59	6.15	83.68	6.15	9.64	28.43	9.64	19.69	235.3	19.69	INFINITY	70.35						
E-26	502125	284487.5	645	0	0.92	53.08	0.92	5.01	185.5	5.01	9.23	70.88	9.23	53.28	215.5	53.28	INFINITY	55.43						
E-27	494375	270425	352	0	1.28	39.93	1.28	1.42	2.19	1.42	7.06	138.1	7.06	16.79	47.58	16.79	INFINITY	153.5						
E-28	496275	273462.5	381	0	1.66	19.33	1.66	8.28	31.82	8.28	15.29	300	15.29	20.97	4.68	20.97	INFINITY	144.8						
E-29	503537.5	282612.5	520	0	0	Low	0	1.42	2005	1.42	17.52	220.5	17.52	INFINITY	50.49									
E-30	514190	279150	672	0	0.1	9.37	0.1	1.28	108.5	1.28	29.5	84.22	29.5	INFINITY	16.79									
E-31	505050	274662.5	505	0	2.53	57.37	2.53	6.44	170	6.44	11.73	6.02	11.73	55.94	205.7	55.94	72.46	44.29	72.46	INFINITY	Low			

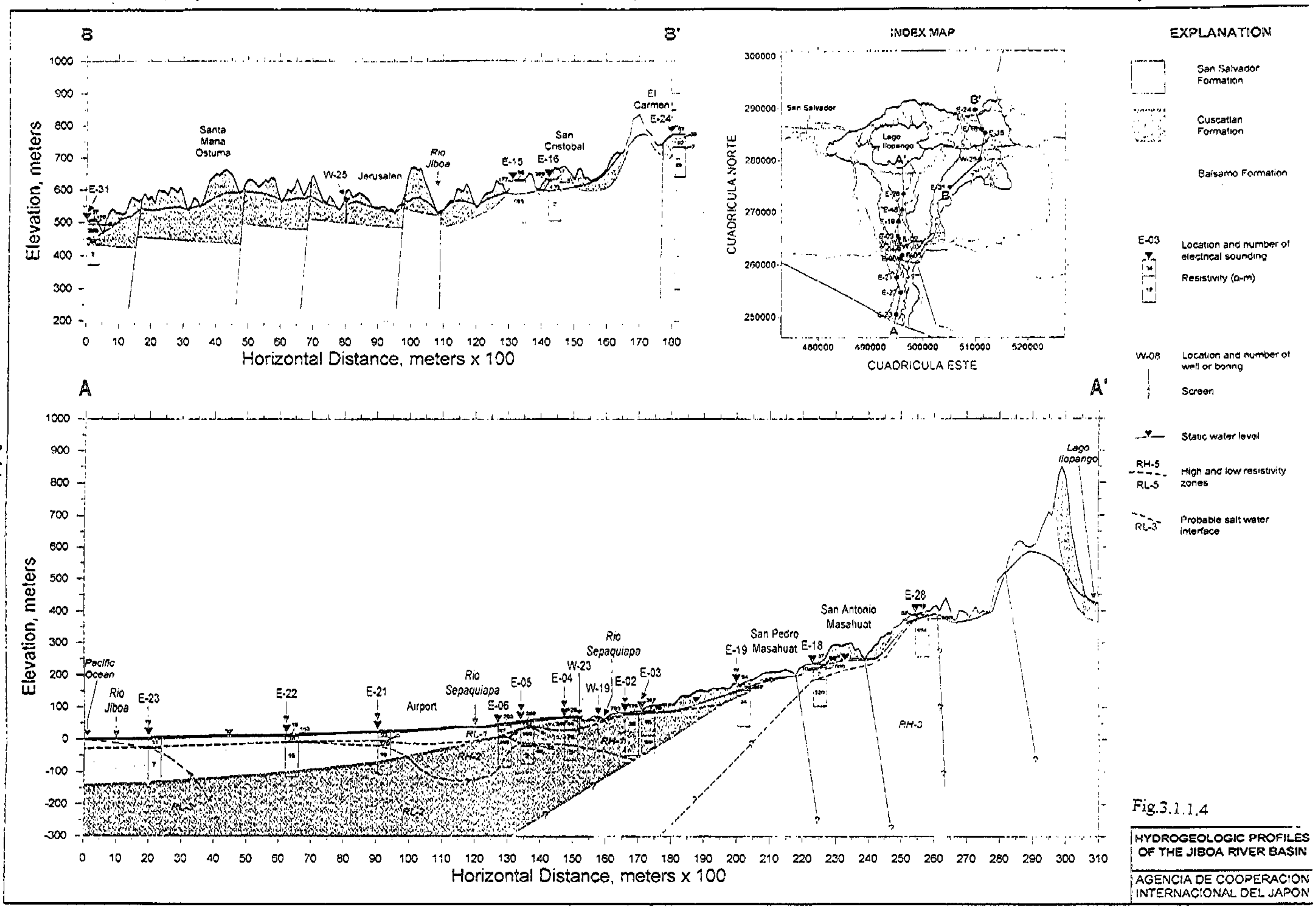


Fig.3.1.1.4

HYDROGEOLOGIC PROFILES OF THE JIBOA RIVER BASIN

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

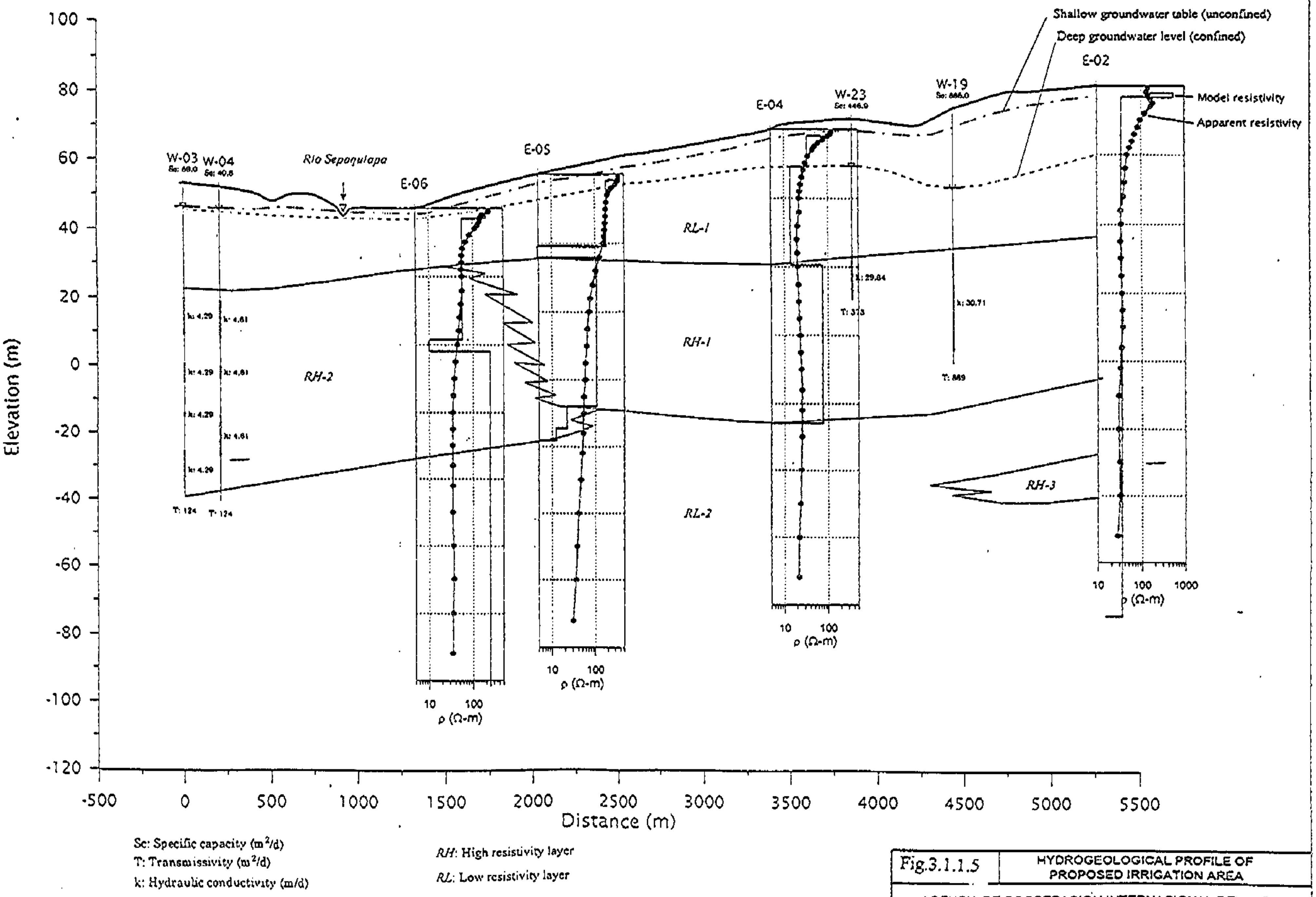
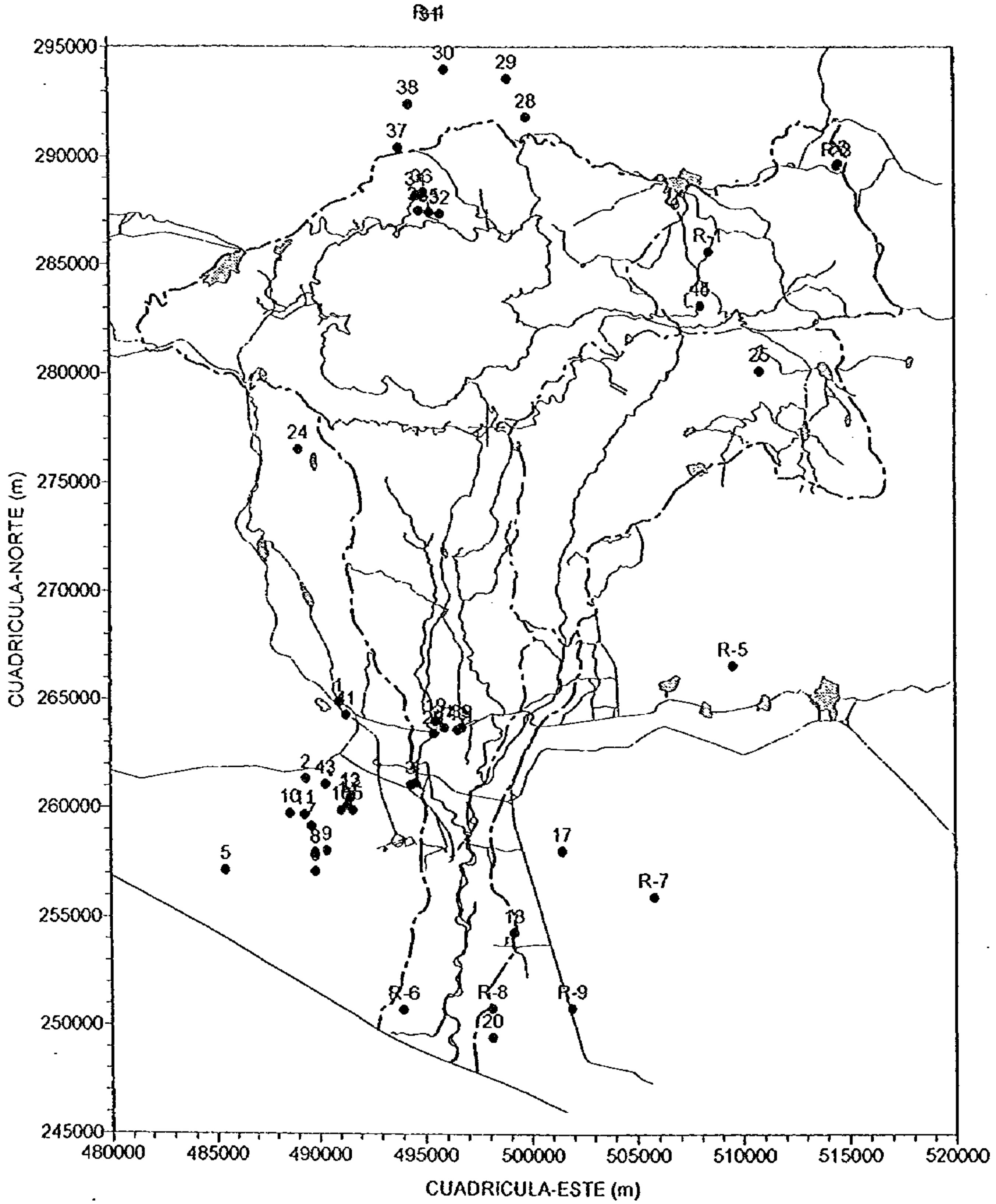


Fig.3.1.1.5 HYDROGEOLOGICAL PROFILE OF PROPOSED IRRIGATION AREA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

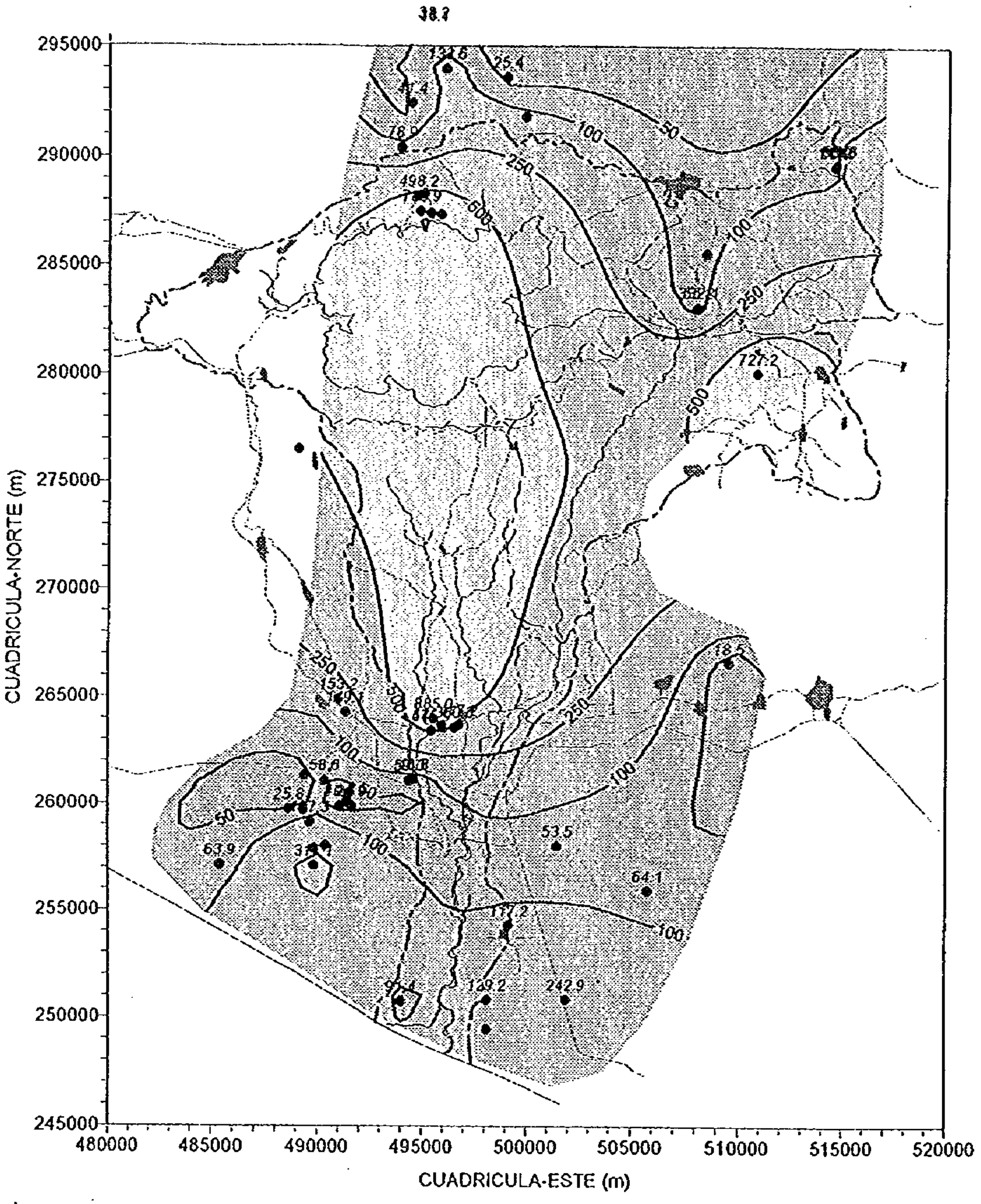


10 ● Location of existing well with No.

Fig.3.1.1.6	LOCATION OF EXISTING WELLS
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)	

Table3.1.1.3 LIST OF EXISTING WELLS RECORDS

Well No	Original Well No	CUADRICULA (m) NORTE	CUADRICULA (m) ESTE	WELL DEPTH (m)	STATIC W.L. (m)	G.L. (m)	Discharge (l/s)	Drawdown (m)	Sc (l/s/m)	Sc (m2/d)	T (m2/d)	S	Pumping time (minute)
1	518	264900	490950	45.72	13.11		16.21	9.14	1.77	153.23	174		4320
2	660	261350	489350	65.84	11.36	50							
3	658	261100	494350	92.66	6.55	33	22.9	33.53	0.68	59.01	124		1800
4	657	261150	494550	92.66	6.1	50	22.52	47.72	0.47	40.77	124		300
5	656	257150	485400	79.55	1.83	7.2	18.93	25.6	0.74	63.89	93		1080
6	550	257100	489800	65.53	4.72	15	63.15	17.37	3.64	314.11	373		1800
7	549	259150	489620	64.62	5.49	27	50.47	34.26	1.47	127.28	155		720
8	548	257900	489800			20							
9	547	258050	490350			20							
10	546	259750	488600	60.96	4.45	35	12.3	41.12	0.30	25.84	37		1390
11	545	259700	489300			30							
12	544	260480	491470			33							
13	543	260550	491500			34							
14	542	260120	491350			31							
15	541	259900	491600	89.61	3.73	31	25.99	77.72	0.33	28.89	25		1800
16	540	259900	491050	71.02	4.57	30	12.74	56.69	0.22	19.42	14		1440
17	667	258050	501430	60.96	2.8	23	30.22	48.77	0.62	53.54	435		300
18	663	254300	499150	31.4	6.61	17	3.5	2.58	1.36	117.21	88		180
19	661	264000	495500	74.26	22.68	80	3.79	0.37	10.24	885.02	369		180
20	659	249480	498100			6							
21	653	263700	495900			70							
22	652	263430	495410	91.44	18.29	70	18.93	2.84	6.67	575.90	931		1650
23	651	263430	495400	52.12	13.72	70	12.62	2.44	5.17	446.87	373		4320
24	517	276550	489050	106.68	9.14								360
25	403	280100	510800	78	23.66	580	5.05	0.6	8.42	727.20	535		180
26	358	289670	514570	103.63	11.58	637	55.52	73.76	0.75	65.03	79		2880
27	359	289670	514570	66.9	18.29	637	25.24	19.51	1.29	111.78	136		1440
28	372	291825	499825	90	40	700							
29	371	293600	498925	39.99	16.41	820	3.03	10.31	0.29	25.39	37		180
30	370	294000	496000	118.87	55.75	720	6.31	4.08	1.55	133.62	162		1440
31	369	295750	495375	101.5	0.61	580	22.08	50.01	0.44	38.15	60		4680
32	714	287350	495775	185.93		460							
33	713	287500	494800	79.25	5.49	455	41.01	4.52	9.07	783.91	1093		1800
34	712	288200	494675	56.4	11.5	520	53.63	9.3	5.77	498.24	605		
35	711	287425	495275			490							
36	710	288325	494975	158.5									
37	367	290425	493875	86.87	76.5	736.6	9.46	10.36	0.91	78.89			480
38	366	292425	494350	112.78	39.93	691	11.55	24.08	0.48	41.44	50		
39	ROSARIO DE LA PAZ #1	263700	496700	52.10	18.28	75	12.62	2.44	5.18	447.19			
40	ROSARIO DE LA PAZ #2	263600	496500	85.32	18.28	75	18.93	4.30	4.40	380.26	600		
41	SAN JUAN TALPA	264300	491300	45.71	13.71		15.77	9.14	1.73	149.06			
42	POZO-2 SAN JUAN TALPA			73.13	20.57		19.18	14.08	1.36	117.70	195.47	1.52E-03	3300
43	SAN LUIS	261100	490300	77.16	6.71		20.47	30.19	0.68	58.58			
44	CACAHUATAL-2	283100	508000	31.38	0		8.71	13.64	0.64	55.16	119.09	1.00E-04	
45	POZO-1 EL CACAHUATAL	283100	508000	46.31	0	450	56.96	14.81	3.85	332.36	911.17	1.00E-04	
R-1	Sn. Ramon	285575	508413	151.45	34.4								
R-2	Sn. Ramon Pozo-1	289575	514500	103.63	11.58	637	55.5	73.76	0.75	65.01	79		2880
R-3	Sn. Ramon Pozo-2	289575	514500	66.9	18.29	637	25.2	19.51	1.29	111.60	136.00		1440
R-4	Chalapan	295850	495330	103.63			22.1	50	0.44	38.19	60.41	1.00E-03	4320
R-5	S7-10-89	266600	509525	110	63.56	218	5	23.41	0.21	18.45	18.63	0.1	1440
R-6	S2-14-86	250750	494000	33.9	-1.84	9	4.72	4.46	1.06	91.44	118	0.001	720
R-7	S2-15-86	255950	505750	42	4.56	18	12.66	17.06	0.74	64.12	90	0.1	180
R-8	S3-27-89	250825	498100	39.65	0.23	8	13.88	9.28	1.50	129.23	223.54	0.1	720
R-9	S3-26-88	250850	501900	61.69	1.99	7	12.68	4.51	2.81	242.92	135.58	0.1	720



125.8 Location of existing well with specific capacity (m²/day)

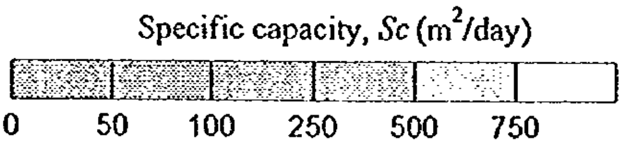
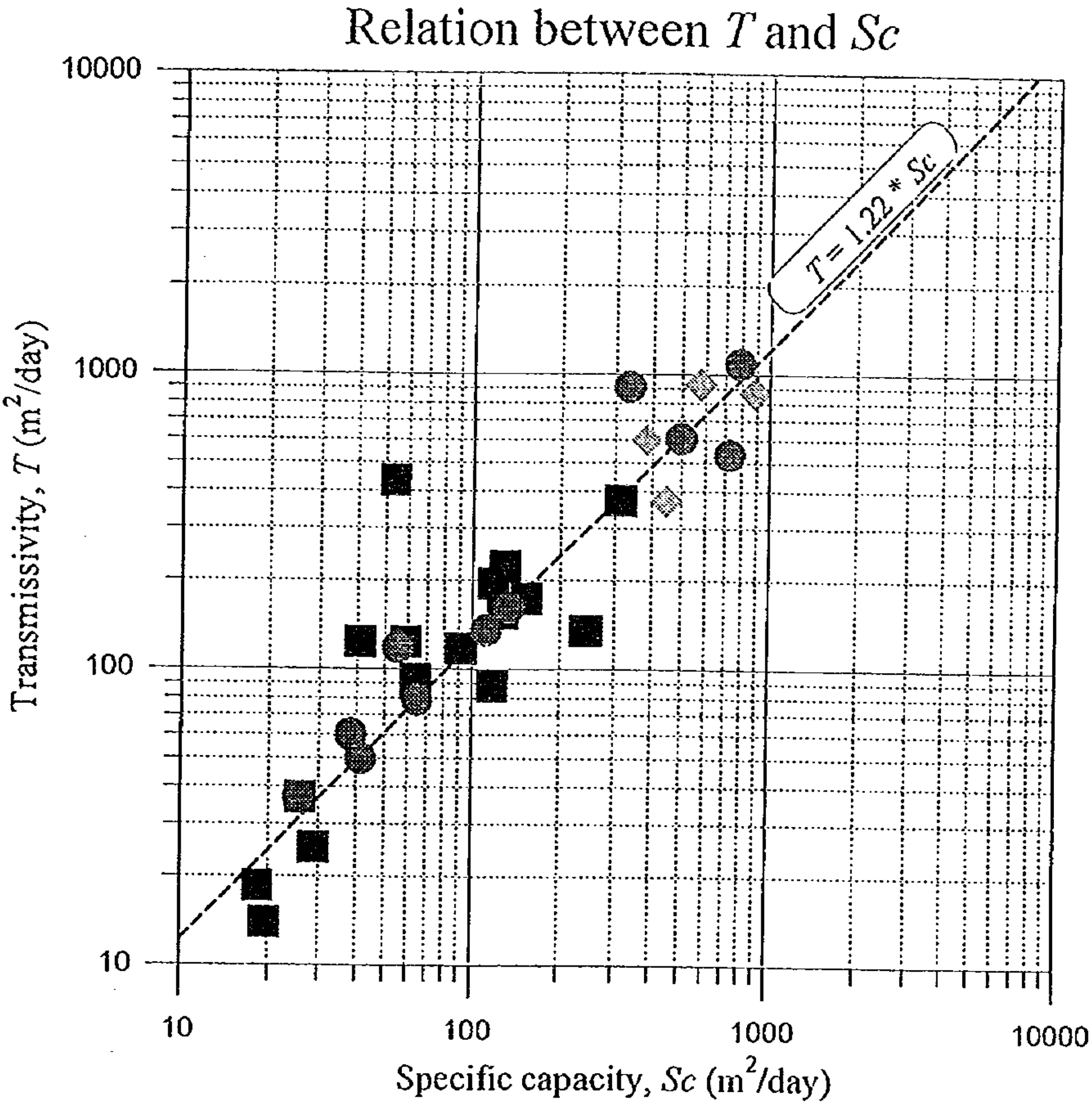


Fig 3.1.1.7	DISTRIBUTION MAP OF SPECIFIC CAPACITY
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)	

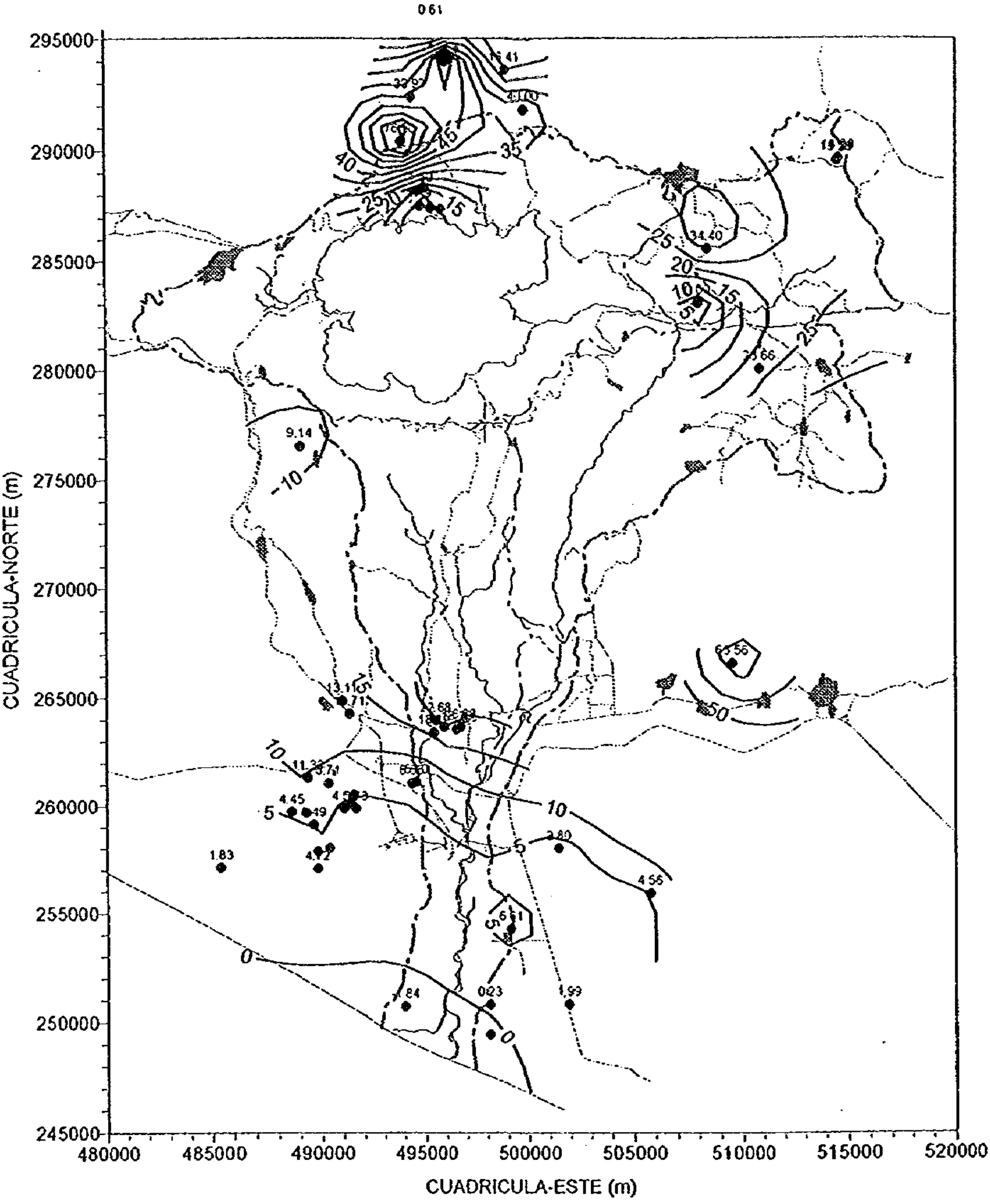


● Wells located in upstream area ($T = 1.234\ Sc$)

◈ Wells located in El Rosario area ($T = 1.165\ Sc$)

■ Wells located in downstream area ($T = 1.189\ Sc$)

Fig.3.1.1.8	RELATION BETWEEN TANSMISSIVITY AND SPECIFIC CAPACITY
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)	



10.25 Location of existing well with depth to groundwater level from ground surface (in meter)

Fig.3.1.1.9	DEPTH TO GROUNDWATER LEVEL AT EXISTING WELLS
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)	

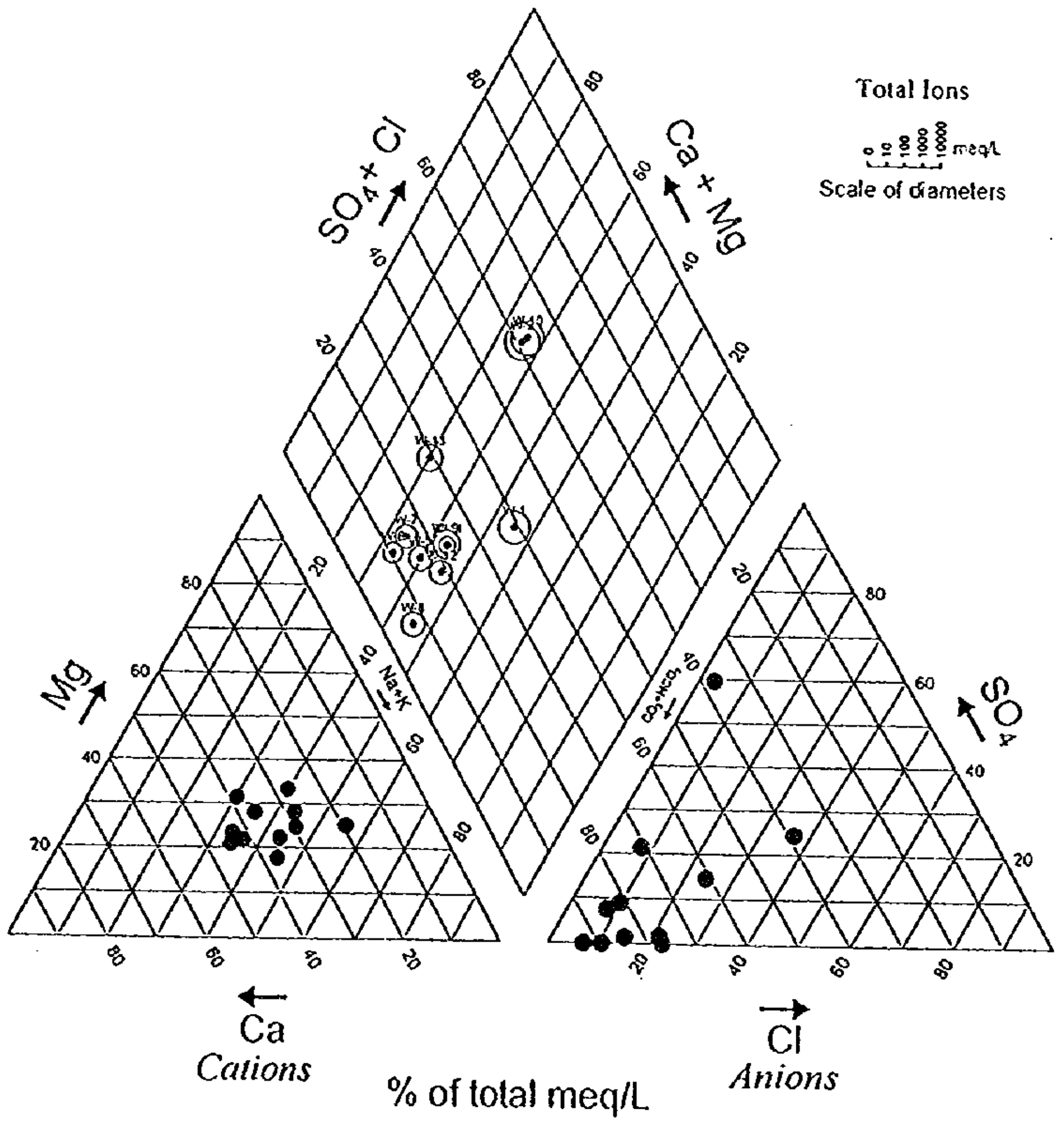


Fig.3.1.1.10	TRILINEAR DIAGRAM OF GROUNDWATER (October 1996)
AGENCIA COOPERATION INTERNATIONAL DEL JAPON	

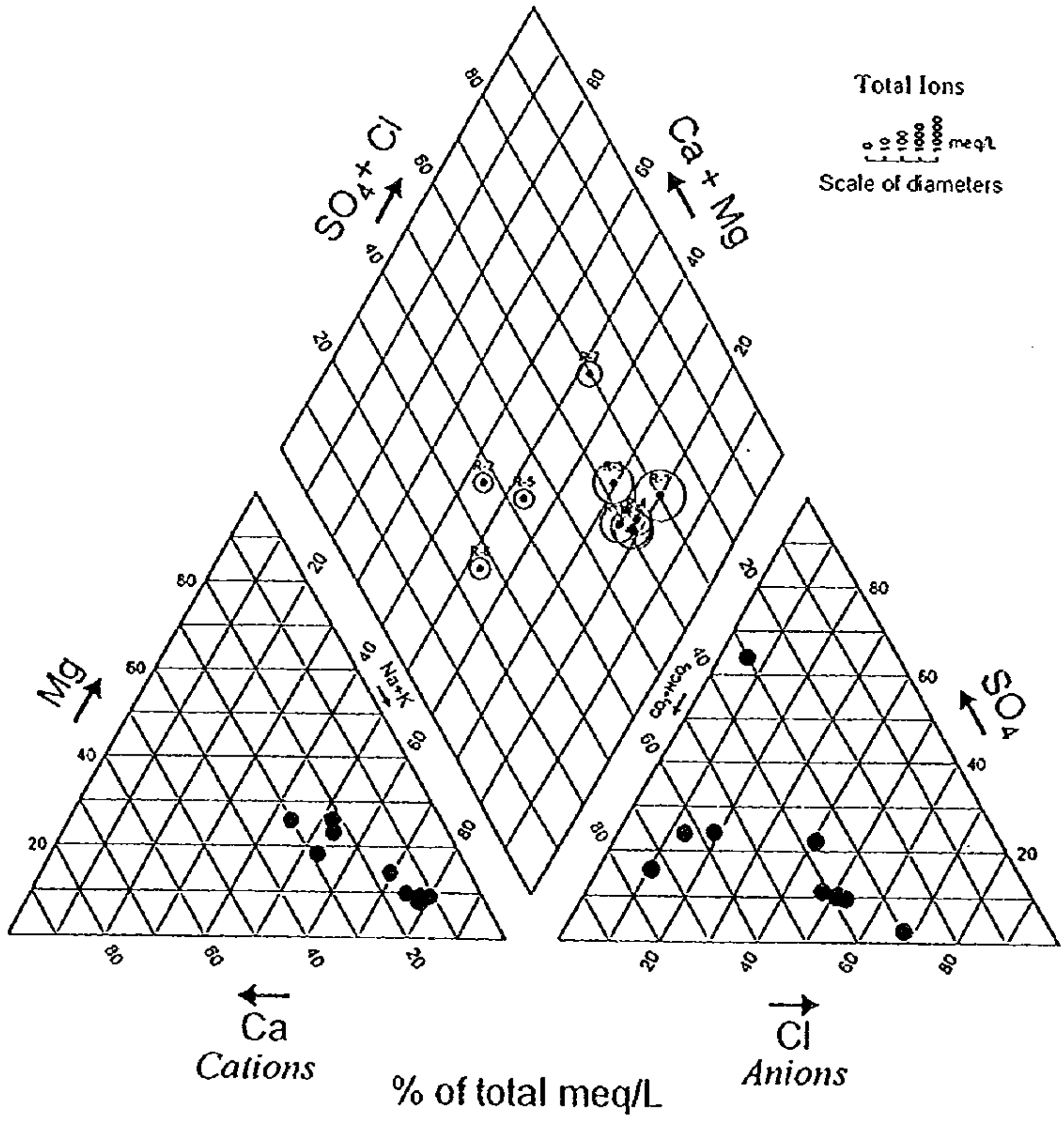


Fig.3.1.1.11	TRILINEAR DIAGRAM OF RIVER WATER (October 1996)
AGENCIA COOPERATION INTERNATIONAL DEL JAPON	

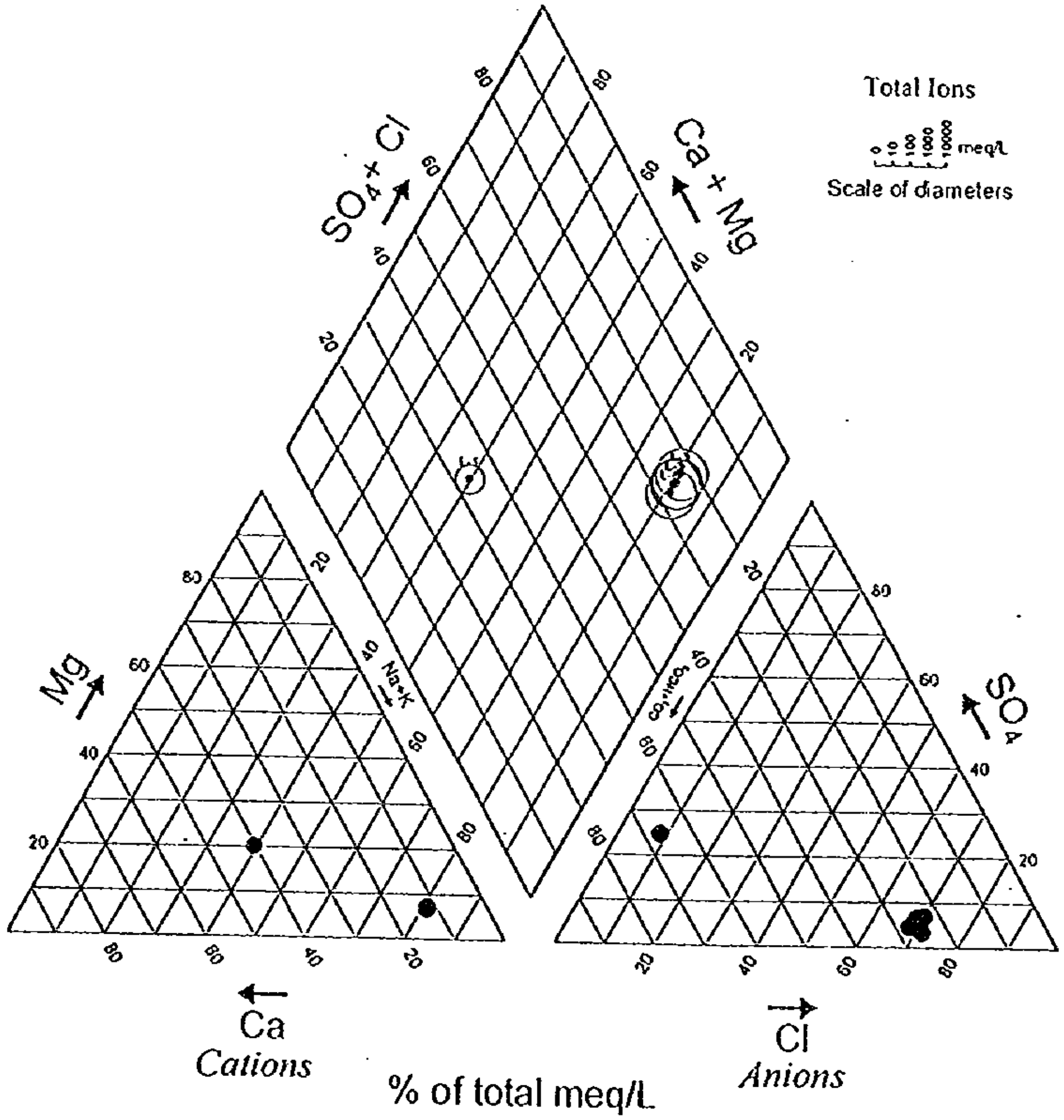
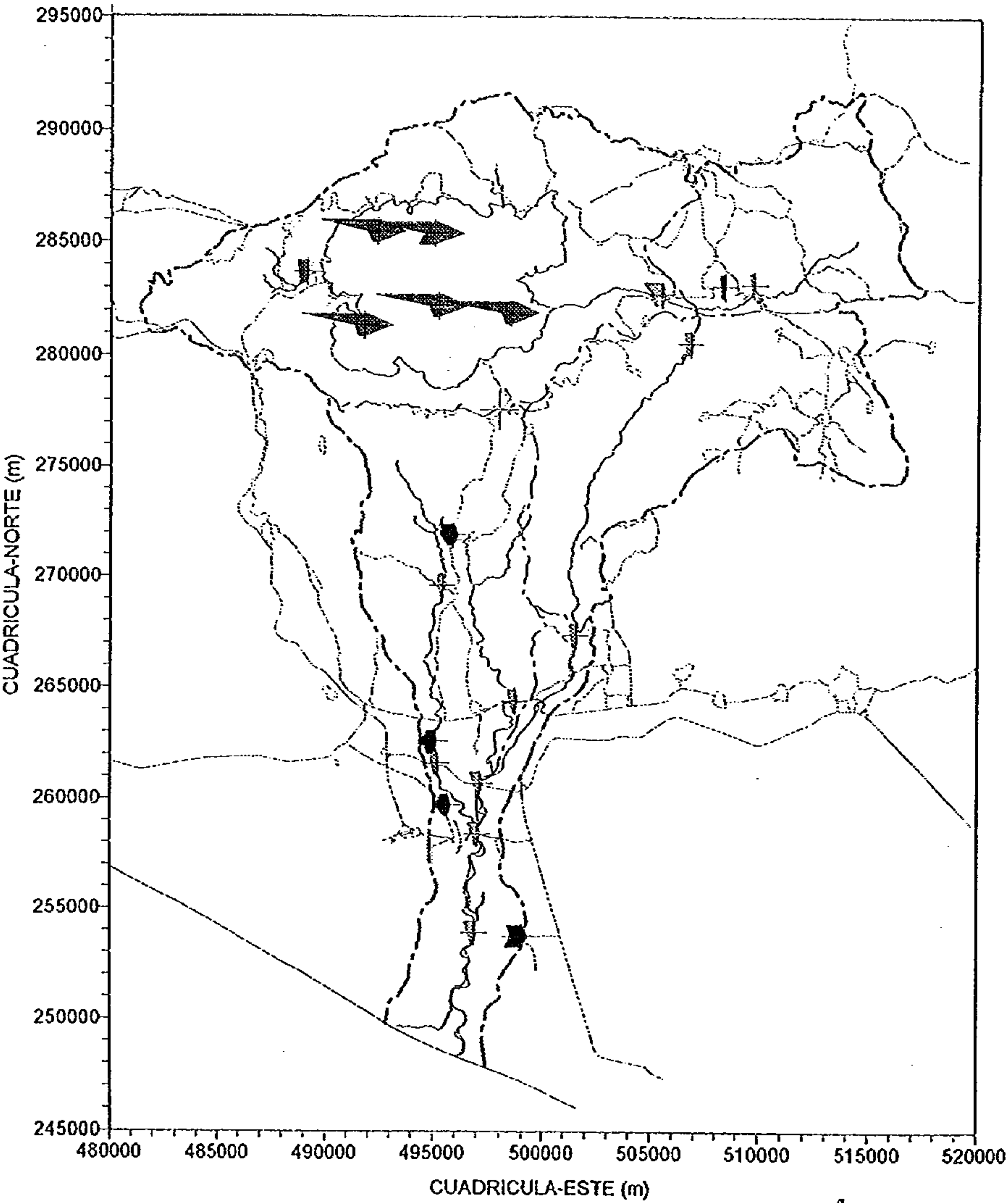
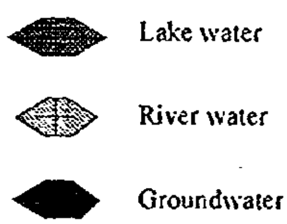


Fig.3.1.1.12	TRILINEAR DIAGRAM OF ILOPANGO LAKE WATER (October 1996)
AGENCIA COOPERATION INTERNATIONAL DEL JAPON	





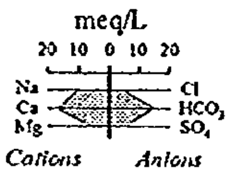


Fig.3.1.1.13	STIFF DIAGRAM OF WATER SAMPLES (February 1996)
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)	

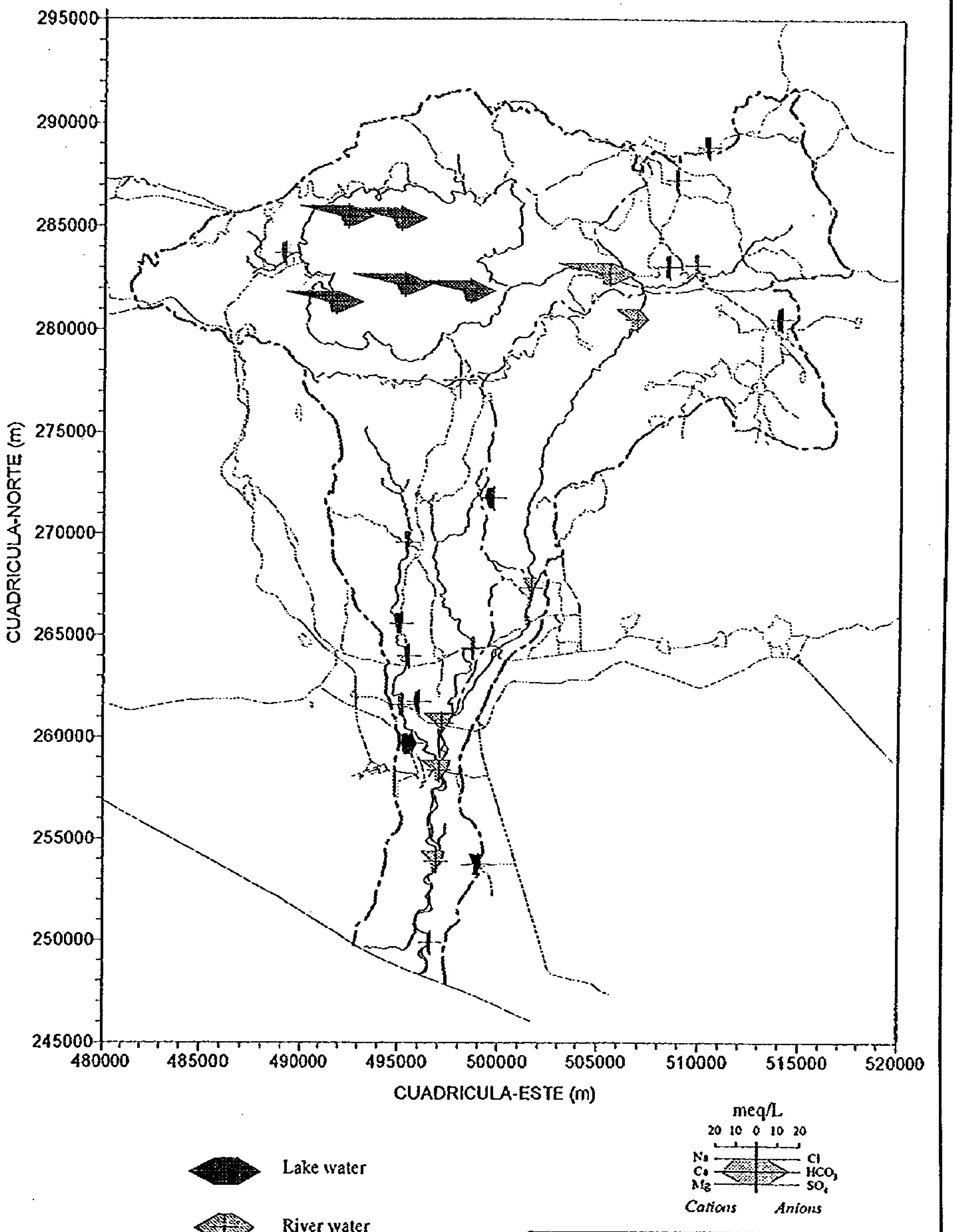


Fig.3.1.1.14	STIFF DIAGRAM OF WATER SAMPLES (October 1996)
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)	

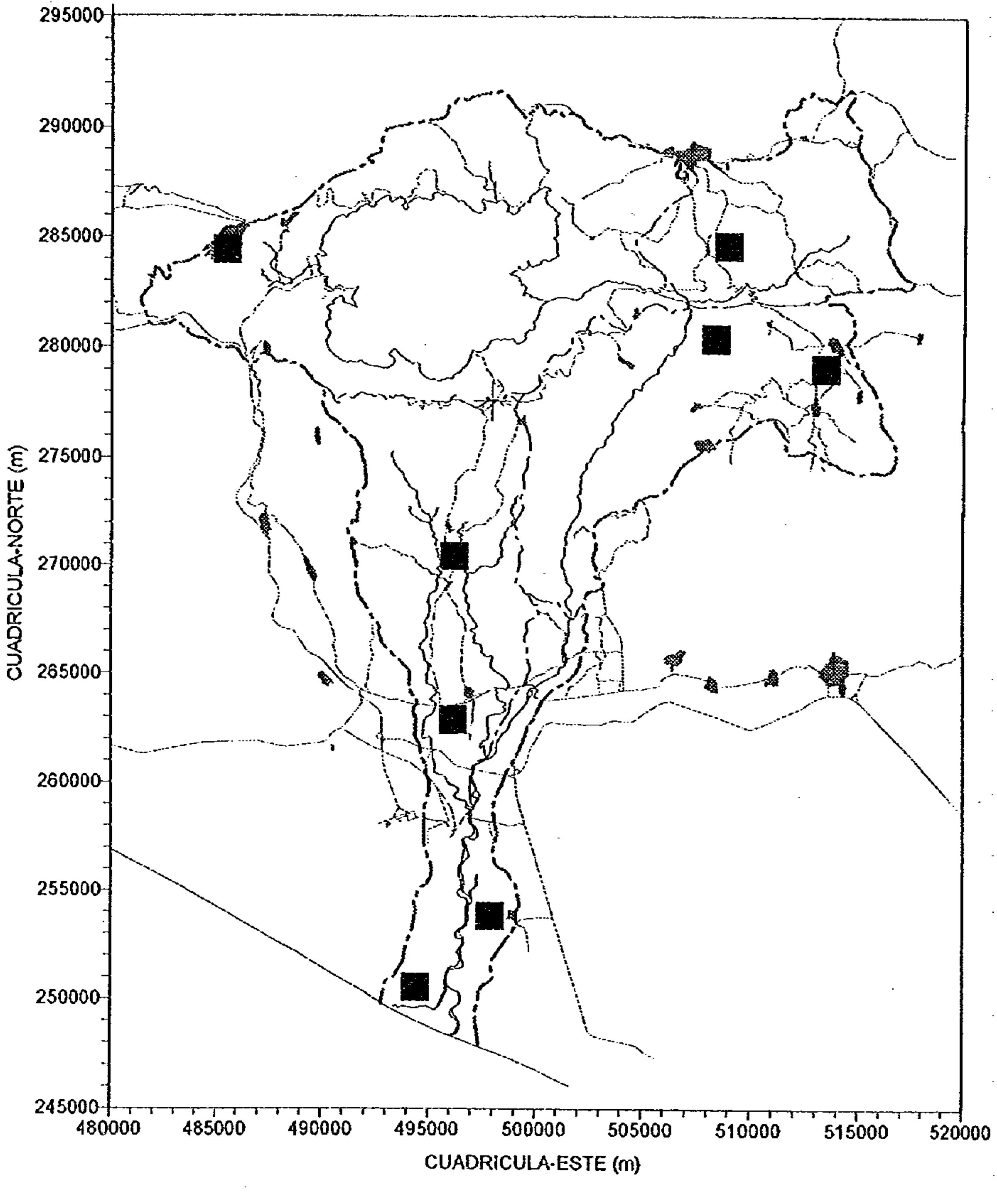


Fig.3.1.1.15	PROPOSED LOCATIONS FOR GROUNDWATER MONITORING WELLS
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)	

3.1.2 Meteorology

The climate in the Study Area is divided into the rainy and the dry season, with the former lasting from May to October and the latter from November to April. Although the area is reported to have an annual mean precipitation of 1,753 mm, the Cojutepeque meteorological observation station indicates a maximum annual precipitation of 1,936 mm, while the Ilopango meteorological observation station records a minimum annual precipitation of 1,373 mm. Six (6) percent of the annual rainfall amount falls in the dry season.

The annual temperature in the Study Area varies by elevation. The downstream area where the international airport is situated has a mean annual temperature of 26.5°C, a maximum temperature of 39.8°C, and a minimum temperature of 14.0°C. In Ilopango, which is located in the upstream area, the mean annual temperature is 23.0°C, the maximum temperature 38.6°C, and the minimum temperature 10.2°C. It is comparatively hot in the Study Area from March to August, during which March and April are the hottest, and considerably cool from September to February, with December as the coolest.

The area has a mean annual humidity rate of 76%. Humidity is high from May to November and low from December to April -- a pattern that relatively corresponds to the dry and rainy season.

Table3.1.2.1 Meteorological Data from the Ilopango Meteorological Observation Center

Ilopango	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall (mm)	4	3	9	44	152	285	327	305	341	239	36	9	1754
Mean Temperature (°C)	22.1	22.6	24.0	24.4	24.2	23.3	23.2	23.1	22.8	22.7	22.3	21.9	23.0
Maximum Temperature (°C)	10.2	10.5	12.0	13.4	15.3	16.6	12.5	12.6	15.0	14.1	12.0	10.8	10.2
Minimum Temperature (°C)	34.4	34.6	35.6	36.2	36.0	33.2	33.4	34.0	33.2	33.7	34.5	32.5	36.2
Humidity	67	68	70	71	82	85	82	83	86	83	76	70	76

Meteorological observations in the surrounding vicinity of the study area are carried out by the Natural Resources Department of the Ministry of Agriculture and Livestock, the Lempa Hydroelectric Power Committee (CEL), the Salvador Foundation for Studies on Coffee, and the University of El Salvador. These institutions focus on several subjects, e.g., rainfall measurements, partial observations of general weather conditions, and observations of essential factors affecting weather conditions. Of the 15 meteorological observation stations in the Study Area, only 10 are in operation (See Figure 3.1.2.1). And of the operating observation stations, the El Rosario, El Carmen, and San Jacinto observation stations only conduct simple rainfall measurements. Further, data from these three stations are considered unreliable because they are operated by residents on a voluntary basis. The El Carmen meteorological observation telemeter established by CEL late last year hardly has any data and is currently undergoing repair. With the exclusion of the La Providencia University observation station situated within the vicinity of the new international airport, meteorological data from the Ilopango, Cojutepeque, and the New International Airport observation stations are considered reliable. Cojutepeque uses auto-recording instruments and is operated by inexperienced volunteers, hence data from this station are deemed slightly unreliable in respect to operation and maintenance and equipment layout.

With the operating meteorological observation stations in the Study Area, the basin area was divided into 3 zones using the Thiessen division method. The mean annual rainfall was set at 1,753 mm.

Table 3.1.2.2 Current Condition of Meteorological Stations

Code	Name	Category	Basin	Location	Year Established	Remarks
S10	Aerop. Ilopango	CP3	A	San Salvador	1953	operating but needs new equipment
P	Finca La Providencia	CP3	A	La Paz	1972	operating; needs to be incorporated into the national network; automation recommended
C1	San Rafael Cedros	P	B	Cuscatlan	1932	closed in 1979
C9	Cojutepeque SM	CO3	A, B	Cuscatlan	1969	operating but needs new equipment
C12	Canton Buena Vista	P	A	Cuscatlan	1972	closed in 1977
P3	Rosario de La Paz	P	E	La Paz	1960	operating
P9	San Miguel Tepezones	P	A, E, C	La Paz	1968	closed in 1978
P10	Paraiso de Osorio	P	C	La Paz	1968	closed in 1980
P11	Hacienda Astoria	CO3	D	La Paz	1970	closed in 1979
P14	Aeropuerto El Salvador	CP3	D	La Paz	1980	operating
V1	Molineros	P	C	San Vicente	1936	closed in 1980
V3	Finca San Jacinto	P	C	San Vicente	1951	operating; installation of pluviometer recommended
V4	Finca El Carmen (MAG)	P	C	San Vicente	1951	operating; closure recommended
	Finca El Carmen (CEL)	CP3	C	San Vicente	1995	undergoing adjustment works
	Finca El Carmen (Pro- Café)	CP3	C	San Vicente	1996	operating

Note: CP3: Principal Meteorological Station
CO3: Ordinary Meteorological Station
P: Pluviometric Station

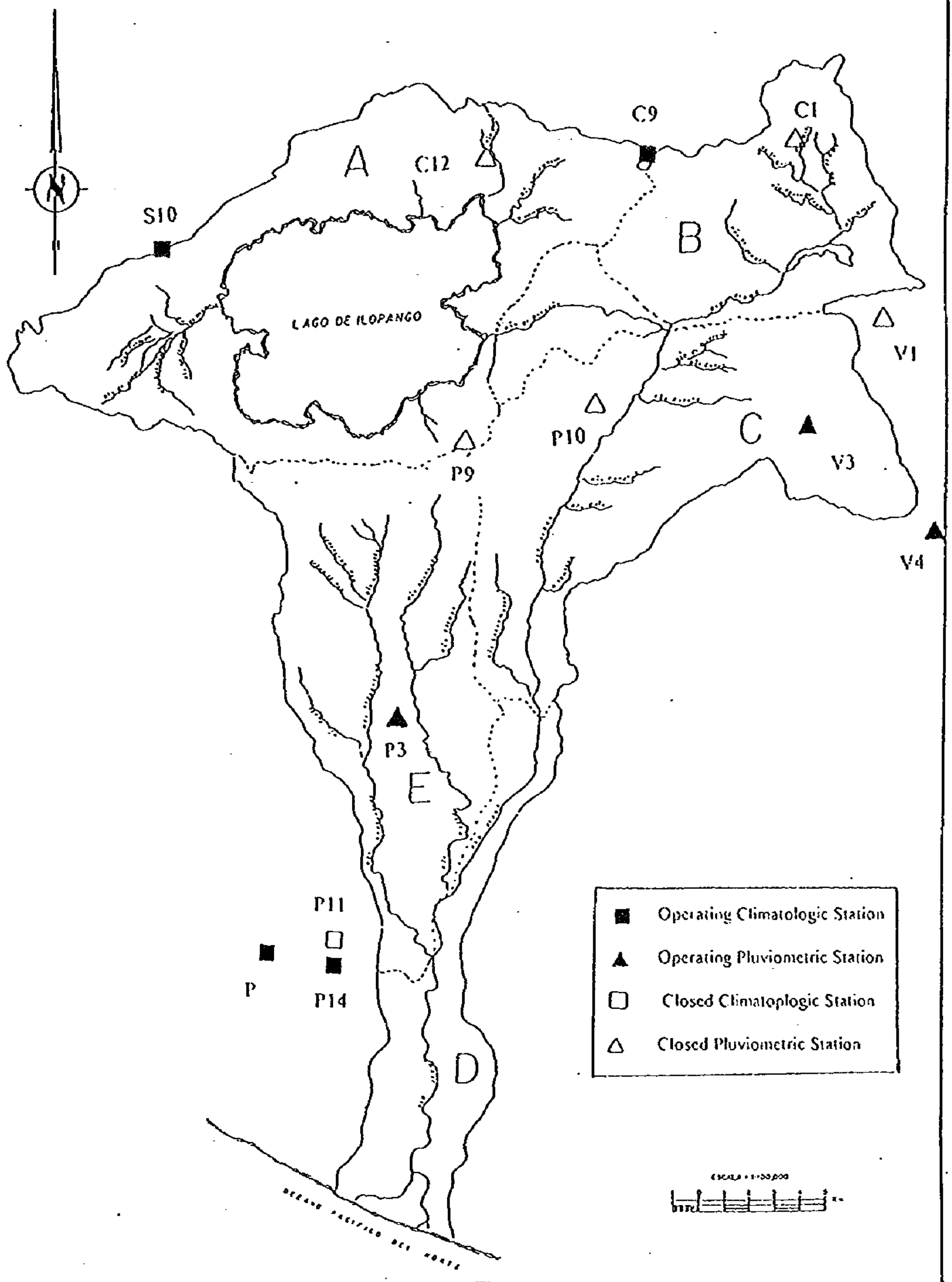
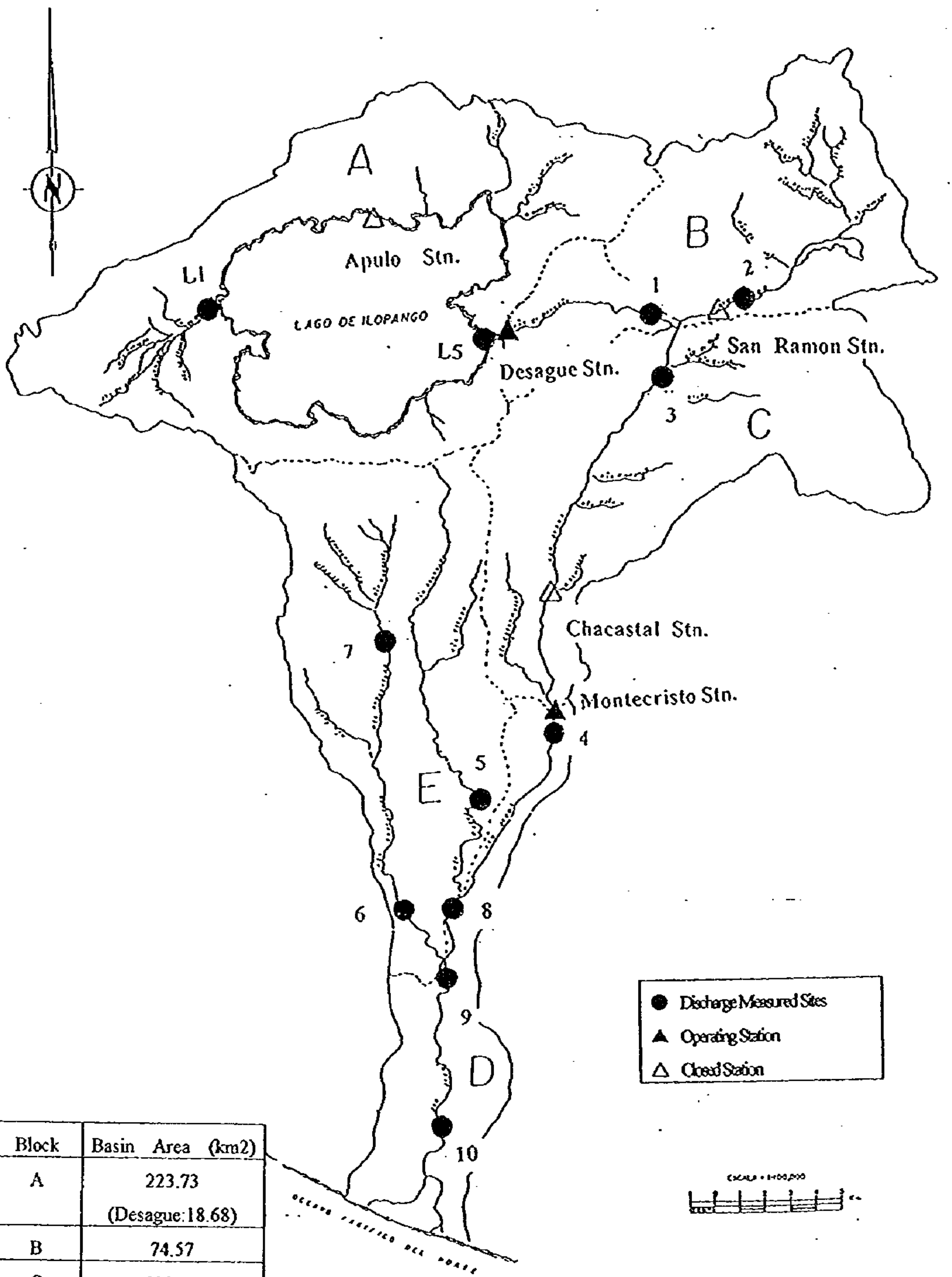


Fig 3.1.2.1

Location of Existing Meteorological Stations

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)



Block	Basin Area (km2)
A	223.73 (Desague:18.68)
B	74.57
C	131.11
D	56.86
E	119.32
Total	606.59

Fig.3.1.2.2

Existing Hydrologic Stations & Measured Sites

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)

(2) Hydrology

Jiboa River originates from San Rafael Cedros, which is 700 m above sea level, and flows into the Pacific Ocean. It measures 61.5 km, has a catchment area of 605.6 km² and a river density of 0.92. The flow of Ilopango Lake, a caldera lake with a catchment area of 223.73 km², joins the main current of the Jiboa River as it merges with the Desague River. The main tributaries of the Jiboa River are: the Chorreron River originating from San Vicente Volcano, and the Tilapa and Sepaquiapa rivers flowing from southern Ilopango.(See Figure 3.1.2.2)

The Montecristo runoff observation station has been measuring the water level and runoff of Jiboa River since 1978. However, the station has no data for the 1985 - 1992 period. Accordingly, the 1972 - 1982 water level and runoff data taken by the San Ramon observation station upstream were used. Of the tributaries of Jiboa River, only the water level and runoff data of the Desague River were available. The table below shows the mean annual runoff data obtained from the Montecristo observation station.

Observation Station	Catchment Area Covered	Mean Annual Runoff	Mean Annual Rainfall	Runoff Ratio
Montecristo	429.41 km²	142.62 MCM	1,753 mm	18.95%

The table below shows the average monthly runoff data obtained from the Montecristo observation station. In correlation to the monthly rainfall distribution, runoff in the Jiboa River peaks in August, September and October. According to the observation station records, the total annual runoff amount varies from 105 million m³ (MCM) to 237 million m³ (MCM). Influenced by fluctuations in rainfall, the annual runoff ratio varies from 0.14 to 0.26.

Average Monthly Runoff Data from the Montecristo Observation Station

(Unit: MCM)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
4.76	3.11	3.15	3.15	5.46	11.82	13.63	20.48	30.57	27.78	11.95	6.76	142.62

The results of the annual rainfall frequency analysis conducted at the Ilopango meteorological observation station conclude the following: ① a rainy year means an annual rainfall runoff amount close to a 5 year excess probability value, ② a dry year means an annual rainfall runoff amount close to a 5 year non-excess probability value, and ③ the monthly runoff and specific runoff in a normal, rainy, and dry year, by using the mean value of acquired data as mean annual runoff, are as shown in the following table, based on the monitoring list of the Montecristo observation station.

Table 3.1.2.3 Monthly and Specific Runoff Data at Montecristo Observation Station

	Monthly Runoff (MCM)			Specific Runoff ($m^3/s/km^2$)		
Month	Normal Year	Rainy Year	Dry Year	Normal Year	Rainy Year	Dry Year
January	4.76	5.81	5.72	0.00414	0.00505	0.00498
February	3.44	3.98	3.98	0.00331	0.00383	0.00383
March	3.15	3.63	3.45	0.00274	0.00315	0.00300
April	3.25	3.78	3.79	0.00292	0.00339	0.00340
May	5.46	7.75	9.21	0.00474	0.00673	0.00801
June	12.22	25.27	11.98	0.01098	0.02271	0.01076
July	13.63	11.15	10.64	0.01185	0.00970	0.00925
August	20.48	17.48	11.70	0.01780	0.01520	0.01017
September	31.58	35.84	25.00	0.02838	0.03220	0.02246
October	27.78	22.17	24.50	0.02415	0.01927	0.02130
November	12.35	11.50	10.27	0.01110	0.01033	0.00922
December	6.76	7.98	5.96	0.00588	0.00694	0.00518
Year	144.87	156.33	126.18	0.01067	0.01154	0.00930

The mean annual runoff in the entire basin area is estimated at 200.96 MCM, by adding the rainfall amount in the Jiboa River basin (605.6 km^2) and the mean runoff ratio (0.1894) recorded by the Montecristo runoff observation station. The table below shows the specific runoff calculated by the Montecristo runoff observation station and the utilizable water volume of the main rivers and tributaries, calculated based on their respective recharge area. In a normal year, 69% (98.45 MCM) of the basin runoff makes up the water volume supplied to areas within the basin. However, the runoff volume in the dry season is only 23% of the said amount.

Table3.1.2.4 Utilizable Water Volume of Jiboa River and Tributaries

Name of River	Water Recharge Area (km²)	Normal Year (MCM)		Rainy Year (MCM)		Dry Year (MCM)	
		Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season
Jiboa River Upstream	74.57	5.86	19.30	6.37	20.78	5.76	16.15
Chorreron River	42.12	3.31	10.90	3.60	11.74	3.25	9.12
Amohapa River	13.25	1.04	3.43	1.13	3.69	1.02	2.87
Timiaya River	10.49	0.82	2.72	0.90	2.92	0.81	2.27
Chicomulingo River	10.01	3.64	12.00	3.96	12.92	3.58	10.04
Tilapa River	44.15	3.47	11.43	3.77	12.30	3.41	9.56
Sepaquiapa River	65.47	5.14	16.95	5.59	18.24	5.06	14.18

(3) Flood Runoff Analysis

A practical formula was used for flood runoff analysis, the results of which are shown in the table below.

Table 3.1.2.5 Peak Runoff Discharge during Flood Time

Code No.	Name of Basin	Basin Area (km²)	Watercourse (km)	Peak Runoff Discharge (m³/sec)			
				1/100	1/50	1/30	1/10
B	Jiboa River Upstream	74.57	18.44	157	143	133	112
A-1	Ilopango Lake	205.05	-	11	9	8	7
A-2	Desague River	18.68	7.30	26	23	22	18
C-1	Chorreron River	42.12	14.31	82	75	70	59
E-1	Tilapa River	53.85	21.24	111	104	98	86
E-2	Sepaquiapa River	65.47	23.78	131	121	114	97
	River Mouth	605.59	61.51	736	679	637	548

As can be seen from the above table, the results of the flood analysis conclude that the total runoff from the Jiboa River (B), Tilapa River (E-1), and the Sepaquiapa River (E-2) makes up more than half of the total flood volume.

(4) Long Period Runoff Analysis

This analysis was carried out at the Montecristo observation station, using the tank model. The Jiboa River discharge measured in the Montecristo station was made up of the discharge from the Jiboa basin free of the Ilopango Lake basin discharge, and discharge from the Ilopango Lake basin area. Accordingly, 2 tank models were used for the simulations:

1) Tank Model for Jiboa River

a)	Simulation Period	:	May 1993 to April 1994
b)	Rainfall Data	:	rainfall data of Ilopango Station
c)	Evapotranspiration	:	probable monthly evapotranspiration calculated at the Ilopango Station
d)	Model Adjustment	:	repetitive calculation and adjustment of parameters (discharge orifice coefficient, orifice height) until the value corresponds with the discharge value measured at the Montecristo Station.
e)	Catchment Area	:	224.36 km^2
f)	Model Structure	:	As shown in Figures 3.1.2.3 and 3.1.2.4, lateral orifice discharge refers to discharge into rivers, and bottom orifice discharge refers to ground infiltration.

2) Tank Model for Ilopango Lake

a)	Simulation Period	:	May 1971 to April 1973
b)	Rainfall Data	:	rainfall data of Ilopango Station
c)	Evapotranspiration	:	probable monthly evapotranspiration calculated at Ilopango Station
d)	Model Adjustment	:	repetitive calculation and adjustment of parameters (discharge orifice coefficient, orifice height) until the value corresponds with the discharge value measured at Desague Station and the water level of Ilopango Lake recorded by the Apulo Station.
e)	Catchment Area	:	Lake Ilopango - 70.48 km^2 Ilopango Basin - 134.57 km^2
f)	Model Structure	:	As shown in Figures 3.1.2.3 and 3.1.2.4, the 2 tank models (Model A for the Ilopango lake basin area and Model B for the Ilopango Lake) are parallel to each other. The lateral orifice discharge of Model A is used in Model B and the bottom orifice discharge refers to ground infiltration. The lateral orifice discharge in Model B refers to discharge from Ilopango Lake flowing into the Desague River, and bottom orifice discharge refers to ground infiltration.

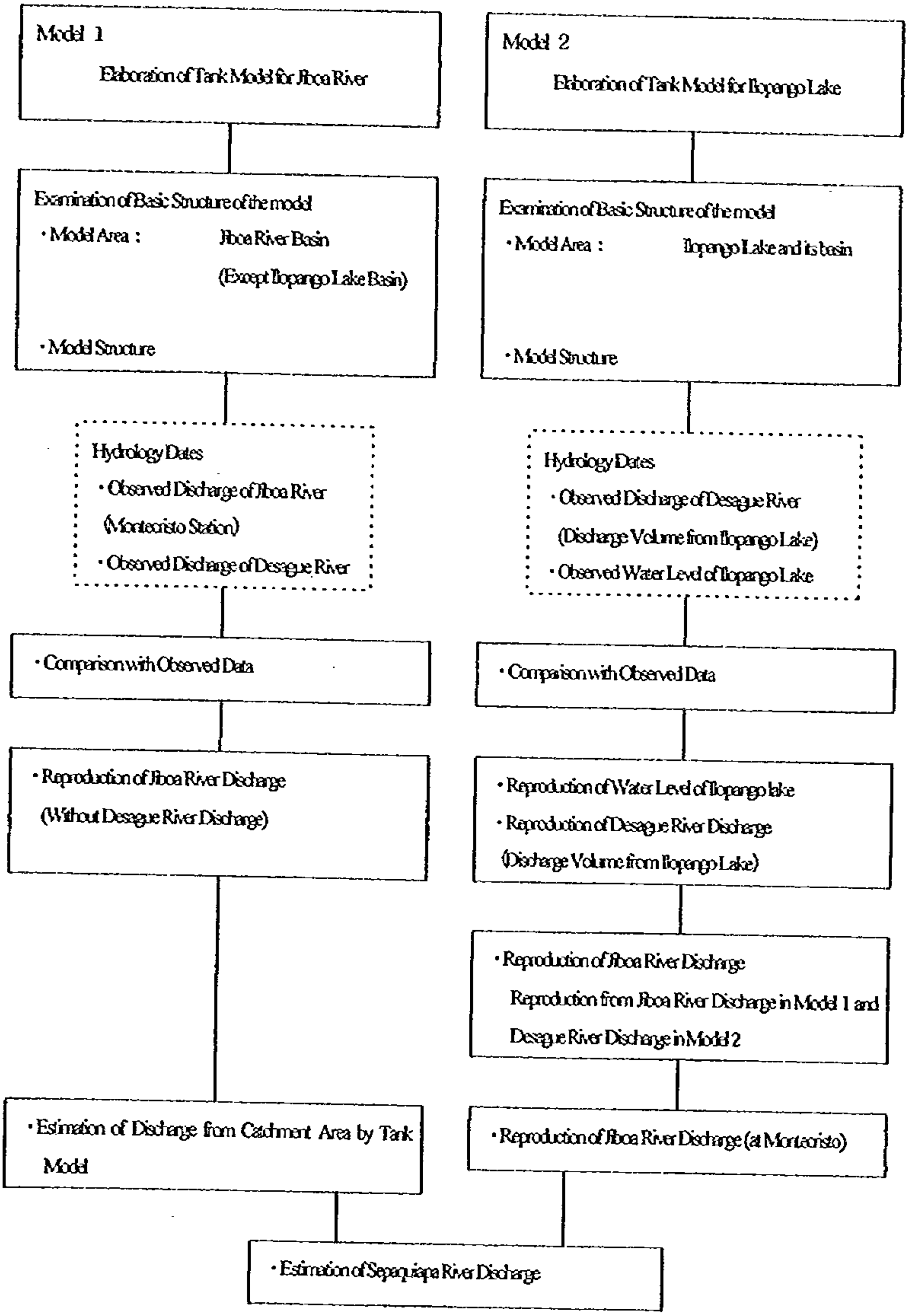


Fig.3.1.2.3 Flow Chart for Elaboration of Tank Model

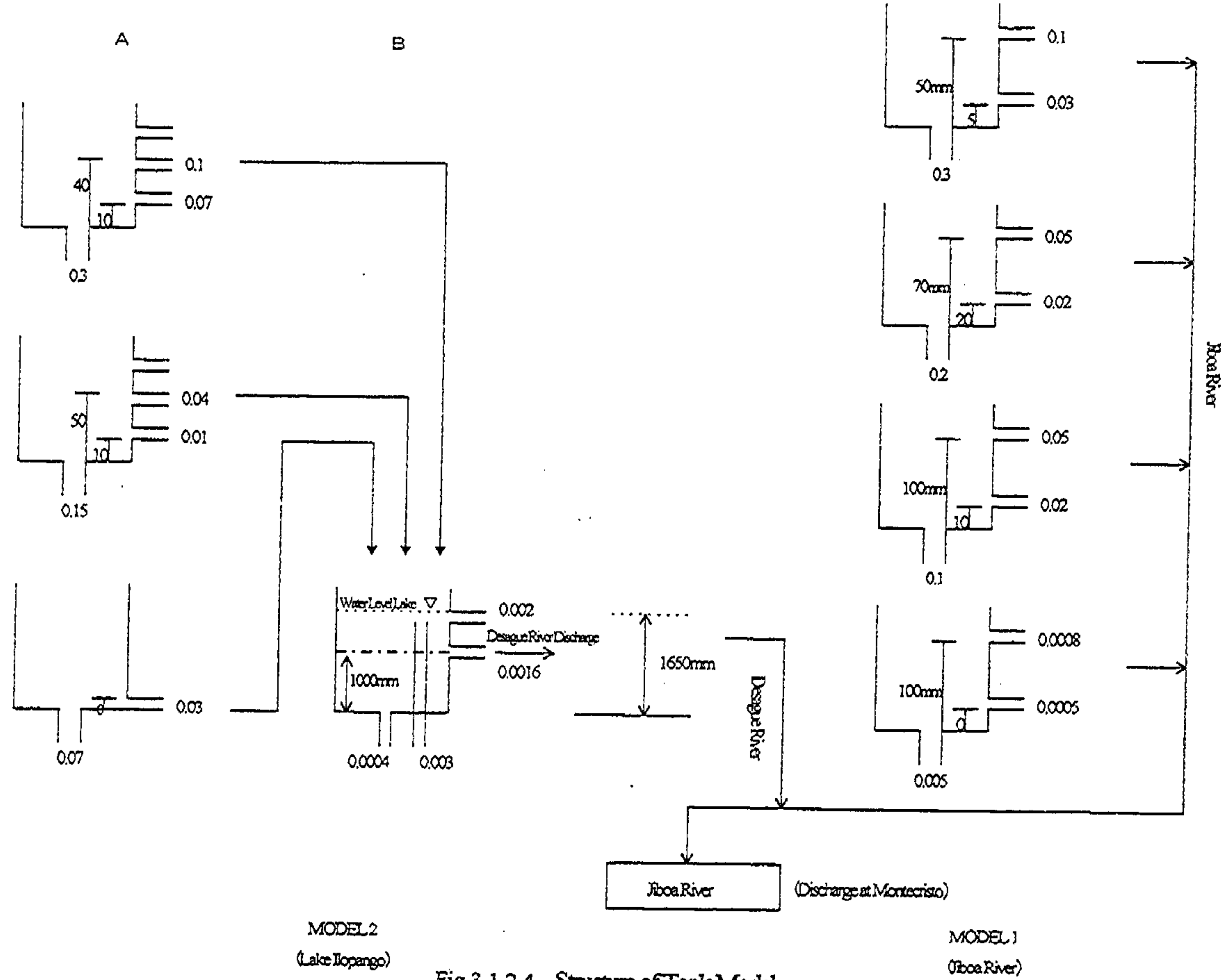


Fig.3.1.2.4 Structure of Tank Model

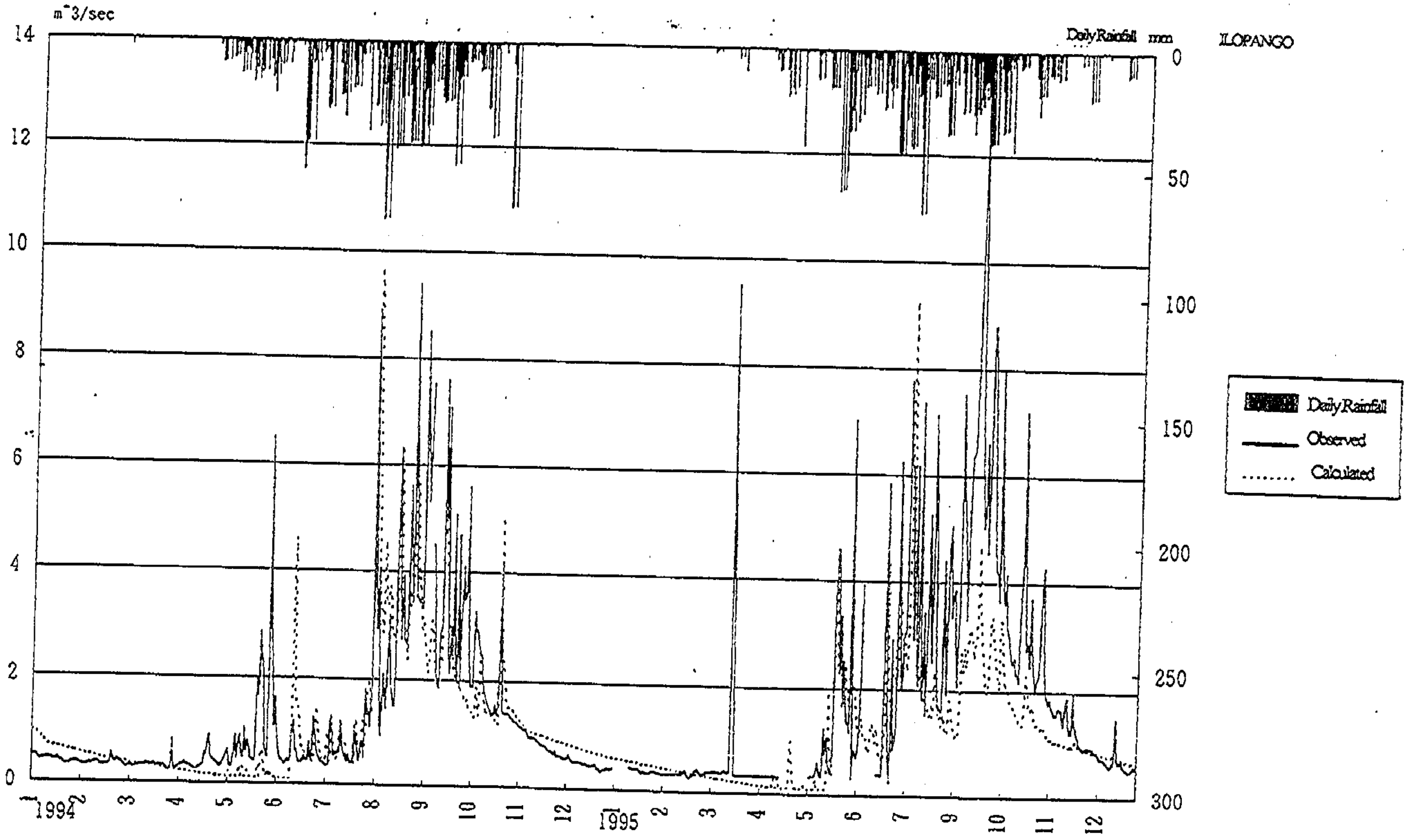


Fig.3.1.2.5 Simulation of Discharge in 1994-1995 (With Desague Discharge)

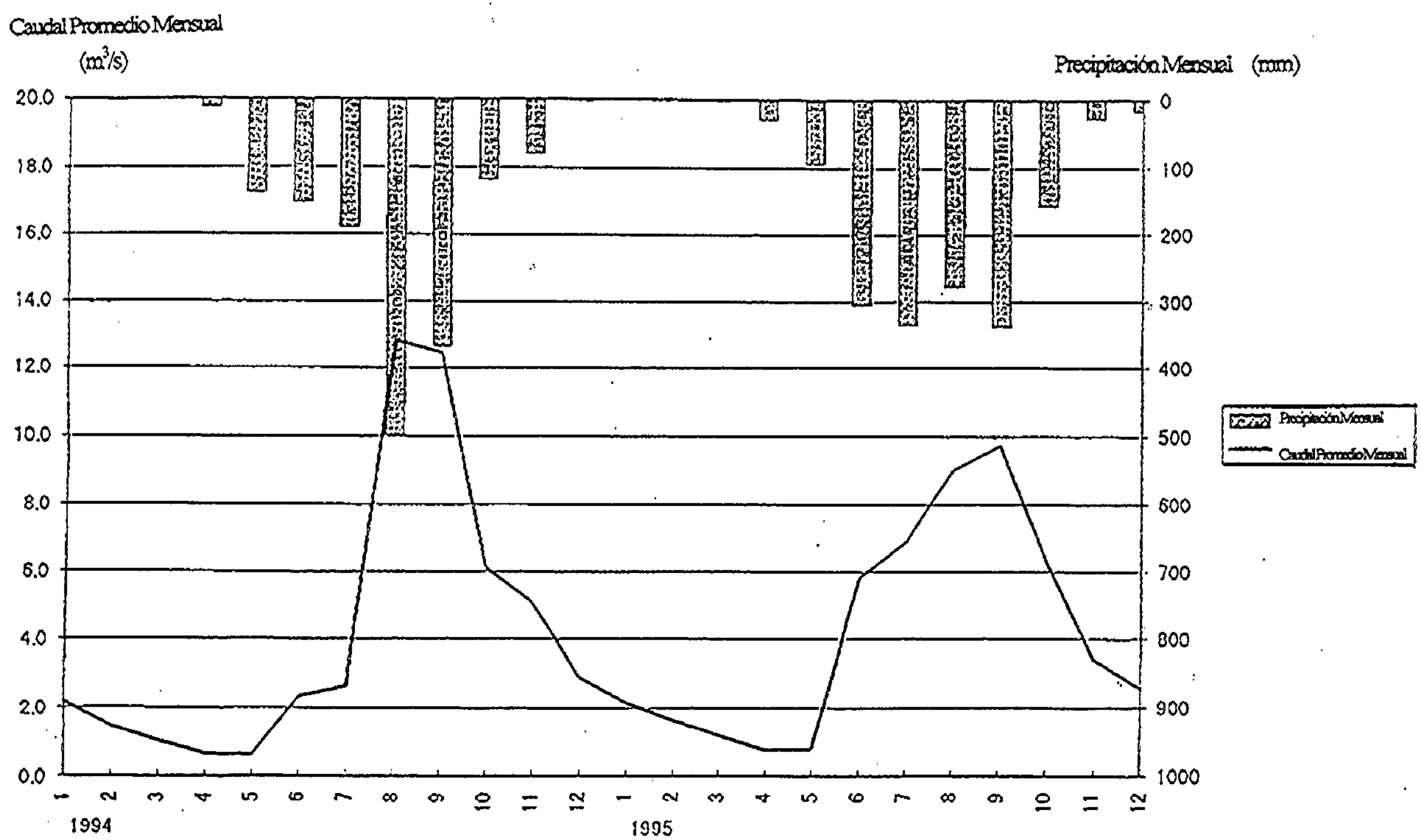


Fig.3.1.2.6 Caual Estimado Mensual del Río Sepaquiapa

3.1.3 Land Use ▪ Soil

(1) Land use

To get a better understanding of the relation between gradient and land use, spot images from January and March of 1996 were obtained and analyzed. A digital terrain model was made from images taken on March 11 and 22 to define slope division and obtain contour lines. The current land use map (cover pages) is based on information from spot images of January 15, 1996 and data from the field survey during the same time. In addition, total areas within each land use category for each slope division were calculated (cover page).

Land use patterns in the Study Area are divided into: a) farmland, b) pasture (natural pasture, tame pasture), c) forest, d) urban area, e) lake, ponds and river, and these account for 36 %, 9 %, 40 %, 4 %, 12 % of the Study Area, respectively. Ilopango Lake makes up the majority of lake, ponds and river at 71.2 km^2 and accounts for 12 % of the Study Area. The remaining lake, ponds, and river are negligible (less than 1 %) by comparison.

1) Distribution of arable land, pasture and forests according to gradient

The distribution of farmlands, pastures and forests in each slope is shown in Table 3.1.3.2.

53 % of the land has a gradient of 0-10% (referred to as arable herein), 21 % a gradient of 11-25 % (referred to as sloped herein), and 26 % inclines at a gradient of 26 % or more (referred to as steep slope herein). Soil erosion prevention measures are needed for lands with a slope of more than 11 % (DGRNR). Blocks A, C, and E contain the most arable land with some sloped and steeply sloped lands. Therefore these blocks are judged to be most suitable for cultivation.

75% of the pastures have a gradient of 0-14 %, and 11 % is steeply sloped. D and E blocks contain the most significant distribution of pasture land. In D block, where land is flooded by the Jiboa River in the rainy season, pasture land accounts for 1,820 ha, or 32 % of the area. 34% of the forests have a gradient of 0-10%, while 25 % are sloped and 40 % steeply sloped. Forests are mostly distributed in A and C blocks, and only about 2% in D block.

As outlined above, the Study Area contains considerable forests, 65 % of which are distributed in lands with a slope of more than 11 %. Sloped and steeply sloped lands do not infer the absence of forest on the hillsides of the mountains.

However, some soil erosion prevention measures by agroforestry, are necessary, because the steeply sloped lands are arable and sloped lands are used for pasture. This is especially true in E block, where only few forests exist and most of the sloped and steeply sloped areas are cultivated or used as pastures.

2) Geographic features and present land use

The geographic features in the basin can be classified as follows:

a) Crater lake, crater wall of Ilopango volcano,
b) San Vicente volcano
c) Plains at the foot of San Vicente volcano
d) Coastal plains
e) Dissected plateau

A Block

The characteristic features in this block are a caldera lake, Ilopango Volcano, a caldera cliff, and a somma. San Salvador, the capital of El Salvador, is located along the northwest edge of A block. Due to urbanization, factories and collective housing have been built in Ilopango, San Marcos, and San Martín which comprise part of the San Salvador metropolitan area. As for the area surrounding Santo Tomás which is along the expressway to the international airport, maize and field beans including vegetables and roses marketed in the capital are grown. The caldera lake area near San Salvador has been developed as a tourist site, and is constructed with hotels, restaurants, a golf course, and a jetty.

Coffee and fruit trees are grown on the southern half of the Ilopango lake area and around the somma. Candelaria, along the east shore of the Ilopango lake, is particularly famous for the production of citrus fruits such as oranges. Moreover, large-scale poultry farming is conducted in the southern half of Ilopango lake and Cojutepeque. Chicken droppings from these large-scale poultry farms are used as organic fertilizer by some farmers cultivating vegetables and fruit trees.

B Block

This block is situated on a progressively dissecting plateau. The cities of Cojutepeque, San Rafael Cedros, and Santo Domingo are located along the Pan American highway which runs along the north edge of the Study Area. More importantly, Cojutepeque functions as a collection and distribution city for vegetables and fruits produced in the surrounding area. Vegetables are grown in addition to maize, field beans and sorghum in San Cristobal and San Ramón. In the dry season, some areas in the latter cultivate vegetables by irrigation using the water from Jiboa River and its tributaries either by use of PVC pipelines or pumping.

C Block

This block consists of the San Vicente volcano, plains on the northern foot of the volcano, and a dissected plateau. Coffee is grown on the hillside of San Vicente volcano while the plains surrounding Verapaz and Guadalupe are chiefly cultivated with sugarcane and partly with maize and field beans. Maize, field beans, some vegetables, fruit trees, coffee, and bananas are grown on the dissected plateau where the main town is San Pedro Nonualco. Pineapple has been grown from way back in Santa Maria Ostuma.

D Block

This block mostly covers the coastal plains. Cotton was grown by large landowners in the coastal plains before the Agrarian Reform. Now, sugarcane and sesame are grown by the cooperative groups and the landowners. To a lesser extent, watermelon and maize are also grown.

E Block

This block is on a dissected plateau. Coffee and fruit trees are grown from the south rim of the Ilopango somma to San Antonio Masahuat. Maize and sorghum are mainly grown around San Pedro Masahuat, and to a lesser extent vegetables.

The dissected plateau is the most common geographic feature used for agriculture in the Study Area. Typical land use patterns on the dissected plateau are illustrated in Figure 3.1.3.1. Villages are structured on the plateau and gently-sloping lands, which are also constructed with roads. Maize, rice, vegetables, fruit trees, coffee, and bananas are grown here, making the region important to agricultural production in the Study Area. A forest partly forms the steeply sloped area between the gently-sloping land and the river where coffee and bananas are also grown. Some vegetables are grown on the river bank terrace. During the dry season, irrigation is carried out using water from Jiboa River upstream and its tributaries, either by pumping or by use of PVC pipes.

The significant differences in land use upstream and midstream are as follows:

a) In the midstream area, the gently sloping section of the steep slope connected to the river bank terrace is partly cultivated with vegetables.
b) As the riverside terraces midstream continue to expand, the elevation approaches that of the surface of the river
c) The cultivation of coffee, field beans and fruit trees will not be possible on the dissected plateau and sloped areas (altitude of less than 400 m) below the midstream area.

3) Present area for crop cultivation

The present area for crop cultivation in farmlands (cultivated lands, orchards, and coffee plantations) was estimated based on the present land use map, field survey, and the farm economy survey (Table 3.1.3.3).

Basic grains are cultivated in large areas in the Study Area and account for about 60% when the fields planted with maize, sorghum, and field beans are combined. Rice accounts for about 2%, and to a lesser extent fruit trees, coffee, and sugar cane are grown.

In A block, the area cultivated with fruit trees and coffee is relatively large compared with other blocks, while vegetables cover a relatively large area in B block in comparison with other blocks. Also, there are significant areas cultivated with fruit trees, sugarcane, and coffee.

In C block, the area cultivated with coffee, fruit trees, and sugarcane is relatively large compared with other blocks.

In D block, the area cultivated with sugarcane, sesame and watermelon is relatively large compared with other blocks, while the area cultivated with basic grains is small.

In E block, the area cultivated with basic grains is relatively large compared with other blocks.

(2) Soil

The soils in the Study Area are mainly formed of pyroclastic materials which originated from the Ilopango volcano, and alluvial soils which originated from pyroclastic materials.

The soils are classified largely into Regosol, Lithosol, Latosol and alluvial soils, with Regosol occupying the largest area.

The A, B, C, and E blocks, which are mostly sloped, are covered by Regosol, Lithosol and Latosol soils. Alluvial soils are distributed in the D block, which is a coastal plain, and their soil texture is sandy loam, silty clay, and light clay. Moreover, soil which is derived from mangrove forests is distributed in the area surrounding the mouth of the Jiboa River.

The soils are characterized by low productivity and high water permeability as defined below:

Regosol: Any soil of the azonal order without definite generic horizons and developing from or on deep, unconsolidated, soft sediment deposits such as sand, loess, or glacial drift.

Lithosol: A group of azonal soils characterized by an incomplete solum or no clearly expressed soil morphology, and consisting of freshly and imperfectly weathered rock or rock fragment.

Latosol: A suborder of azonal soils including soils formed under forested, tropical, humid conditions and characterized by low silica sesquioxide ratios of the clay formations, low base exchange capacity, low activity of the clay, low content of most primary minerals, low content of soluble constituents, a high degree of aggregate stability, and usually a red color.

Table 3.1.3.1 Present land use

Land use	Slope percentage (%)			
	0-10	11-25	> 25	Total
	Area (km^2)			
Cultivated land	113.4	46.1	55.7	215.2
Grass land	38.8	7.3	5.5	51.6
Forest land	83.5	60.9	97.8	242.1
Urban area	16.7	2.9	2.6	22.2
Lakes, marshes and rivers	73.8	0.3	0.2	74.4
Total	326.2	117.5	161.9	605.6
	Ratio (%)			
Cultivated land	34.8	39.3	34.4	35.5
Grass land	11.9	6.2	3.4	8.5
Forest land	25.6	51.8	60.4	40.0
Urban area	5.1	2.5	1.6	3.7
Lakes, marshes and rivers	22.6	0.2	0.2	12.3
Total	100.0	100.0	100.0	100.0

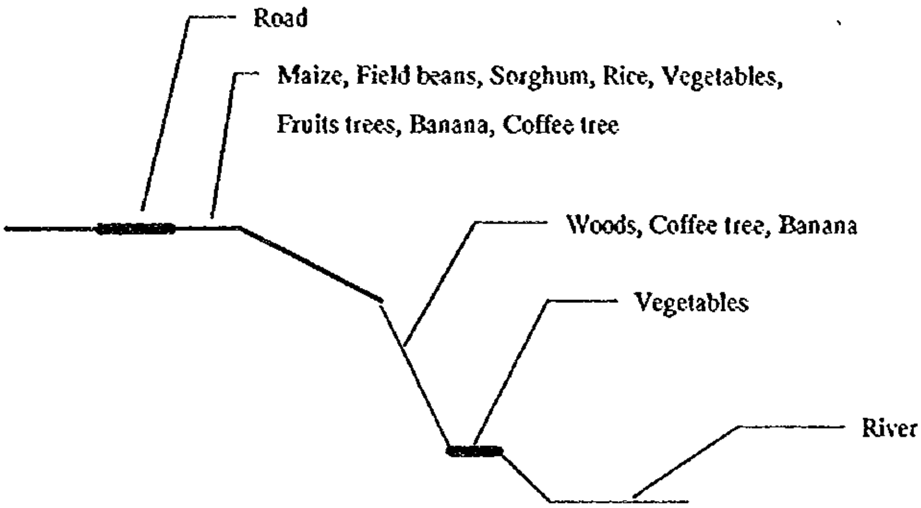
Source: CNES, 1996.01.15, Spot Image, field survey by JICA Study Team (1996)

Table 3.1.3.2 Distribution of cultivated land, grass land and forest land on different slopes

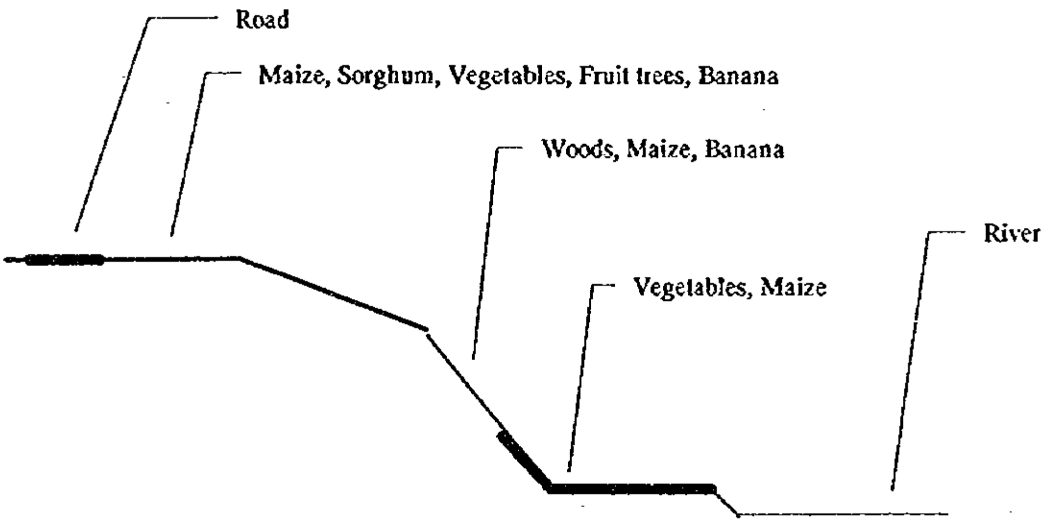
Block	Slope percentage (%)				Slope percentage (%)				Slope percentage (%)			
	0-10	11-25	> 25	Total	0-10	11-25	> 25	Total	0-10	11-25	> 25	Total
	Cultivated land				Grass land				Forest land			
	Area (km^2)				Area (km^2)				Area (km^2)			
A	16	11	18	45	3	1	1	5	27	22	40	89
B	13	10	6	29	4	2	1	6	15	11	10	36
C	25	14	16	55	5	2	2	9	20	18	28	65
D	27	1	1	30	17	0	1	18	5	0	1	6
E	32	10	14	57	10	1	2	13	17	10	19	46
Total	113	46	56	215	39	7	6	52	83	61	98	242
	Ratio(%)				Ratio(%)				Ratio(%)			
A	14	24	31	21	7	16	23	10	32	36	41	37
B	12	22	11	14	9	27	12	12	18	18	10	15
C	22	30	29	25	12	32	27	17	24	29	28	27
D	24	3	3	14	45	5	9	35	6	1	1	2
E	28	22	26	26	26	20	28	25	21	16	20	19
Total	100	100	100	100	100	100	100	100	100	100	100	100
	Ratio(%)				Ratio(%)				Ratio(%)			
A	36	24	39	100	54	21	24	100	30	25	45	100
B	46	34	21	100	58	32	11	100	41	31	28	100
C	45	25	30	100	55	27	18	100	31	27	42	100
D	90	5	5	100	95	2	3	100	82	8	10	100
E	56	18	25	100	77	11	12	100	37	21	42	100
Total	53	21	26	100	75	14	11	100	34	25	40	100

Source: CNES, 1996.01.15, Spot Image, field survey by JICA Study Team (1996)

Upstream



Midstream (altitude from river is about 400 m above sea level)



Source: Field survey by JICA Study Team (1996)

Figure 3.1.3.1 Present Land Use at Upstream and Midstream Basin Areas

Table 3.1.3.3 Present crops planted area in the Study Area (ha)

Crops	Block A	Block B	Block C	Block D	Block E	Total
Basic grains						
Maize	2,453	1,557	2,395	1,126	4,222	11,753
Sorghum	456	139	1,197	212	1,885	3,677
Field beans	1,647	694	898	16	1,093	4,348
Rice	35	31	389	0	113	568
Subtotal	4,591	2,420	4,880	1,354	7,313	20,346
Cash crops						
Sugar cane	-	462	1,168	1,214	-	2,844
Sesame	-	-	30	625	75	730
Ground nut	-	-	-	100	-	100
Fruit trees	1,717	586	1,377	47	980	4,708
Coffee tree	1,483	400	1,841	6	285	4,015
Vegetables	245	308	120	-	264	937
Watermelon	-	-	-	136	-	136
Subtotal	3,446	1,757	4,536	2,128	1,604	13,470
Planted area	8,037	4,177	9,415	3,482	8,918	33,817
Cultivated area	4,451	2,944	5,478	2,995	5,654	21,523
Cropping intensity	1.81	1.42	1.72	1.16	1.58	1.57
			Ratio (%)			
Basic grains						
Maize	30.5	37.3	25.4	32.3	47.3	34.8
Sorghum	5.7	3.3	12.7	6.1	21.1	10.9
Field beans	20.5	16.6	9.5	0.5	12.3	12.9
Rice	0.4	0.7	4.1	0.0	1.3	1.7
Subtotal	57.1	57.9	51.8	38.9	82.0	60.2
Cash crops						
Sugar cane	-	11.1	12.4	34.9	-	8.4
Sesame	-	-	0.3	17.9	0.8	2.2
Ground nut	-	-	-	2.9	-	0.3
Fruit trees	21.4	14.0	14.6	1.4	11.0	13.9
Coffee tree	18.5	9.6	19.6	0.2	3.2	11.9
Vegetables	3.1	7.4	1.3	-	3.0	2.8
Watermelon	-	-	-	3.9	-	0.4
Subtotal	42.9	42.1	48.2	61.1	18.0	39.8
Planted area	100.0	100.0	100.0	100.0	100.0	100.0

Source: CNES, 1996.01.15, Spot Image, field survey by JICA Study Team (1996)

As these soils have high water permeability, sprinkler irrigation is inferred to be more suitable than furrow irrigation in this area.

Ilopango Lake was observed to contain high levels of arsenic concentration. In accordance with this observation, soil samples were extracted from 6 places within the basin and 1 place in the surrounding area for arsenic analysis. Alluvial soil samples of Jiboa River were taken from San Jose Luna and Santa Emilia; alluvial soil samples of the adjacent Lempa River were taken from La Calzada, while the rest of the samples were from places unaffected by the flow of Jiboa River. The results of the soil analysis are tabulated below.

Sampling Areas	Cultivated Crops	Arsenic (As) Concentration (ppm)
San Jose Luna	maize	1.90
San Jose Luna	water melon	3.25
Santa Emilia	sesame	1.60
Santa Anita	maize, cucumber, papaya, loroco	1.92
El Socorro	maize	0.82
San Francisco	maize, field beans	1.60
La Calzada	maize, cucumber	1.40

The study area was found to contain a maximum of 3.25 ppm of arsenic, a value lower than the 15 ppm set for the paddy fields in Japan. Therefore, there is no need to set any limit on the arsenic contents in the area. The arsenic contents in the study area are estimated to originate from the sediments of the volcano in Ilopango.

3.1.4 Natural Environment

(1) Ecosystem of the Study Area

The Jiboa River Basin is classified into 2 types of ecosystems: 1) hot sub-tropical wet forest covering the peri-Ilopango Lake, middle and lower Jiboa River basin below 600 m above sea level, and 2) cool sub-tropical wet forest in the upper basin, more than 600 m above sea level.

(2) Precious Wild Life

Ample species of fauna and flora are identified in the Jiboa River basin, and some mangrove species are observed near the Jiboa River mouth. Currently, the National Park Service of DGRNR has identified 24 mammal species, 46 species of reptile, 179 species of bird, and 18 amphibian species in the said basin (see Annex H-1). Among the identified species, 19 of the mammal species (see Annex H-2-1), 39 of the reptiles (see Annex H-2-2), 66 of the birds (see Annex H 2-3), and 10 amphibians (see H-2-4) are subject to CITES. As for flora, 156 species are identified in the Jiboa River basin but none of them are included in CITES.

3.2 Social Condition

3.2.1 Local Administration

The project area partly straddles 4 Departments: La Paz, Cuscatlan, San Vicente and San Salvador. The location of these departments is shown in figure 3.2.1. The municipalities in each Department are as follows:

LA PAZ (297.69 km²)

1. El Rosario	2. Jerusalén *	3. Mercedes La Ceiba *
4. Paraíso de Osario *	5. San Antonio Masahuat *	6. San Emitido *
7. San Francisco Chinameca	8. San Juan Nonualco	9. San Juan Tepezontes *
10. San Luis	11. San Miguel Tepezontes *	12. San Pedro Masahuat
13. San Pedro Nonualco	14. Santa María Ostuma	15. Santiago Nonualco
16. Tapalhuaca		

CUSCATLAN (123.87 km²)

1. Cojutepeque	2. Candelaria *	3. El Carmen
4. San Cristóbal *	5. San Pedro Perulapan	6. San Rafael Cedros
7. San Ramón *	8. Santa Cruz Analquito *	9. Santa Cruz Michapa

SAN VICENTE (49.41 km²)

1. Guadalupe	2. Santo Domingo	3. Tepetitan
4. Verapaz		

SAN SALVADOR (64.14 km²)

1. Ilopango	2. San Marcos	3. San Martín
4. Santiago Texacuangos	5. Santo Tomas	6.Soyapango

Eleven of the above municipalities with asterisks are wholly included in the Study Area. The rest of the municipalities partly make up the Jiboa River basin. The Jiboa River basin covers a total area of 605.6 km² with Ilopango Lake -- which is 70.5 km² -- and 535.1 km² excluding Ilopango Lake. La Paz Department occupies 55.6% of the basin, Cuscatlan 23.2%, San Salvador 12.0%, and San Vicente 9.2%.

Municipalities have cantons (sub-divisions). A canton does not have any substantial function and the border of a canton depends on the inhabitants. Some municipalities do not know the correct name and number of cantons in the area. According to basic data of the population census for three of the municipalities in the Study Area, San Cristóbal has 7 cantons, San Antonio Masahuat, 6, and San Pedro Masahuat, 18. Municipal and

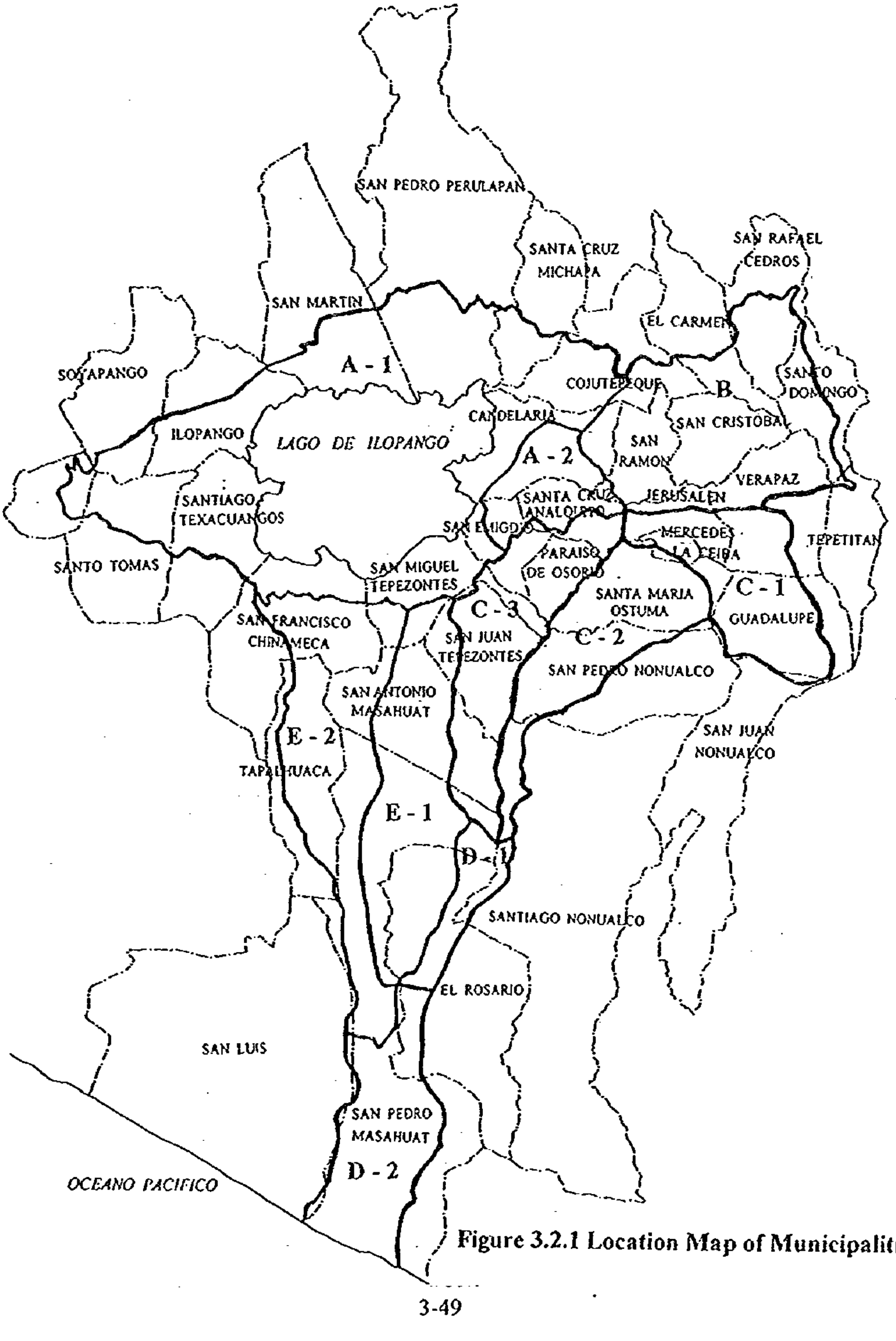


Figure 3.2.1 Location Map of Municipalities

agricultural extension offices, however, pointed out that these lists include units smaller than a canton.

3.2.2 Population

Table 3.2.2.1 shows the estimated present and future populations in the Jiboa River basin. The populations were calculated by multiplying the 1992 census data by the percentage of the Jiboa River basin area. According to ISDEM (Instituto Salvadoreño de Desarrollo Municipal), the population in the basin was 322,644 persons in 1996 and shall be 376,502 and 410,213 in 2005 and 2010, respectively.

Table 3.2.2.2 shows the 1996 population by sub-basin. Region A including San Salvador, has 65.6% of the total population in Jiboa River basin, region B along the Pan-American highway has 13.3%, region C has 10.1%, region D has 4.0%, and region E 6.9%. San Salvador occupies only 12.0% of the basin but covers 51.2% of the population, Cuscatlan has 23.2% of the basin and 24.4% of the population, La Paz, 55.6% of the basin but only 20.2% of the population, and San Vicente, 9.2% of the basin and 4.3% of the population.

Population density reflects these conditions. Region A has the highest population density of 1,382 persons/km² in 1996, followed by region B with 576.7 382 persons/km² Regions C and D have almost the same densities of 247.4 persons/km² and 229.2 persons/km², respectively. Region E has the smallest density of 187.5 persons/km². San Salvador has 2,568.8 persons/km², Cuscatlan, 632.7 persons/km², San Vicente, 282.5 persons/km², and La Paz, 218.8 persons/km². Regions A and B in the basin have a higher population density than the national average at 243.3 persons/km² in 1992 and 260.6 persons/km² in 1996. Thus, the Jiboa River basin has a relatively high population pressure (Table 3.2.2.3).

Of the 1992 national population, urban population made up 50.4% and rural population 49.6%. In the basin, the urban population occupies 67.1% and the rural population 32.9%, mainly due to the urban population in San Salvador, the capital. In the same year, the population is 84.9% urban and 15.1% rural in San Salvador, 30.4% urban and 59.6% rural in La Paz, , 40.4% urban and 59.6% rural n Cuscatlan, and 41.3% urban and 58.7% rural in San Vicente. Excluding San Salvador, the rural population is higher than the urban population in the other three departments (Table 3.2.2.4).

The national ratio of male to female population was 48.6% men and 51.4% women in 1992. Male population was 48.1% and female population was 51.9% in the 35 municipalities in the Study Area. These municipalities had a slightly higher female population ratio compared to the national level. At 51.2%, the rate of female population

Table 3.2.1.1 Area in Jiboa River Basin by Departments & Sub-basin

(km2)

	A	B	C	D	E	TOTAL	
LA PAZ	23.36	1.68	96.47	56.86	119.32	297.69	55.6%
	0.6%	0.6%	32.4%	19.1%	40.1%	92.7%	
CUSCATLAN	65.75	53.43	4.69			123.87	23.2%
	53.1%	43.1%	3.8%			100.0%	
SAN VICENTE		19.46	29.95			49.41	9.2%
		39.4%	60.6%			100.0%	
SAN SALVADOR	64.14					64.14	12.0%
	100.0%					100.0%	
TOTAL	153.25	74.57	131.11	56.86	119.32	535.11	100.0%
	28.6%	13.9%	24.5%	10.6%	22.3%	100.0%	

Table 3.2.2.1 Estimated Population by Departments in Fiture

(persons)

	1992	1996	2000	2005	2010
LA PAZ	60,820	65,139	69,764	76,014	82,819
CUSCATLAN	73,181	78,377	83,944	91,460	99,649
SAN VICENTE	13,411	14,363	15,383	16,761	18,261
SAN SALVADOR	153,840	164,765	176,466	192,267	209,484
TOTAL	301,252	322,644	345,557	376,502	410,213

Table 3.2.2.2 Population by Departments & Sub-basin in 1996

(persons)

	A	B	C	D	E	TOTAL	
LA PAZ	5,548	411	23,773	13,031	22,376	65,139	20.2%
	8.5%	0.6%	36.5%	20.0%	34.4%	100.0%	
CUSCATLAN	41,482	35,821	1,074			78,377	24.3%
	52.9%	45.7%	1.4%			100.0%	
SAN VICENTE		6,180	7,777			13,957	4.3%
		44.3%	55.7%			100.0%	
SAN SALVADOR	164,765					164,765	51.2%
	100.0%					100.0%	
TOTAL	211,795	43,003	32,439	13,031	22,376	322,644	100.0%
	65.6%	13.3%	10.1%	4.0%	6.9%	100.0%	

Table 3.2.2.3 Population Density by Departments & Sub-basin in 1996

(persons/km2)

	A	B	C	D	E	TOTAL
LA PAZ	237.5	244.5	246.4	229.2	187.5	218.8
CUSCATLAN	630.9	670.4	229.0			632.7
SAN VICENTE		317.6	259.7			282.5
SAN SALVADOR	2,568.8					2,568.8
TOTAL	1,382	576.7	247.4	229.2	187.5	602.9

Table 3.2.2.4 Rate of Urban & Rural Population in Jiboa River Basin: 1992

(%)

	Urban	Rural
La Paz	30.4	69.6
Cuscatlan	40.4	59.6
San Vicente	41.3	58.7
San Salvador	84.9	15.1
Total	67.1	32.9
El Salvador	50.4	49.6

Table 3.2.2.5 Rate of Urban & Rural Population by Gender in Jiboa River Basin: 1992

(%)

	Total		Urban		Rural	
	Men	Women	Men	Women	Men	Women
La Paz	48.8	51.2	47.2	52.8	49.6	50.4
Cuscatlan	48.0	52.0	46.4	53.6	49.1	50.9
San Vicente	48.4	51.6	46.7	53.3	49.6	50.7
San Salvador	47.9	52.1	47.6	52.4	49.4	50.6
Total	48.1	51.9	47.5	52.4	49.4	50.6
El Salvador	48.6	51.4	47.3	52.7	49.9	50.1

Table 3.2.2.6 Rate of Enrollment & Literacy of Agricultural EAP in Jiboa River Basin:1992

(%)

	Rate of Enrollment	Urban		Rural	
		Men	Women	Men	Women
La Paz	26.4	82.3	76.6	67.8	62.6
Cuscatlan	25.3	84.0	80.1	66.7	60.7
San Vicente	27.0	79.8	77.1	59.4	59.2
San Salvador	31.2	91.4	87.1	77.0	71.2
Total	27.5	84.4	80.2	67.7	63.4
El Salvador	26.5	86.8	82.3	59.5	57.5

Table 3.2.2.7 Educational Experiences of Agricultural EAP in Jiboa River Basin:1992

(%)

		Primary & Secondary School		Highschool		No Enrollment
		Unfinished	Finished	Unfinished	Finished	
La Paz	men	54.8	5.2	0.5	1.1	22.8
	women	36.0	3.0	0.4	1.3	25.9
Cuscatlan	men	51.4	7.0	0.4	0.8	19.3
	women	48.5	5.7	0.4	0.7	19.3
San Vicente	men	45.2	6.0	0.5	0.9	21.1
	women	44.9	3.9	0.2	0.4	25.2
San Salvador	men	47.5	53.8	0.8	2.8	26.1
	women	42.2	4.7	0.1	7.4	25.6
Total	men	49.9	20.3	0.6	1.5	22.7
	women	46.7	4.3	0.3	3.8	24.6
El Salvador	men	45.9	4.3	0.4	1.0	26.0
	women	44.9	3.5	0.5	2.1	26.6

in La Paz is lower than the national average, while the ratio of the other three departments is slightly higher than the national average. Urban areas tend to have a higher rate of female population than rural areas in the basin as well as nationwide. Rural female population in the basin is 50.6%, which is higher than the national rural average of 50.1%. Every department has a high rate of rural female population (see Table 3.2.2.5).

In terms of age composition, the younger age groups make up the bulk of the population, and the older age groups the rest. There are some trends where the female average age is older than the male average age and that the urban average age is older than the rural average age. These trends are common in the areas related to the Jiboa River basin.

The national male average age was 25.4 years old and the national female average age was 27.0 years old in 1992. In the basin, the male average age was 24.3 years old, female average age was 25.8 years old, and both average ages were lower than the national averages. Similarly, urban average ages in the basin (male 24.6 and female 26.4 years old) were lower than the national urban average (male 25.7 and female 27.7 years old). The low average age suggests the relatively low condition of amenities.

The national rural male average age of 23.6 years old was the same as the rural male average age in the basin, while the rural female average age in the basin of 24.5 years old was a little higher than the national rural female average age of 24.1 years old. This is probably because social conditions in the urban area are more favorable to women than in the rural, and this is generally due to the fact that the Study Area is near the capital and far from areas damaged by the civil war. Any outbreak in diseases or injuries in the area requiring treatment can be coped with immediately due to its closeness and relatively good access to the Capital.

Male literacy is also higher than female literacy and urban literacy is higher than rural literacy. In the national average of 1992, urban male literacy was 86.8%, urban female literacy was 82.3%, rural male literacy was 59.5%, and rural female literacy was 57.5%. Only San Salvador had a higher urban male literacy (men: 91.4%, women: 87.1%) than the national average. In rural areas, San Vicente has a slightly lower male literacy (59.4%) than the national average. Other related rural areas had better male and female literacy rates than the national average (Table 3.2.2.6). The Jiboa river basin has a relatively high literacy rate.

In 1992, many of the agricultural EAP in the basin over 10 years old were either primary or secondary school dropouts or have never been to school. Agricultural male EAP made up 49.9% of the primary or secondary school dropouts in the basin and 22.7% of the percentage of those never been to school. Agricultural female EAP made up 46.7% of primary and secondary school dropouts and 24.6% of those never been to school.

The EAP in the basin who have never been to school was smaller than the national average (male 26.0% and female 26.6%), but the rate of primary and secondary school dropouts was larger than the national average (male 45.9% and 44.9%). Thus, people in the basin generally go to school but many dropout due to financial problems or because they have to work and help the family. Female educational opportunity is smaller than that of males in the basin as well as nationwide (see Table 3.2.2.7).

3.2.3 Economy

(1) Agriculture

With the exclusion of San Salvador, agriculture is the key industry in the Jiboa River basin. The national agricultural EAP was 35.5% of the total EAP, 24.5% of which makes up the agricultural EAP in the basin (Table 3.2.3.1); agricultural EAP in San Salvador is very small (6.4%). The bulk of the agricultural EAP in the basin is in La Paz (58.8%), followed by San Vicente (69.4%), and Cuscatlan (36.3%). The agricultural EAP average in Cuscatlan is slightly higher than the national average. In the Jiboa River basin, there are many municipalities in which agriculture is the key industry. Agricultural EAP is generally higher in rural areas. Where the rate of agricultural EAP is small, the rates of manufacturing industry and commerce are high. EAP in fisheries totals 546 persons in the entire Study Area and about half fish at Ilopango Lake. With the exclusion of San Salvador, almost all rural male EAP were in agriculture. Commerce occupies about 20% of rural female EAP in every department. Manufacturing industry has over 30% of rural female EAP in Cuscatlan and San Salvador.

Estimated agricultural EAP in the Jiboa River basin in 1996 totaled 25,562: 10,929 persons in La Paz, 8,427 in Cuscatlan, 2,403 in San Vicente, and 3,903 in San Salvador. The women make up 4.9% of the national agricultural EAP. La Paz has almost the same rate at 5.0%, Cuscatlan 3.9%, San Vicente 3.6%, and San Salvador 7.5% (see Table 3.2.3.2).

Agricultural EAP includes various occupational types. Some people in agricultural EAP hold positions such as manager, guard, farm clerk and others. People characterized under farm households are the farmers and skilled laborers in farming and fishery (referred to as "skilled farmers") and the unskilled laborers (referred to as "unskilled farmers"). Most unskilled laborers in agricultural EAP are thought of as landless farmers and temporary or seasonal workers.

The number of skilled farmers in the basin in 1996 totaled 11,971, that is 46.8% of the agricultural EAP in the basin: 5,049 in La Paz, 4,129 in Cuscatlan, 1,177 in San Vicente, and 1,616 in San Salvador (see Table 3.2.3.2). The total number of unskilled farmers

Table 3.2.3.1 Agricultural Economically Active Population in Jiboa River Basin : 1996

	Total EAP	Agricultural EAP	%
La Paz	18,576	10,929	58.8
Cuscatlan	23,216	8,427	36.3
San Vicente	3,465	2,403	69.4
San Salvador	59,239	3,803	6.4
Total	104,496	25,562	24.5
E l S a l v a d o :	1,776,472	630,294	35.5

Table 3.2.3.2 Skilled laborer & Unskilled laborer in Jiboa River Basin : 1996

		Agricultural EAP in river basin		Farmer & skilled laborer		Unskilled laborer	
		% of gender	number	% in total	number	% in total	number
La Paz			10,929	46.2	5,049	52.2	5,705
	men	95.0	10,383	47.3	4,911	51.1	5,305
	women	5.0	546	25.3	138	72.6	400
Cuscatlan			8,427	49.0	4,129	50.0	4,214
	men	96.1	8,098	49.9	4,041	49.2	3,984
	women	3.9	329	27.2	88	69.1	230
San Vicente			2,403	49.0	1,177	50.1	1,204
	men	96.4	2,316	49.6	1,149	49.4	1,143
	women	3.6	87	32.3	28	67.0	61
San Salvador			3,803	42.5	1,616	49.8	1,616
	men	92.5	3,518	44.1	1,551	48.9	1,552
	women	7.5	285	22.1	65	61.1	64
Total			25,562	46.8	11,971	49.8	12,739
	men	95.1	24,315	47.9	11,652	49.3	11,984
	women	4.9	1,247	25.6	319	60.6	755

Note: These are calculated by each rate in 1992 Census.

was 12,739, 49.89% of the agricultural EAP in the basin: 5,705 in La Paz, 4,214 in Cuscatlan, 1,204 in San Vicente, and 1,616 in San Salvador. The male agricultural EAP in the basin was 50% skilled farmers and 50% unskilled farmers. Unskilled laborers occupied 60% - 70% of the female agricultural EAP.

There is another classification of agricultural EAP in the 1992 census and this was referred to in the classification of the 1996 agricultural EAP in the basin shown in Table 3.2.3.3. There are 21,699 independent laborers in the basin, and they make up 84.9% of the agricultural EAP. There are 80 owners of big farms, who are also referred to as employers, and they constitute 0.3% of the agricultural EAP. Employees, which refer to permanent workers, number 1,597, 5.9% of the agricultural EAP, while cooperative members number 1,656 and 6.4% of the agricultural EAP. Other categories including family laborers are omitted in the table. San Salvador had a higher rate of employees than the other departments, while La Paz had a higher rate of cooperative members than the others.

Skilled farmers with access to lands (40.1%) -- ratio exclusive of employers (0.3%) and cooperative members (6.4%) -- refer to small and medium scale independent farmers holding lands. Independent laborers (38.1%) -- ratio exclusive of skilled farmers -- refer to temporary and seasonal agricultural laborers.

The agricultural statistics of MAG only contains data on livestock by department and data on crops by region. It has no data on crops by department or municipality. MAG plans to publish data on crops by department from 1997, to form local agricultural policies closely related with local conditions. Because data by department is not available at present, existing data on agricultural production statistics is multiplied by the rate of the area in the Jiboa River basin. The rate of the basin in region II is 3.5% and the rate of basin in region III is 9.9% (see Table 3.2.3.4). The figures in this section are not actual and are only used to explain general agricultural conditions. More detailed analysis is presented in other sections, e.g., livestock farming.

Table 3.2.3.5 shows the main crop production for 1994-1995. 10,736 Mz was used to cultivate maize in the basin, which is 2.39% of the total area used to cultivate maize nationwide. At 27.1 qq/Mz, the yield was higher than the national average yield of 23.2 qq/Mz and is 2.78% of the national production of maize. The cultivated area of frijol beans in the basin was 3.04% of the total area used to cultivate frijol beans nationwide. At 12.1 qq/Mz, the yield in the basin is a little lower than the national average yield of 12.6qq/Mz and is about 2.91% of the national production. The yield of sorghum in the basin was the same as the national average yield at 22.8 qq/Mz, but smaller than the national average in terms of area coverage. The yield of rice in the basin, at 70.3 qq/Mz, was somewhat higher than the national average yield of 66.0 qq/Mz. Further, the area

Table 3.2.3.3 Condition of Employment in Agricultural Economically Active Population in Jiboa River Basin : 1996

		Agricultural EAP in Basin	Independent laborers %	Independent laborers number	Employees & laborers %	Employees & laborers number	Patrons & employers %	Patrons & employers number	Cooperators %	Cooperators number
La Paz	total	10,929	81.6	8,918	6.6	721	0.3	32	10.1	1,104
	men	10,383	82.3	8,545	6.4	665	0.3	32	9.5	986
	women	546	55.6	373	11.9	56	0.2	0	29.6	118
Cuscatlan	total	8,427	91.8	7,736	3.9	329	0.2	17	3.0	253
	men	8,098	92.0	7,450	3.9	316	0.2	17	3.0	243
	women	329	83.9	286	6.9	13	0.4	0	5.0	10
San Vicente	total	2,403	91.4	2,196	2.2	53	0.3	7	3.1	74
	men	2,316	91.9	2,128	2	49	0.3	7	2.9	67
	women	87	74.3	68	7.6	4	0.3	0	10.2	7
San Salvador	total	3,803	74.9	2,848	13.0	494	0.6	24	5.9	224
	men	3,518	75.8	2,666	12.4	436	0.7	24	5.6	196
	women	285	52.7	182	29.4	58	0.3	0	13.3	28
Total	total	25,562	84.9	21,699	6.2	1,597	0.3	80	6.5	1,656
	men	24,315	85.5	20,790	6.0	1,465	0.3	80	6.1	1,492
	women	1,249	72.8	909	10.6	132	0.0	0	13.1	164

Note: These are calculated by each rate in 1992 Census.

Table 3.2.3.4 Rate of Area of Jiboa River Basin Area in Agricultural Region

	Total area (km2)	Jiboa River Basin area (km2)	(%)
Region II			
Chalatenango	2,016.6		
La Libertad	1,652.9		
San Salvador	886.2	64.1	7.233
Cuscatlan	756.2	123.9	16.385
Total	5,311.9	188.0	3.539
Region III			
La Paz	1,223.6	297.7	24.330
Cabanas	1,103.5		
San Vicente	1,184.0	49.4	4.172
Total	3,511.1	347.1	9.886
El Salvador	20,720 *	535.1 *	2.583

Note: * = Land Area.

Table 3.2.3.5 Estimation of Agricultural Production in Jiboa River Basin : 1994-1995

		National	Region II Total	Regeon III Total	Region II in Basin	Regeon III in Basin	Total in Basin	Rate in National
MAIZ	Mz	450,000	89,100	76,700	3,153	7,583	10,736	2.39
	QQ	10,449,000	2,525,400	2,037,100	89,374	201,388	290,762	2.78
	QQ/Mz	23.2	28.3	26.6	28.3	26.6	27.1	116.74
FRIJOL	Mz	106,100	43,900	16,900	1,554	1,671	3,224	3.04
	QQ	1,334,300	510,700	210,500	18,074	20,810	38,884	2.91
	QQ/Mz	12.6	11.6	12.5	11.6	12.5	12.1	95.71
MAICILLO	Mz	173,800	30,000	30,900	1,062	3,055	4,116	2.37
	QQ	3,956,900	759,000	676,700	26,861	66,899	93,760	2.37
	QQ/Mz	22.8	25.3	21.9	25.3	21.9	22.8	99.90
ARROZ	Mz	21,300	11,100	5,200	2,701	514	3,216	15.09
	QQ	1,405,200	803,700	306,800	195,540	30,330	225,870	16.07
	QQ/Mz	66.0	72.4	59.0	72.4	59.0	70.3	106.46
		National	LA PAZ Total	S. VICENTE Total	LA PAZ in Basin	S. VICENTE in Basin	Total in Basin	Rate in National
ALGODON	Mz	2,575	127	4.0	4.5	0.2	4.7	0.18
	QQ	60,526	4,605	120	163	5.0	168	0.28
	QQ/Mz	23.5	36.3	30.0	36.3	30.0	36.0	153.34

Source: Calculation based on "Anuario de Estadísticas Agropecuarias 1994-1995" by MAG y DGEA.

Table 3.2.3.6 Production of Jiboa Sugar Milling Factory 1993-4

	Sugar Cane Area (Mz)	Sugar Cane Production (s.t.)	Sugar Cane Yield (t/Mz)	Sugar Production (QQ)	Sugar Yield (lb/s.t.)	Sugar Yield (%)
Jiboa	7,912	553,855	70.00	1,116,470	201.58	10.08
National	66,036	3,562,845	53.95	7,029,078	197.29	9.86
% in Total	12.0	15.5	-	15.9	-	-

Note : s.t.=2,000 lb. QQ=100 lb.
Source : MAG, "Informe de Coyuntura," Oct. 1994.

cultivated with rice in the basin (15.09%) and the production (16.07%) are also significantly higher than the national figures. According to national agricultural statistics, only 5 departments, including La Paz and San Vicente, cultivated cotton. At 36.0qq/Mz, the yield in the basin was considerably higher than the national average yield of 23.5 qq/Mz. However, the area cultivated with cotton (0.18%) and the production (0.28%) were relatively insignificant.

There is a sugar milling factory in the Jiboa River basin which contracts farmers to cultivate and harvest sugarcane. The milling factory contracted an area of 7,912 Mz in 1993-94, that is 12.0% of the national area cultivated with sugarcane. The production was 553,855 st. which was 15.5% of the national production. The rate of cultivated area was higher than the rate of production because the yield is 70.0 t/Mz which is higher than the national level of 53.95 s.t./Mz. The factory produced 1,116,470 qq of sugar in 1993-94, 15.9% of the national production of sugar. The rate of production of sugar from sugarcane is 10.08% and is a little higher than the national level (9.86%) (see Table 3.2.3.6).

(2) Livestock

The agricultural statistics of MAG contain some data on livestock by department. In 1994, the number of cattle slaughtered in the Jiboa River basin was 8,065 heads, 4.99% of the national average (see Table 3.2.3.7). The number of pigs slaughtered in the basin was 4,543 heads, 3.38% of the national average (see Table 3.2.3.8). The number of poultry for egg production in the basin was 412,266 doves, 9.13% of the national average (see Table 3.2.3.9), while poultry for meat production totaled 134,784 doves, 3.6% of the national average (see Table 3.2.3.10).

With respect to crops, the Jiboa River basin actively produces sugarcane and rice, has a high yield of maize which is only cultivated in a small area, and cultivates kidney beans on a wide area but harvests a small yield from the product. With respect to livestock, the number of cattle and pigs slaughtered in the basin exceeds the national figure, and the same may be said of poultry in the basin. Poultry for eggs is 9% of the national total mainly due to the Jiboa River basin's proximity to the capital, which is where the largest marketplace nationwide is. In addition to traditional crops, the farmers also successfully cultivate fruits and vegetables. However, there are no data on these activities.

3.2.4 Socio-economic Environment

(1) Inhabitants

Some of the areas in the middle and lower basins, e.g. Santiago Texacuango, San Miguel Tepezontes, San Juan Tepezontes, San Pedro Nonualco, San Antonio Masahuat and San

Table 3.2.3.7 Number of Cattle Slaughtered in Jiboa River Basin in 1994

(heads)

	Municipal total	Rate of Basin (%)	Number in Basin
SAN SALVADOR	65,662	7.23	4,749
CUSCATLAN	14,924	16.38	2,445
LA PAZ	3,191	24.33	776
SAN VICENTE	2,250	4.17	94
Total	86,027		8,065
NATIONAL	161,772	4.99	

Source: Calculation based on "Anuario de Estadisticas Agropecuarias 1994-1995."

Table 3.2.3.8 Number of Pigs Slaughtered in Jiboa River Basin in 1994

(heads)

	Municipal total	Rate of Basin (%)	Number in Basin
SAN SALVADOR	30,393	7.23	2,198
CUSCATLAN	3,793	16.38	621
LA PAZ	5,921	24.33	1,441
SAN VICENTE	6,773	4.17	283
Total	46,880		4,543
NATIONAL	134,488	3.38	

Source: Calculation based on "Anuario de Estadisticas Agropecuarias 1994-1995."

Table 3.2.3.9 Number of Poultry for Eggs in Jiboa River Basin in 1994

(doves)

	Municipal total	Rate of Basin (%)	Number in Basin
SAN SALVADOR	947,437	7.23	68,529
CUSCATLAN	264,568	16.38	43,348
LA PAZ	1,234,648	24.33	300,388
SAN VICENTE	-	4.17	-
Total	2,446,653		412,266
NATIONAL	4,517,898	9.13	

Source: Calculation based on "Anuario de Estadisticas Agropecuarias 1994-1995."

Table 3.2.3.10 Number of Poultry for Meats in Jiboa River Basin in 1994

(doves)

	Municipal total	Rate of Basin (%)	Number in Basin
SAN SALVADOR	480,524	7.23	34,757
CUSCATLAN	564,591	16.38	92,506
LA PAZ	21,830	24.33	5,311
SAN VICENTE	52,970	4.17	2,210
Total	1,119,915		134,784
NATIONAL	3,744,643	3.60	

Source: Calculation based on "Anuario de Estadisticas Agropecuarias 1994-1995."

Pedro Masahuat, have been inhabited by the natives ages before the pre-Hispanic era.

According to CONCULTURA of the Ministry of Education, there are no specific ethnological issues that would impede the Project in the Study Area. Even if the natives have traditionally kept their own customs and culture, they speak Spanish, as opposed to the situation in Guatemala. Thus, the culture in El Salvador is said to be a mixture of American Indians and Spanish.

(2) Institution/Custom

1) Fishery Rights

CENDEPESCA which is under MAG is responsible for the regulation of fishing activities in El Salvador in accordance with the Fisheries Law Decree No. 799 enacted in 1980. The decree requires people who wants to fish commercially to obtain a fishing license, fishing boat license and fisherman ID card, also issued by CENDEPESCA.

Priority is given to residents along the river with regard to the issuance of fishing rights; this is not actually controlled however. The above mentioned fishery right is for small scale fishing in Ilopango Lake and industrial fishing for shrimps by the Jiboa River mouth.

Fishing is controlled in terms of catch size and not the volume. Five of the articles in Decree No. 799 was revised and officially announced on March 27, 1996. Revisions were mainly carried out to reinforce the conservation of pregnant and female shrimps in order to protect marine resources.

2) Water Rights

Water rights concerning irrigation and drainage are regulated by Decrees No. 17 and 153 enacted in 1970. The government entity responsible for the enforcement of these laws is MAG. However, the Ministries of Economy, Public Works, and Public Health are also partially responsible for the stable use of hydrological resources.

The right to use a water source may be obtained from the responsible organs that will confirm the landlord's opinion. Applications may be filed at municipal halls. The right to use groundwater resources for the construction of a well for drinking water supply is freely given to the landlord. If the water source is to be used for irrigation, the user is required to obtain a permit from MAG. Since this law was only subject to individual users, it has been revised and is currently under discussion with DGRNR. The revised law also obliges not only individual users but also water associations to pay all necessary cost for irrigation water use.

3) Right of Common

A right of common is not established in the Study Area because there are no state owned communal lands; most of the land in the Study Area is privately owned (including lands mortgaged to ISTA).

4) Land System

Agrarian reform has been executed from the 1980s to the early 1990s in order to improve the subsistence farmer's life which is influenced by the large-scale land tenure system. According to Decree No. 153, any individual farmlands beyond 100 ha categorized under land class I, II, III, and IV, and 150 ha of farmlands categorized under land class V,VI, VII are subject to the 1980 Agrarian Reform. However, Article 105 of the Constitution stipulates the protection of individual land assets of up to 245 ha. Thus, the first agrarian reform expropriated any individual land assets beyond 500 ha as referred to in the newly enforced Decree 154.

For the implementation of the Agrarian Reform, Decree 207 was established in order to eliminate unfair exploitation systems that require farmers to pay by cash or impose royalties for the right to cultivate land. Decree 207 aimed at reallocating the land possessed by an absentee landlord to peasant farmer, and FINATA, a loan organization for farmers, was established to smoothly enforce this decree.

FINATA finances and assigns farmland to peasants and farm workers. The maximum amount of land that can be transferred by FINATA to peasants is limited to 7.0 ha, and payment for the land is required to be completed within 30 years. During the payment period, land ownership cannot be transferred or sold by the holder of the title deed.

(3) Endemic and Epidemic Diseases

According to the 1995 statistics issued by the Ministry of Health (see Table 3.2.4.1), the outbreak of malaria and dengue fever is negligible but the most common diseases are bronchitis, flue, diarrhea caused by parasites or unknown factors, malnutrition, rabies and so on. Further, the difference in the outbreak pattern of such diseases in the basin was not clearly detected.

In 1994, USAID reported that water-borne diseases in the Study Area, i.e., diarrhea, dehydration, contributed to the increase in infant mortality rate, especially in rural areas.

Table 3.2.4.1 **Major Endemic/Epidemic Diseases by Sub- Basin in 1995**

Sub-basin / Disease	A		B		C		D		E		Ratio(%)
	Treated	Ratio(%	Treated	Ratio(%	Treated	Ratio(%	Treated	Ratio(%	Treated	Ratio(%)	(%)
Faringo Amigdalitis	13390	32.5	3273	30.0	3988	29.9	488	36.6	2049	33.6	31.8
Cataro Comn	11409	27.7	3769	34.6	4193	31.5	408	30.8	2126	34.9	30.1
Infecciones	4951	12.0	1750	16.0	1655	12.4	63	4.8	858	14.1	12.7
Bronconeumonia	3858	9.4	699	6.4	712	5.3	108	8.2	39	0.8	7.4
Parasitosis Intestinal	4416	10.7	1324	12.1	2158	16.2	204	15.4	665	10.9	12.0
Amiviasis sin Abceso	1495	3.6	93	0.9	151	1.1	54	4.1	128	2.1	2.6
Animal transmi de	1014	2.5	0	0	0	0	0	0	0	0	1.4
Desnutirician leve	690	1.7	0	0	471	3.5	0	0	227	3.7	1.9

Source : Ministry of Public Health/1995

(4) Sanitary Condition

1) Drinking Water

ANDA, the governmental entity responsible for potable water supply, has narrowed its water supply coverage to urban and peri-urban areas. Outside of the ANDA water supply area, local water supply depends on the Ministry of Health's unit for rural water and sanitation, PLANSABAR (Plan National de Saneamiento Basico Ual), dug wells, boreholes, or river water. Accessibility to treated water in urban areas is much higher than in rural areas by a ratio of 5 to 1. There are no legal water quality standards in El Salvador, and the guidelines issued by CAPRE are tentatively employed. Therefore, ANDA has proposed the new regulations with respect to wastewater control, hydraulic resources, sewage system, and creation of a new agency for national water resources conservation.

2) Human/Animal Excreta

Within the Study Area, the metropolitan area along the west side of Ilopango Lake and the major cities are mostly equipped with flush toilets. In the rural area, pit latrines predominate; only very few households had flush toilets with septic tanks. Large scale poultry farms located around Ilopango Lake and within B block export chicken manure to neighbouring Guatemala or produce them for use as organic soil fertilizer. In the lower basin, some cooperative farms breeding cattle utilize cattle manure as organic fertilizer.

3) Effluent, Domestic Wastewater, and Solid Waste Materials

The west side of the Ilopango Lake basin is densely populated. Industrial parks are located in San Marcos and along the Pan American Highway. Most of the factories manufacturing paper products, chemicals and pharmaceuticals, plastics, paints, metal plating, and textiles discharge some type of untreated effluent to the basin. The list obtained from

UEDA/ANDA has 450 factories registered in the country, of which 84 are located within the Study Area. On the other hand, the factories registered with the Ministry of Health total 1500 nationwide. Thus, the number of factories not registered by UEDA/ANDA appears to be considerable.

Domestic wastewater generated from urbanized areas like Santo Tomas, San Marcos and Matasano is discharged into Ilopango Lake basin without treatment, while in rural areas, domestic wastewater is drained into the ground without any treatment system. Open dumping grounds for solid waste generated from Metropolitan San Salvador (460 t/day) and other cities are also scattered in the Study Area including the peri-Ilopango Lake Basin. Solid waste is openly burnt at dumping grounds, and the ash which is assumed to contain harmful substances like dioxin, flows into the basin with rain water. The lack of control of effluent, sewage or solid wastes discharge endangers human health, damages river ecosystems, contaminates critical groundwater resources and so on.

(5) Agro-chemicals and fertilizers

As mentioned in item (3) of section 2-5, 15 kinds of agro-chemicals were banned in 1988. Of the principal 16 agro-chemicals mentioned in the semi-annual agro-chemical report review issued by DGEA in 1992, 9 are prohibited pesticides. In terms of agro-chemical residues, analyses in 1987-88 of the former cotton-growing area of the littoral lowlands indicated the presence of three organophosphates above EPA water quality standards in all 28 river and 26 well samples taken. Table 3.2.4.2 shows the principal pesticides used on certain key crops grown in El Salvador for local consumption and export.

Table 3.2.4.2 Principal Pesticides Used on Certain Key Crops in El Salvador

Crops	Principal Pesticides Used
Maize	Phoxim, Methamidophos, Paraquat, Terbufos, Atrazine, Carbosulfan
Beans	Endosulfan, Terbufos, Carbosulfan, Methyl Parathion, Methamidophos, Fenpropathrin
Rice	Methomyl, Methamidophos, Propanil, 2,4-D
Sorghum	Phoxim, Mehamidophos, Paraquat, Terbufos, Atrazine, Carbosulfan
Sugarcane	Malathion, Terbusfos, Carbofuran, Phoxim, Methyl Parathion, Atrazine, Paraquat, Diuron, 2,4-D
Coffee	Endosulfan, Propoxur, Aldicarb, Carbofuran, Phoxim, Terbufos, Methyl Parathion, Malathion, 2,4-D

Source: Environmental Contamination/USAID Report/1995

Of the total amount of pesticides used in El Salvador, insecticides account for 68 % while herbicides and fungicides account for 28 % and 4 %, respectively. Meanwhile, due to the lack of any routine or systematic collection of such data on pesticide use, it is impossible to quantify the ecological effects of pesticide and fertilizer use.

According to the 1993 IBRD report, El Salvador has long held the dubious distinction of being the highest user of pesticide per capita and hectare in Central America. It implies that there is a rural environment that contributes to the expansion of agro-chemical pollution by employing pesticide oriented agricultural credit practices. Use of fertilizer in El Salvador has remained relatively stable for the past 15 years at approximately 240,000 - 250,000 metric tons per year. This represents roughly 325 kg of fertilizers used on every hectare of the approximately 735,000 ha of land cultivated with basic grains and agricultural commodities in production. This high dosage of fertilizer use accelerates eutrophication of rivers and lakes in conjunction with fertilizer run-off and human excreta.

(6) Exploitation of River Sand

For construction purposes, the easily accessible riparian lands in the Jiboa River basin are frequently exploited for river sand extraction causing severe scouring of bridge girder. However, the irrigation law mentioned before is not sufficiently enforced in the Study Area.

(7) Historical Remains/Cultural Assets

Archaeological remains from the Mayan Culture are officially recorded at 334 sites in the country, including 5 in the Study Area. However, around 5,000 sites are estimated to actually exist nationwide. Table 3.2.4.3 below shows the 5 sites in the Study Area, their area coverage and the municipality or department they belong to.

Table 3.2.4.3 Archaeological Remains in the Study Area

Remains	Municipality/Department	Area (ha)
Texas Instruments	Soyapango/San Salvador	1.0
Xalozinagua	Tapalhuaca/La Paz	25.0
La Finquita	Cojutepeque/Cuscatlan	1.0
Petrograbados Los Naranjos	Cojutepeque/Cuscatlan	0.1
Piedra Herrada	SanRafael Cedros/Cuscatlan	0.1

Source: CONCULTURA/Ministry of Education

Currently, the sites are not precisely recorded on the map due to insufficient manpower. Thus, confirmation of actual sites in each municipality is necessary when a development activity is undertaken in these municipalities. These cultural remains are protected by Decree No.513, Cultural Assets Protection Law. However, because the law does not clearly stipulate punishment for infractors, it is currently under revision. These assets are not open for tourism because they are mostly located in private sites co-managed by the landowner and government.

(8) Social Environment in the Pilot Project Area

1) Verapaz

- No legal environmental assessment system (IEE/EIA)
- Population: 6,315 (Male; 3,117, Female; 3,198)
- Administrative unit: 8 cantons and 2 caserillos
- Community organization: 6 ADESCO
- Commonly used agro-chemicals:
  gramoxone, lannate, folidol, malation, compound fertilizer(20-20-0)
- Major economic activity: 90 % of inhabitants belong to agro-sector
- Prevailing sickness: diarrhea, bronchitis, few malaria and dengue fever
- Rural sanitation: the majority have toilets (pit latrines) but have no sewage system
- Cultural assets: none

2) San Cristobal

- No legal environmental assessment system (IEE/EIA)
- Population: 7,130 (Male; 3501, Female; 3629)
- Administrative unit: 6 Cantons
- Community organization: 6 ADESCO
- Commonly used agro-chemicals:
  malation, tamaron, lannate, gramoxone, compound fertilizer(20-20-0), ammonium sulphate, chicken manure,
- Prevailing sickness: bronchitis, diarrhea, cholera/dengue fever (few)
- Rural sanitation: No sewage system; faucets are commonly used
- Cultural assets: none

3) San Antonio Masahuat

- No legal environmental assessment system (IEE/EIA)
- Population: 4,047 (Male; 1953, Female; 2094)
- Administrative unit: 6 Cantons
- Community organization: 2 ADESCO
- Major economic activity: more than 95 % of the inhabitants belong to agricultural sector
- Commonly used agro-chemicals:
  gramoxone, edonal, herban, tamaron, folidol, compound fertilizer(20-20-0)
- Prevailing sickness: flue, cholera, diarrhea
- Rural sanitation: Pit latrines are used in the urban area, but because there is no sewage system domestic water is drained to the ground or river.
- Cultural assets:

Cueva de la Serpiente/Canton Los Lamas
Cueva de la Laiebre
Cuevaa de la Hediondas,

- Reserved area: preservation of deers in its territory financed by FIEAS

4) **San Pedro Masahuat**

- No legal environmental assessment system (IEE/EIA)
- Population: 21,593 (Male; 10,519, Female; 11,074)
- Administrative unit: 17 Cantons and 1 Caserillos
- Community organization: 9 ADESCO
- Commonly used agro-chemicals:
  gramoxone, lannate, tamaron, etc
- Major economic activity:
  Rural: 100 % is involved in farming activities
  Urban: 35 % is involved in farming activities
- Prevailing sickness: chicken-pox, flue, cholera, dengue fever
- Rural sanitation: Urban: pit latrine; Rural: only pits; no sewage system, tanning factory pollutes Sepaquiapa River. The giant poultry enterprise, INCOA, also pollutes the same river with chicken excreta.
- Cultural assets:
  La Posa del Cristo Neguro,
  Pozas de Amatitan
  Reserved area for deer protection -"Bo El Calvario"

(9) **Environmental Problems in the Study Area**

1) The residents of the area where observed to be either unaware of or disinterested in the adverse environmental impacts of soil, forests, and water resources degradation, annihilation of biodiversity, deterioration of coast and marine resources, and the conduct of unsustainable farming and fishery practices.

2) Institutions involved in a) environmental pollution, b) natural resources, c) institutional reinforcement, d) environmental education on legislation, economy, public health, research and information, were found to be weak. The absence of an environmental impact examination system (EIA) was also observed.