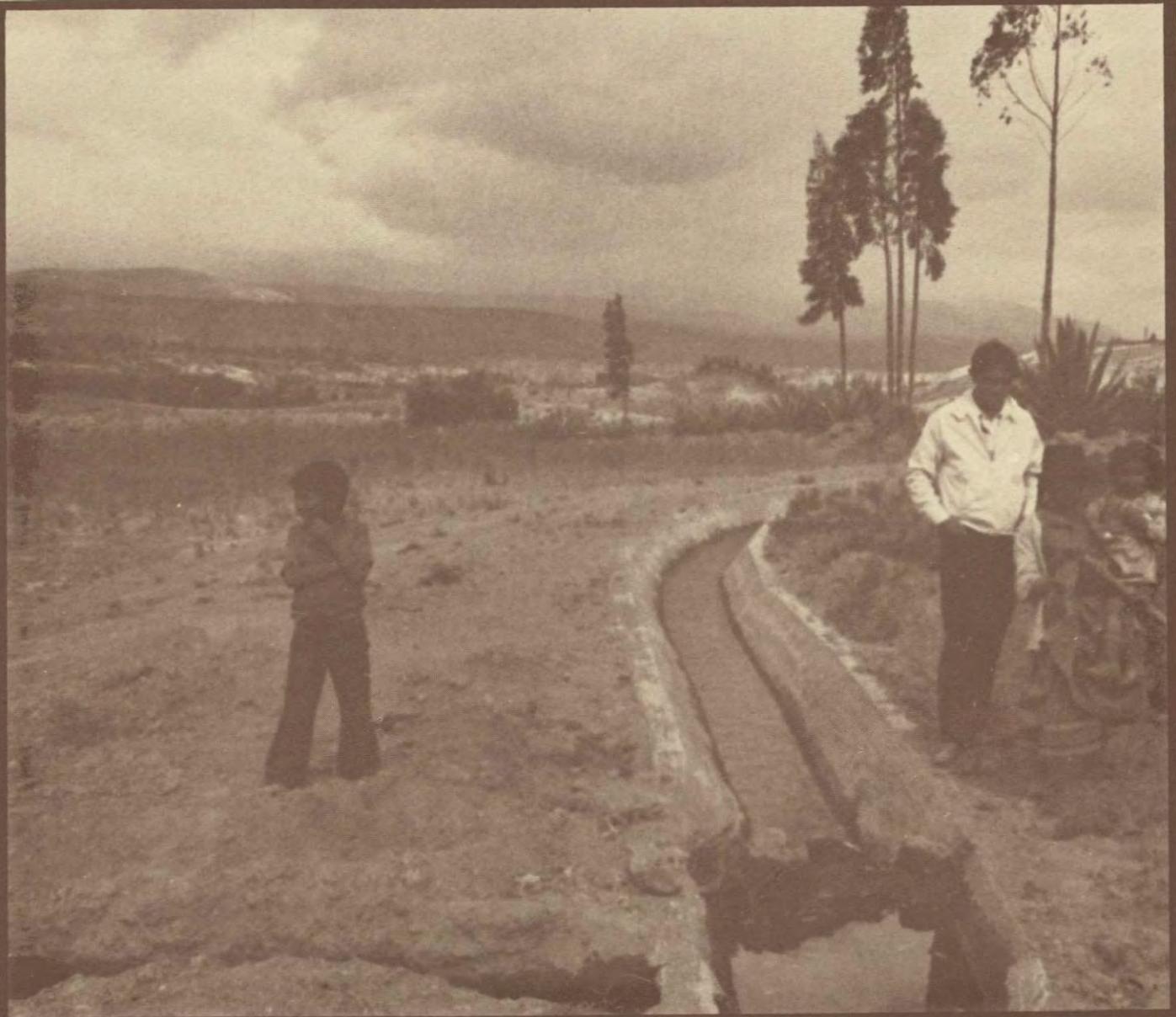


Small Farm Irrigation Improvement in Salcedo, Ecuador: Technical, Economic, and Institutional Feasibility



June, 1980

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**SMALL FARM IRRIGATION IMPROVEMENT IN SALCEDO ECUADOR:
TECHNICAL, ECONOMIC AND INSTITUTIONAL FEASIBILITY**

By

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**The Agency for International Development
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I. SUMMARY DESCRIPTION OF THE SALCEDO IRRIGATION PROJECT

1.1 EXISTING IRRIGATION SYSTEMS IN SALCEDO

1.1.1 Hydrologic Resources in the Salcedo Area

The Cantón of Salcedo is located in the southeast corner of the province of Cotopaxi (refer to Figure 1). The major irrigation systems in the area of Salcedo divert water from five rivers.

1. Río Nagsiche. Has its source in the western páramos of the Cantón of Salcedo and crosses the Parishes of Cusubamba, Mulalillo, Panzaleo and Salcedo. The Río Nagsiche flows into the Río Cutuchi. Six canals are taken from this river.

2. Río Yanayacu. This river comes out of the mountain range in the eastern part of Salcedo and receives water from the Río Quillopacha and the Río Charasacha and finally empties into the Río Cutuchi. The Río Yanayacu supplies three canals that irrigate a section of the eastern part of the Cantón Salcedo.

3. Río Cutuchi. Crosses the Cantón of Salcedo from the north to the south passing near the center of the Cantón. Four canals come from this river.

4. Río Pumancunchi.

5. Río Isinche. Comes into the Cantón of Salcedo from the Cantón of Pijulí and crosses the northeast part of the central Parish before flowing into the Río Cutuchi.

1.1.2 Irrigation Canals in the Salcedo Area

From these five rivers more than twenty canals are taken. Some of these canals are described in the narrative that follows and in Table 1.1.

From the Río Nagsiche:

1. Acequia Martínez. Begins near the town of Cusubamba and serves the communities of Carrilo, Gustavo Iturralde, La Provincia, San Ignacio and Crusera. The available flow is 186 l/sec. The irrigated area is 883 hectares divided between 502 users. The length of the canal is 17 Km.

2. Acequia Marquez. Diverted from the river near Cusubamba and is divided into three branches near Chirinche Bajo: Unalage-Quevedo, Cuchibamba and Planta. Cuchibamba and Planta reunite and continue to Yanachahuar and Lonuinato. The available flow in the main canal is 419 l/sec. The irrigated area of 1,482 hectares is divided between 654 users. The length of the canal is 39 Km.

3. Acequia Chiriboga. Begins near Cruz de Mayo and divides into two branches, Junta La Esperanza which ends near the parish of Antonio José Holguín and Arias which also continues to A. J. Holguín. The flow in the canals is 130 l/sec. The area irrigated is 445 hectares divided among 303 users. The canal length is 13 Km.

4. Acequia Aulestia. Irrigates an area of 3 hectares with a flow of 5 l/sec. The length of the canal is 1.5 Km and it has 12 users.

5. Acequia Playa Quebrada Grande. Serves 10 hectares with a flow of 5 l/sec. The length of the canal is 1.5 Km and it has 12 users.

TABLE 1.1
INVENTORY OF THE RIO NAGSICHE AND THE RIO YANAYACU

Canal	Branch and Map Reference No.	Area Irrigated (Hectares)	Liters per Second	Number of Users	Observations
San Antonio (Q = 275 L/seg.)	A1 San Antonio	306	185.5	1	Hda. San Antonio Comuna
	A2 San José de Alpanalag	217	43.70	153	
	A3 Armando Toro	130	23.00	1	Comuna Potable Water
	A4 San José de Barba	113	17.80	56	
	A5 Consejo Provincial	—	5.00	—	
TOTAL		<u>766</u>	<u>275.00</u>	<u>211</u>	
B. Martínez	B1 Carmen Toro	4	2.00	13	Hda. San Juan
	B2 Carrillos	22	6.00	18	
	B3 San Francisco	7	2.00	10	
	B4 Cobos	73	8.00	68	
	B5 Miranda	15	4.00	1	
	B6 Maldonado	30	4.00	15	
	B7 Chisinche Bajo	70	12.00	71	
	B8 San León	86	18.00	78	
	B9 Chico Martínez	131	23.00	106	
	B10 Grande Martínez	124	30.00	61	
	B11 Miño	191	45.00	48	
	B12 Espinosa	130	29.00	13	
	B13 Agua Potable	—	3.00	—	Mulalillo (2.500 Hab.)
TOTAL		<u>883</u>	<u>186.00</u>	<u>502</u>	

TABLE 1.1 Continued.

Canal	Branch and Map Reference No.	Area Irrigated (Hectares)	Liters per Second	Number of Users	Observations
C. El Marquez (Q = 419 L/seg.)	C1 Cunchibamba Chico y otros	42	6.04	82	
	C2 Poveda-Chasoaló	153	45.28	25	
	C3 Albarado Córdoba y otros	34	6.30	27	
	C4 Joaquín Borja y exhuasip.	132	41.74	12	
	C5 Beatriz Borja y exhuasip.	104	33.84	8	
	C6 Inés Borja y e exhuasip.	90	35.79	8	
	C7 Oswaldo Sevilla	44	17.36	1	
	C8 Enma Sevilla	17	6.83	1	
	C9 Tobías Gutiérrez	44	17.36	1	
	C10 Ricardo Sevilla y Exhuasip.	19	7.60	12	
	C11 Angélica Sevilla	17	6.83	1	
	C12 Matilde Sevilla	17	6.83	1	
	C13 Comuna San Luis	66	6.47	56	
	C14 Cooperativa Pucarumi	45	4.39	34	
	C15 Unalagua-Quevedo	49	14.27	44	
	C16 Marcelo Chiriboga	34	9.83	1	
	C17 Cooperativa San Vicente	205	56.94	154	
	C18 Federico Romo	27	7.71	1	
	C19 Samuel Fernández	18	5.01	1	
	C20 Pequeños Agricultores (I. Sandoval)	30	8.34	12	
	C21 Jorge Holguín	25	6.74	1	
	C22 Sta. Lucía-compradores	18	4.83	9	
	C23 José Porras	20	5.50	1	
	C24 Comité Cívico Sta. Lucía (V. Zapata)	35	9.40	40	
	C25 Junta Unión y Progreso	72	19.70	67	
	C26 Héctor Fernández	22	5.82	1	
	C27 Angel Núñez (compradores)	23	6.30	5	

TABLE 1.1 Continued.

Canal	Branch and Map Reference No.	Area Irrigated (Hectares)	Liters per Second	Number of Users	Observations
C. El Marquez	C28 Sta. Lucía (R. Villacís)	36	10.03	23	
	C29 Unalagua-Salatilín	34	6.80	25	
TOTAL		<u>1.472</u>	<u>419.00</u>	<u>654</u>	
D. Holguín	D1 Junta la Esperanza	99	29.16	105	
Chiriboga	D2 Curiquingue Loma	32	9.13	25	
(Q = 130 L/seg.)	D3 José y Patricio Cuesta	18	5.30	2	
	D4 Compradores (Mulalillo)	41	11.02	2	
	D5 Compradores (Chasoaló)	78	22.45	83	
	D6 Compradores (Sta. Lucía)	30	8.71	15	
	D7 Compradores (Magdalena Chiriboga)	29	8.67	15	
	D8 Elsa Barahona y herederos	28	8.16	3	
	D9 Compradores de Miguel Chiriboga	85	26.67	50	
	D10 Amador Córdova y otros	5	0.69	3	
TOTAL		<u>445</u>	<u>130.00</u>	<u>303</u>	
E. Aulestía		3	5.00	34	
F. Playa-Quebrada Grande		10	5.00	12	
G. La Playa		90	25.00	2	
H. Playa Nagsiche		210	67.00	157	
R. Tingo-Panzaleo 15 Ramales		170	67.00	311	
Vte. Obispo y Huagracorral		157	47.00	—	Caserío Molinopara
TOTAL DEL NAGSICHE		3.998	1.160	ap. 2.049	

TABLE 1.1 Continued.

Canal	Branch and Map Reference No.	Area Irrigated (Hectares)	Liters per Second	Number of Users	Observations
<u>Right Margen (Cantón Salcedo)</u>					
Cumbijín	2	163	200.0	6	
Galpón Alto	3	1.115	128.8	1	
Galpón Bajo	5	82	21.0	3	
Municipio de Salcedo	9	1.017	1.195.0	725	Electric Plant and Potable Water
Planta Eléctrica Vieja	10	—	416.0	1	
Molinos San Vicente y otro	12	—	376.0	4	
Molino Armendaris	14	—	612.0	1	
Pogyos de Yanayacu	15	2	—	1	
Q. Toaín	16	4	48.6	55	
T O T A L		<u>2.383</u>			
<u>Left Margen (outside of the Cantón Salcedo)</u>					
Chagrasacha	1	6.273	308.0	453	
Pucará	4	102	30.0	1	
Lascano	6	26	33.0	1	
Barberis Cobo	7	30	14.5	1	
Yanayacu de Luis Otáñez	8	5	—	1	
Molino San José	11	0.3	—	1	
Bastidas	13	—	—	1	
Quildagua	17	30	40.0	1	
Cruzacha	18	338	69.0	—	
T O T A L		<u>6.804.3</u>			

Source: INERHI.

6. Acequia Playa. Irrigates 90 hectares held by two users. The length of 4.5 Km. carries 25 l/sec.

7. Acequia Playa Nagsiche. Irrigates 210 hectares divided among 157 users. The length of the canal is 10 Km. and it has a flow of 67 l/sec.

From the Río Cutuchi:

1. Acequia Universidad. Serves 470 hectares with a flow of 188 l/sec. The length of 8.8 Km. takes water to 547 users.

2. Acequia Hidalgo. Irrigates 188 hectares with a flow of 130 l/sec. and a length of 31.8 Km.

3. Acequia El Recreo o Molina. Serves three large landholders with a total of 110 hectares. The length is 4 Km. and the flow is 390 l/sec.

4. Acequia La Primavera o Argentina. Irrigates 270 hectares with a flow of 149 l/sec. The length of the canal is 3.4 Km.

From the Río Yanayacu:

1. A canal that begins near the Laguna de Salcucha serving the areas of Casca and Huangashipamba. Length of the canal is 16 Km.

2. A canal that begins in the Laguna de Antejos and serves the areas of Nuñurco, Guanguloma and the surrounding areas by means of two branches, one with a length of 12.5 Km. and the other with a length of 10 Km.

3. Another canal that begins near a marsh and irrigates the area of Cerro Verde Filo with a length of 9 Km.

4. A canal that divides into 4 branches and irrigates the areas of Vellavista, Chambapongo, Salviopungo and other areas. The length of these canals is 14.5 Km.

5. A canal that begins in the marsh Yanaguaicu and divides into three branches that serve the area of Verde Corral, Cortaduría, Palama and Chanchalito. The length of these branches is 15.5 Km.

From the Río Isinche:

1. A canal with a length of 8 Km. that irrigates the areas of Sigchocalle, Collanas and the surrounding farms.

Some of the canals that flow from the Río Yanayacu serve areas that are out of the project area. Table 1.1 indicates which canals serve the project area and which do not. None of the canals are lined, which indicates that the filtration loss could be quite substantial in the areas with sandy soils. In many areas it is not uncommon to have the canal break out of its channel.

The canals described in the preceding narrative and in Table 1.1 are not all of the canals that exist in the Salcedo area. There are many small canals which take water from springs and small streams that have not yet been inventoried. The flows in these canals are usually quite low, about 20 liters per second, and are not very reliable. A lot of communities depend on the flows from these small streams and springs for both irrigation water and water for domestic use.

1.2 IRRIGATION ON TARGET GROUP FARMS

Almost 80% of target group farms have some level of irrigation; the major problem is the insufficiency of irrigation water and not its non-existence. Table 1.2 outlines irrigation patterns for target group farms, as estimated from the PCI Salcedo irrigation survey.

TABLE 1.2
IRRIGATION PATTERNS ON TARGET GROUP FARMS

Farm Size	Number of Farms Total	% of Farms with Some Irrigation	% of Cultivable Land with Some Irrigation	Total Target Group Area	
				Partially Irrigated.	Not Irrigated At All
				Ha.	Ha.
All Farms	5,335	79.5%	63.6%	7042	2432
0-1 Ha.	2,766	78.3%	64.3%	1416	391
1-5 Ha.	2,161	80.4%	70.5%	3926	1192
5-10 Ha.	408	75.0%	38.9%	1699	850

Source: Salcedo Irrigation Survey (83 farms) 1980.

The scarcity of water can be seen in the fact that while almost 80% of the farms have some water, only 64% of the cultivable land ever receives irrigation. While the proportion of farms with at least some water is high, the number without any type of irrigation is not insignificant—1,127 target group families are completely without access to water. On these totally unirrigated target group farms there are 2,751 Ha. of land of which about 2,000 Ha. are probably irrigable if water supplies were available.

1.3 WATER REQUIREMENTS AND AVAILABILITY

1.3.1 Water Requirements

The water requirements for a project include the water which is consumed beneficially by transpiration of the crop and the non-beneficial use and losses which include percolation and evaporation and conveyance and distribution losses. These water requirements can be satisfied by precipitation, ground water or irrigation or a combination of these sources. If the precipitation is sufficient and well distributed, irrigation is not required. But if precipitation is insufficient or poorly distributed, and the ground water table is low, the need for irrigation is critical for good production. Such is the case in Salcedo. Because of insufficient rainfall and/or a poor distribution of rainfall, irrigation is required for good crop production and in some cases for any crop production at all.

Because of the wide variety of topography in the cantón of Salcedo there are many different micro-climates that make defining the climate in a general way quite difficult. In the areas at lower elevations the mean annual temperature is 18°C and the mean annual rainfall is around 500 mm. In the higher elevations the mean temperature drops to around 13°C and the mean annual rainfall remains about the same at about 450 to 550 mm. At higher elevations the temperature decreases and rainfall increases slightly.

The consumptive use was calculated by INERHI using the modified Blaney-Criddle formula. The climatic data used in the calculation came from the lower elevations and so the calculated consumptive use is slightly higher than what it would be if the figures used were from higher, cooler elevations. The projected crop mix entered into this calculation. Table 1.3 gives the estimated net water requirements and water requirements at 55% efficiency in cubic meters per hectare.

TABLE 1.3
ESTIMATED WATER REQUIREMENTS AND REQUIREMENTS AT 55% EFFICIENCY

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Net Irrigation Require- ment (M ³)	449	251	145	188	188	258	341	315	343	305	378	552	3,713
Require- ment at 55% Efficiency (M ³)	816	456	264	341	341	469	620	573	629	555	687	1,004	6,750

Source: INERHI.

The total water required in the project is calculated by multiplying the requirement at 55% by the total number of hectares in the project—30,918 hectares. These values are given in Table 1.4.

TABLE 1.4
TOTAL WATER REQUIRED IN MILLIONS OF CUBIC METERS.

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
25.23	14.1	8.16	10.54	10.54	14.5	19.17	17.7	19.29	17.16	21.24	31.04

Source: INERHI.

1.3.2 Water Availability

The water available for irrigation can come from the three major rivers—Río Yanayacu, Río Cutuchi and Río Nagsiche—or it can come from some of the smaller streams or springs that are found in the area. Table 1.5 gives the mean monthly streamflow values for each of these three major rivers. The location of these rivers is shown in Figure 2.

TABLE 1.5
MEAN MONTHLY STREAMFLOW IN M³/SEC.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Yanayacu	8.25	5.98	7.95	8.01	8.90	16.93	17.08	14.03	11.11	7.41	5.97	5.30
Cutuchi	11.05	13.24	13.38	18.49	15.78	14.85	12.73	10.94	10.97	12.59	15.48	13.21
Nagsiche	1.85	3.77	2.64	2.47	2.01	1.94	2.13	1.79	1.61	1.85	1.88	1.82
Total	21.20	22.99	23.97	28.97	26.69	33.72	31.94	26.76	23.69	21.83	23.33	20.33

Source: INERHL

Using the total values to calculate the maximum possible water available gives the values found in Table 1.6.

TABLE 1.6
MAXIMUM POSSIBLE WATER AVAILABLE IN MILLIONS OF CUBIC METERS

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
56.78	55.62	64.20	75.09	71.49	87.40	85.55	71.67	61.40	58.97	60.47	54.45

Source: INERHL

1.3.3 Water Deficits and Excesses

Inspection shows that it appears that there is sufficient water to irrigate all of the project if we use all of the water available in each of the three major rivers. This, of course, is assuming that the water can be delivered to all of the project, which is a false assumption because of the topography of the project area and the locations of the rivers. But for calculations this assumption is being made. We must also remember that not all of the water in the river will be available for irrigation because of further downstream uses such as irrigation, power generation, etc. Table 1.7 gives the net difference between water available and water demand assuming that 50% of the water in the rivers is available.

TABLE 1.7
DIFFERENCE BETWEEN WATER AVAILABLE AND WATER REQUIRED

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
50% of Water Available (Millions of M ³)	28.39	27.81	32.10	37.55	35.75	43.7	42.78	35.84	30.70	29.24	30.24	27.23
Water Required at 55% Efficiency (Millions of M ³)	25.23	14.10	8.16	10.54	10.54	14.5	19.17	17.70	19.29	17.16	21.24	31.04
Difference	3.16	13.71	23.94	27.01	25.21	29.2	23.61	18.14	11.41	12.08	9.0	-3.81

From Table 1.7 it can be noted that even with a 25% increase in water requirements, every month but January and December is below the 50% level of all water available. By the same method we can calculate the same kind of results if the water available is decreased by 25%. Even if the extreme case is calculated in which water requirements increase by 25% and the water supply decreases by 25%, we get the results indicated in Table 1.8, which shows the percentage of all available water needed to cover the water requirements.

TABLE 1.8
PERCENTAGE OF AVAILABLE WATER NEEDED FOR WATER REQUIREMENTS

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
74%	42%	21%	23%	25%	28%	37%	41%	52%	49%	59%	95%

It must be remembered that these calculations were made using all 30,918 hectares in the Salcedo area. This caused an overstating of the water demanded from the river sources.

Another possible and very likely reason that there is a shortage of water when calculations indicate there is sufficient water is that the efficiency of water use is less than 55%. The conveyance losses are probably very high because none of the canals are lined. Other types of losses are probably high also because of the primitiveness of the irrigation structures.

Another example of the importance of better irrigation efficiency can be made by examining one of the canal systems that serves a portion of the Salcedo area. Acequia El Marquez serves 654 users by distributing 419 l/sec. to 1,472 hectares. If we calculate the water requirements of this number of hectares we have the following:

TABLE 1.9
WATER REQUIREMENTS IN MILLIONS OF CUBIC METERS FOR THE AREA
SERVED BY THE ACEQUIA EL MARQUEZ AT 55% EFFICIENCY

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1.2	.67	.39	.50	.50	.69	.91	.84	.92	.82	1.01	1.48

Assuming that the flow in the canal remains the same the year round, this value is calculated as 1.12 million cubic meters per month. Comparing this value to the water requirements in the area shows that only December and January require more water than is available, but a survey conducted in the area showed that 97% of the farmers felt that they needed more water. This is a fair indication that more water is needed. Where the calculations show that sufficient water is available if the efficiency is 55% or better, but other indicators show that water is lacking, the assumption can be made that the efficiency is less than 55%. In order for the target group farmer to have the full benefits of the water that is available to them, the efficiency of water conveyance and on-farm water use must be increased substantially. With the existing water conveyance and distribution systems and the current on-farm water management practices, the farmers in the zone of Salcedo are unable to reach the required efficiency.

1.4 INERHI EXISTING PLANS FOR SALCEDO

INERHI has projects in the construction stage in the Salcedo zone and some projects also in the planning stage. This section will briefly describe these projects.

1.4.1 Project Latacunga-Salcedo-Ambato

This project is located in the provinces of Cotosaxi and Tungurahua. The total potential irrigable area covered by this project is 8,400 hectares, 1,450 of which are in the Cantón of Salcedo. These hectares are contained between the elevation line of 2,730 meters on the west side of the Río Cutuchi and the Río Cutuchi itself. The location of the canal is indicated on Figure 1 in Section 1.1.2.

This project is currently under construction. The most northern part of the canal is being used at this time. The construction that is ongoing right now is the aqueduct over the Río Nagsiche. Once this aqueduct is finished, another large section of the project will be able to use the water from this canal. The project Latacunga-Salcedo-Ambato is being funded by the Interamerican Development Bank and the GOE.

1.4.2 Project Dávalos-Chiriboga

This project has the object of irrigating an area of 495 hectares in the east-central part of Salcedo. The water for this project will come from the Río Cutuchi from the same location on the river as the diversion for the Latacunga-Salcedo-Ambato. The general borders of this project are the Río Cutuchi and the elevation 2,730 meters on the east side of the river. Figure 3 shows the location of the project.

The distribution of land in this zone is similar to the distribution of land in Salcedo in general. Ninety-five percent of the farmers hold only 36% of the land, which means that there are a few large landholders and many minifundistas whose mean farm size is 0.9 ha.

This project is under construction and is being funded by the GOE. The main distribution canal has been excavated and is being lined. The Ecuador IRD Project proposes joint funding with the GOE for the construction of the distribution system.

1.4.3 Project Chaupi-Palama

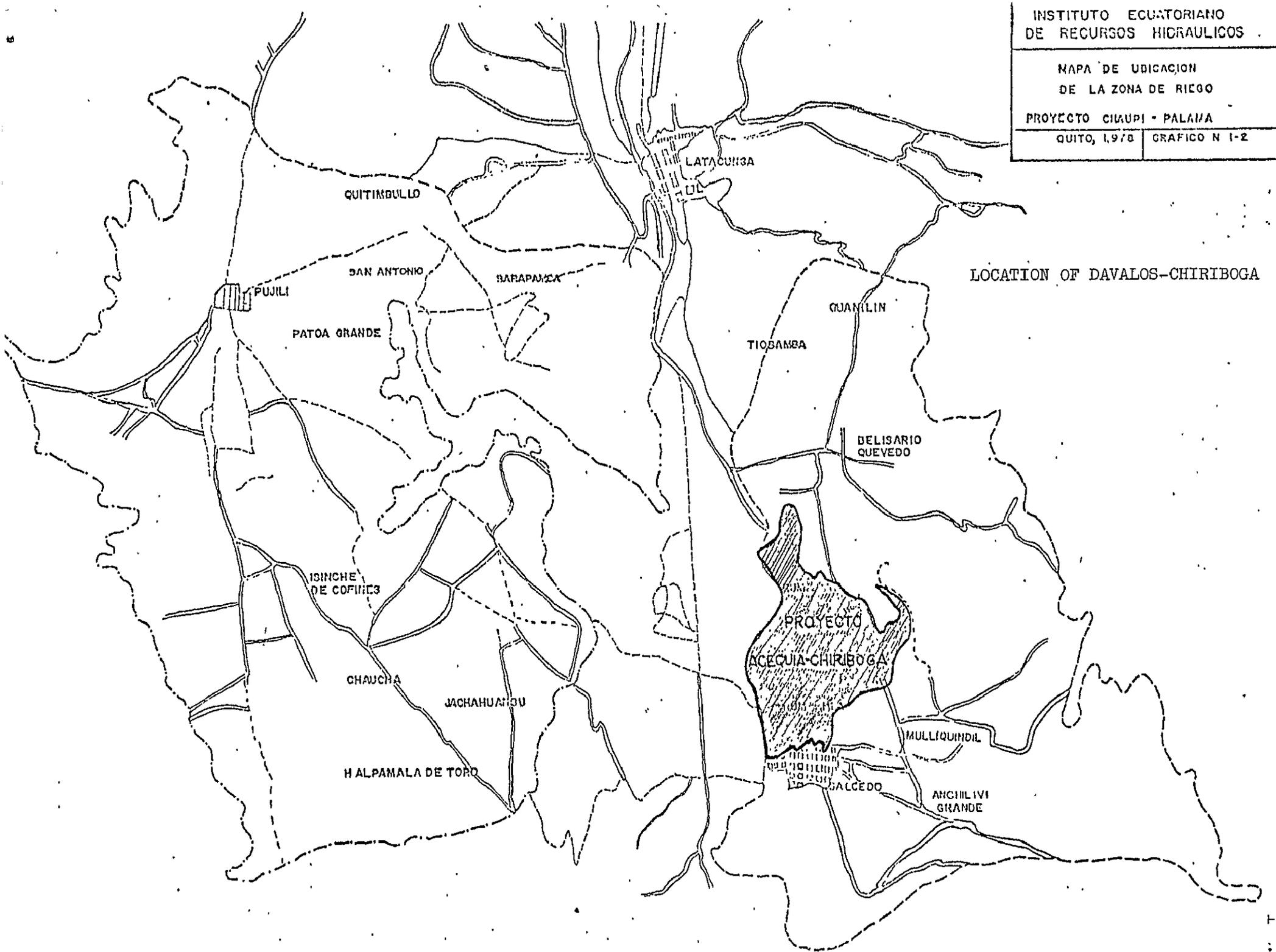
This project is bounded on the north by the Quebrada Quitilgua, on the south by the rivers Nagsiche, Cutuchi and Yanayacu, on the east by the elevation 3,050 meters on the Cordillera Central, and on the west by the elevation 3,000 meters on the Condillera Occidental. The project Chaupi-Palama is in the planning stage. Water is to be obtained from the rivers Negro, Alaguez and Cutuchi.

The construction of the irrigation works for this project involves several tunnels and transferring water from one basin to another. These problems add to the difficulty of obtaining financing for this project that the GOE has encountered. Irrigation in this area is generally done with water from small streams and springs.

1.4.4 Project Nagsiche

This project will capture waters from the Río Nagsiche at the elevation 3,000 meters and will be used to irrigate the zones of Chininche Bajo, Tayoloma, La Provincia, Mulalillo and San Ignacio. The area to be irrigated by the project is 1,500 hectares.

This project is at the pre-feasibility stage. The Ecuador IRD project proposes funding the feasibility study for the Nagsiche Project. The boundaries of the project are the Río Nagsiche on the north, on the west by the 3,000 meters elevation line, on the south by the Quebrada Puttohuayu, and on the east by part of the canal Latacunga-Salcedo-Ambato.



1.5 THE WATER PROBLEM IN SALCEDO: WATER USE INEFFICIENCY AND INSUFFICIENCY

1.5.1 Farm Water Deliveries

Most farmers receive insufficient water for irrigation and many receive this water at a frequency that is impossible to use correctly. Many times the farmer may receive only one turn per month and the water received during that turn is insufficient to irrigate his land. Table 1.10 shows the typical frequency and duration of water turns.

TABLE 1.10
FREQUENCY AND DURATION OF WATER TURNS

	Maximum Flow Lt/Sec.	Average Turns per Month	Average Hours per Month	Average Length of Canal (Km.)	Average Cost per Year US\$	Average Cost per Meters US\$
All Farms	20.2	2.2	8.0	2.7	8.7	0.012
0-1.0 Ha.	19.8	2.5	5.9	4.5	7.8	0.015
1.0-5.0 Ha.	20.1	2.1	8.3	2.0	7.6	0.011
5.0+ Ha.	21.7	2.3	14.0	2.0	20.8	0.016

Source: Salcedo Irrigation Study (83 farms) 1980.

This table shows that water delivered to farms is insufficient and that the amount of water distributed to farms does not increase as it should when the land irrigated increases. The duration of turn does increase some, but not as much as is necessary.

A farmer with 1 hectare of irrigable land who receives the normal flow of 19.8 l/sec. for 5.9 hours per month will receive 421 cubic meters of water, which, depending on his crop mix, will be close to the water required during the high demand months of November, December and January. But for this water to be used effectively by the crops, the farmers on farm water use efficiency must be near 100%! This kind of efficiency is very difficult to obtain with the current practices. It is difficult to obtain with very state-of-the-art practices. It should be noted that a farmer who irrigated only 0.5 hectares and received the same water turn would have sufficient water even with poor application and use efficiency. A farmer with 2.5 hectares and receiving the average water turn of 20.1 l/sec. for 8.3 hours per month would only receive 648 cubic meters of water. This would be insufficient water to irrigate all his land in the high water requirement months and only with good application efficiency could he irrigate all his land in normal months.

Field work showed that in some areas of Salcedo the water received is dependent upon the land to be irrigated, while in other areas the water is equally divided among all users of a canal on a ditch regardless of how much land they have. In this latter situation, the small

landholders can expect to receive almost all the water they need, while the larger landholders (1.1-5.0 hectares) will lack much water. But even in the instances where individuals receive all the water required by their crops, poor application and use efficiency greatly reduce the potential benefits.

1.5.2 Irrigation Impact on Yield in the Salcedo Area

In a dry area such as the Salcedo zone the difference in yield between a crop that is irrigated and the same non-irrigated crop yield is usually quite substantial. But from data gathered in the survey that was conducted, differences that would be expected do not exist. Table 1.11 shows the difference between irrigated and non-irrigated yields of some of the important crops in Salcedo.

TABLE 1.11
YIELD IMPACT OF IRRIGATION (Kg/Ha)

	All Farms		0-1 Ha.		1-5 Ha.		5+ Ha.	
	Irr. Yield	Non-Irr. Yield						
Cebada	606.0	598.0	618.6	607.0	596.3	594.3	644.0	604.0
Arveja	425.9	0.0	432.8	0.0	422.9	0.0	438.0	0.0
Frejol	485.0	0.0	431.0	0.0	512.0	0.0	0.0	0.0
Papas	10,120.6	7,740.5	10,194.0	7,037.0	10,181.1	7,863.8	9,365.3	7,458.0
Habas	671.0	678.2	654.5	735.0	673.8	667.3	0.0	665.0
Maiz	508.4	469.0	495.8	469.0	509.5	0.0	535.0	0.0
Alfalfa (Cargas)	172.5	0.0	174.7	0.0	172.4	0.0	171.0	0.0
Mellocos	920.0	697.0	0.0	694.0	920.0	697.8	0.0	0.0
Cebolla	8,273.0	0.0	0.0	0.0	8,273.0	0.0	0.0	0.0
Ajo	4,304.0	0.0	0.0	0.0	4,304.0	0.0	0.0	0.0

Source: Salcedo Irrigation Study (83 farms) 1980.

The most probable explanation for the slight differences in yield is that the farms that are called irrigated are really only partially irrigated. The farmer tries to water all his crops each water turn, but the water received is not sufficient to make a marked influence in the crop yield. Often the farmer with irrigation rights will suffer some of the same problems as the farmer without irrigation rights. Some problems that are occurring now are crop decreases and high insect damage. In severe dry weather the farmer with irrigation rights will sometimes not receive his irrigation turn for a number of reasons. His crop will then suffer just as the crop of the non-irrigating farmer.

1.6 FEASIBLE SOLUTIONS: FARMER AND TECHNICAL PERSPECTIVES

1.6.1 Farmer's Perspective

Of the farmers surveyed, 97% felt that more irrigation water would increase their crop production and farm income. When asked what could be done to increase the water available to them, the following results were obtained:

<u>Possible Actions</u>	<u>Percent Indicating This Would Be Important</u>
Construct new diversion structures	39%
Improve existing diversion structures	64%
Line distribution canal	77%
Put in a well	14%
Change water rights	3%

They were also asked what they could do to improve use of water on their farms. The results were as follows:

<u>Possible Actions</u>	<u>Percent Indicating This Would Be Important</u>
Level land	14%
Recapture irrigation runoff	2%
Line farm ditches	59%

1.6.2 Technical Feasibility

It is certain that more water and improved water management practices would increase yield and therefore increase the income of the farmer. The challenge comes in implementing changes that will increase the water supply and improve the farmer's practices. It must be determined which of all the alternatives are economically, physically and socially practical.

When the farmers were interviewed and 39% felt that new diversion structures would increase the available water, many probably felt that this meant a new source of water, one that was previously untapped. In the Salcedo area there are probably no new sources of surface water. It is feasible to improve the existing diversion structures by adding flumes that would measure the flow and also by general improvements to decrease losses, etc., at the diversion, both in rivers and in the primary canals. The lining of the distribution canals is a very important part of increasing the water delivered to the farms. None of the canals in the area are lined, excepting the current construction by INERHI, and filtration losses are estimated to be high. The more critical parts are the locations where the soil is quite sandy. Washouts of the canal banks are not uncommon, which means that many farmers go without water while the canal is being repaired.

Groundwater is not a very important source of water in Salcedo. Few wells exist and in many locations it is not feasible to drill wells because of the depth of the water table. There are areas where wells can be drilled and at a minimum effort because the water table is near the surface. These areas are the lower elevations in those sections of the zone where the topography is relatively flat. INERHI has done some feasibility studies on wells in the Salcedo area.

Leveling the land could increase the irrigation efficiency somewhat, but the benefits would generally not be worth the cost. There are some areas where it would be economically feasible, but these are a small percentage of all the area of the zone. Recapturing irrigation runoff is not a very feasible step because there is very little water that runs off the fields. The lining of farm ditches drew a lot of attention from the farmers surveyed. Fifty-nine percent felt this would increase their on-farm efficiency. There is a definite need for increased on-farm efficiency, but cement lining of on-farm ditches is not really practical. Other methods that can be used are lining with plastic sheeting or putting in PVC pipes to use as the distribution system on the farm. Flexible tubing is also a good way to distribute water more efficiently.

There are other methods of increasing on-farm water management efficiency. One is installing small, low-pressure sprinkler systems. These systems can be gravity fed and can greatly increase the uniformity of application. Another method would be using small pumps to lift the water above the level of the canal or irrigation ditch to allow more land to be irrigated. None of these techniques can be used as a panacea for all the small farm water management problems that exist in Salcedo, but each can be applied in some locations. The problems can be very location-dependent and the solutions are also. Many solutions are yet to be discovered and only can be through close, on-site studies.

2.1 FEASIBILITY OF INCREASING THE SUPPLY OF WATER TO SMALL FARMS

2.1.1 Improving Conveyances: Lining Canals

The main distribution canals that take water out of the rivers and carry it to the secondary distribution canals are major sources of water loss. A lot of water is lost through seepage and a lot of water is also lost at the points where water is diverted from the main canal into the secondary canals. Lining these canals could decrease the loss through seepage to about 5% and the loss in the division compartments to about 5% also. This would give a primary delivery efficiency of 90% where the current efficiency is about 60%. The cost of lining canals has been estimated by INERHI. The costs include labor to excavate and form the canals to the correct size and shape, materials for forms and setting forms, materials for cement and machinery and labor to mix and pour the cement. The canal lining proposed under the Ecuador IRD project for Salcedo will be furnished by volunteer labor from the different comunas and cooperatives that use water from the canal. With this basis, the cost per cubic meter of cement along with materials and men necessary to line a canal is calculated to be as follows:

Materials	US\$30.00
Labor	US\$12.00
Machinery	<u>US\$ 2.00</u>
	US\$44.00
30% Utilities and Taxes	<u>US\$13.20</u>
Total	US\$57.20 per cubic meter

Source: INERHI.

A canal of the size to carry 1 cubic meter per second requires 0.30 cubic meters of cement for every meter of length. Since the canals which will be lined are smaller than this, usually between 500 l/sec. and 1 cubic foot, the value used to calculate the cost of the canal lining is \$15.00 per linear meter. It is estimated that lining 16 kilometers of primary canal will increase the water supply to about 4,000 hectares. The total cost of lining these canals is estimated to be \$240,000.00.

2.1.2 Improving Diversion Structures

The existing diversion structures were generally built by the local cooperatives or comunas under the direction of INERHI or a local engineer. Some were constructed without plans or analysis. Most are not working as they should. Many cannot take water from the rivers when the streamflow is low. Diversions are being defined as the structures which take water from a river, small stream, or spring and conduct this water into a canal or ditch. Also included in this definition are the diversions from primary canals into secondary or parcel level canals or ditches. The materials required for improving diversion structures are cement, forms, reinforcing bars, metal headgates, etc. There should be measuring devices such as parshall flumes or other types placed in many of these diversions to measure the amount of water being diverted. Diversion works will be modified to allow the capture of more water when streamflow is low. Because it is impossible to give the cost per diversion structure improved, it is estimated that for the 16 kilometers of canal being relined the cost for improving the diversion structures should be \$60,000.00.

2.1.3 Groundwater Development

Because of the drought that has been affecting the area of Salcedo in recent years, there has been a desire to find other and more reliable sources than the major rivers that fluctuate according to the precipitation. The only real possibility for obtaining a new source of water is groundwater. In studies conducted in the area of Salcedo, INERHI estimated the cost of groundwater and indicated some of the locations where groundwater extraction is feasible. The INERHI study was done in what is now part of the Project Chaupi-Palama which is east of the town of Salcedo. Six wells were drilled, costs were obtained and the water quality was analysed.

The costs of each of the three wells capable of pumping 60 l/sec. averaged about \$45,000.00. The cost per cubic meter pumped averaged 1.3 cents. This is considerably more than what the farmers are paying now, but they are usually not asked to pay the full cost of the water. At 55% water use efficiency and pumping 4,000 hours per year, one pump with a flow of 60 l/sec. could irrigate approximately 128 hectares. The design and construction of the distribution system is estimated to cost \$27,000.00. This gives a total of \$72,000 per system. The following section is a brief description of the INERHI groundwater study.

2.1.4 A Hydrogeologic Study for the Chaupi-Palama Project in the Salcedo Zone by INERHI

In consequence of the drought over the past few years the rivers and streams have seen a diminishing flow. Because of this a great number of petitions have been received by INERHI and they in turn have initiated a hydrogeological study within the Chaupi-Palama Project. As a basis for the present study the report from the Cotopaxi Project, which was financed by BID, will be studied and similar information will be collected. The Cotopaxi Project originally was to comprise a surface area of 700 square kilometers; however, because of many problems this area was limited to 280 square kilometers which corresponds to the area on the right side of the Cutuchi River. The Chaupi-Palama Project will cover the area on the left side of the same river, as well as the right side.

Reviewing the hydrogeologic research work, on the right side of the river, which will serve to determine recommendations with respect to the Chaupi-Palama Project, the following is cited:

Points of leveled and inventoried aquifers	23
Tested wells and observed piezometers	6
Sounding meters (perforations)	1410 mts.
Pump tests	5
Chemical analyses	23

It also should be mentioned that transmissivity calculations, exploitable flow during pump testing, static and dynamic aquifer levels, etc. were determined.

Within the research which has been accomplished in the Chaupi-Palama Project has been a geophysics field survey. Twenty-two electrical soundings, most of which were near the Pan-American Highway, were recorded. Therefore, for the present study, two principal goals have been set which are:

a. Identification of underground water resources which are economically exploitable and which can be utilized for agricultural growth on fitting land which has been benefited by irrigation, given the lack of availability of surface water resources.

b. Determination of the most efficient and economic methods of tapping and distributing the subterranean waters in the region of study. Two forms of investigation will be used, which are:

1. Direct; by means of investigative drilling, and
2. Indirect; by means of electrical resistivity (geophysics).

The direct method was used in the research of the Cotopaxi project during which there was no consideration of the prospecting of subterranean waters using the less costly indirect

method which is mentioned above. The Chaupi-Palama Project will use this method so as to do a more extensive job with the hope of establishing the locations of underground water sources.

The drilling in the Cotopaxi Project, which is now within the Chaupi-Palama Project, was done to depths between 150 and 300 meters. The base was not found in any of the 6 perforations, but it was estimated to exist at a depth of near 500 meters. There was a correlation obtained between the materials and thicknesses of materials encountered while drilling at the various sites.

2.1.4.1 The Cost of Underground Water

To calculate the cost of elevating 1 cubic meter of water to the ground level, the following factors were considered:

The necessary investment:

- Cost of well drilling
- Pump and motor cost and installation fee
- Civil Engineering technical assistance cost

General annual costs:

- Interest on the capital investment
- Capital insurance
- Vigilance
- Amortization period of the sounding and casing equipment
- Fuel costs
- Amortization period for the pumping equipment
- Maintenance

Aspects of a technical order:

- Pump flows
- Dynamic pumping head
- Hours of pumping
- Yield
- Potential of the pumping equipment

i. Necessary Investment.

The drilling cost of a model well that would yield 60 liters/second and 40 l/sec. in each of the three selected areas is estimated as follows:

<u>Flow (l/sec.)</u>	<u>Pujili Site</u>	<u>Isiche Site</u>	<u>Salcedo Site</u>
60	\$16,264. US	\$15,444. US	\$14,836. US
40	\$14,496. US	\$13,384. US	\$12,956. US

The cost of the motors and pumps has been estimated at \$28,000. for a 40 l/sec. well and \$28,000. for a 60 l/sec. well.

The casing cost was estimated at \$2,500.

ii. General Annual Costs

The interest on the capital investment has been set at 6%.

The insurance on the capital investment will be 2%.

The salary of those engaged in vigilance is set at \$360 per year.

The amortization period for the well and casing is estimated at 25 and 30 years, respectively.

The cost of diesel fuel will be 15.6¢ per gallon.

The amortization period for the pumping equipment is 10 years.

The cost of lubricating fluids, grease, maintenance, and repairs is 15% of the total energy cost.

iii. Technical Factors

The flow of the model wells will be 60 l/sec. and 40 l/sec. in accordance with the required flows in the selected areas.

The dynamic pumping heads in accordance with the selected areas and required flows are as shown in the following table:

<u>Flow (l/sec.)</u>	<u>Pujili Site</u>	<u>Isiche Site*</u>	<u>Salcedo Site</u>
60	100 meters	65 meters	60 meters
40	90 meters	55 meters	50 meters

It is expected that pumping installations will work 4,000 hours per year.

The pumping equipment has been considered to be 60% efficient.

iii. Cost and Investment of One Cubic Meter Pumped from Model Wells in the Chaupi-Palama Project

Following are tables presenting the technical characteristics and costs of the model wells constructed through the project according to the selected areas.

*The dynamic head in this sector was taken according to data found at well 3 A of the Cotopaxi Project. This well is found at an elevation 2,883 meters above sea level, for which reason the dynamic head at higher sectors could be greater.

Pujili Site

Flow l/sec.	Diameter Inches	Depth Meters	Dynamic Head Meters	Investment Dollars	Price per M ³ Pumped
60	14	120	100	46,264.	0.0144
40	10	120	90	36,496.	0.0148

Insinche Site

Flow l/sec.	Diameter Inches	Depth Meters	Dynamic Head Meters	Investment Dollars	Price per M ³ Pumped
60	14	90	65	45,444.	0.0120
40	10	90	55	35,384.	0.0124

Salcedo Site

Flow l/sec.	Diameter Inches	Depth Meters	Dynamic Head Meters	Investment Dollars	Price per M ³ Pumped
60	14	80	60	44,836.	0.0116
40	10	80	50	34,956.	0.0120

3.1 FEASIBILITY OF INCREASING THE WATER USE EFFICIENCY ON SMALL FARMS

3.1.1 On-Farm Irrigation Infrastructure

i. On-Farm Conveyance and Diversion Devices.

The techniques used for farm level diversion in the Salcedo area are rudimentary at best. The ditch that passes the farm is generally carrying about 20 liters and the diversion to the farm is made by throwing some sod and dirt in the ditch and sealing it off so the water runs into the farm. The water usually must pass several of these diversions before it winds its way to the farm that is to receive the water. In each of these diversions a small amount of water is lost. The ditches are usually narrow and deep because of erosion. Often the diversion for the farm must be made several hundred meters upstream because of the depth of the ditch when it passes the farm. Once the water is on the farm the farmer must distribute it to his crops in an equal manner. The ditches are sometimes running straight down hill, which aggravates the erosion problem. On-farm ditches are generally small, poorly organized, and allow a great deal of seepage and other forms of loss.

The proposed solutions for these problems are to improve the diversion techniques by placing preformed metal headgates or diversion structures or by pouring small cement headgates at the points of diversion. The water diverted in these improved diversions would then go into PVC pipe to travel to the farm. Once on the farm, more PVC pipe could be used to distribute the water or flexible plastic tubing could be used in place of the rigid PVC. One possible advantage of this system is that with good filtration and enough elevation drop between the point of diversion and the farm, a low pressure sprinkler system could be used. Another way of distributing the water on the farm more uniformly would be the use of gated pipe which distributes an almost equal amount of water to each furrow.

If conditions do not permit the installation of metal or cement diversion structures, canvas or plastic dams could be supplied. These would simplify diverting the flow in a ditch. Often a farmer will have difficulty in directing the water to his farm from the distribution ditch because to reach his farm the water must cross a road, gully or some other physical barrier. To solve this problem, many ditches are divided and half runs on each side of the road or the diversion is made a long distance upstream at a point where there is a way of crossing the barrier. The water then travels in a small ditch until it reaches the farm. Problems such as this have caused the distribution system to become very complicated and disorganized. The availability of culverts could be very important when the distribution scheme is being organized or reorganized. They would allow a road or other physical barrier to be crossed wherever necessary, not just wherever possible.

All these techniques and devices—headgates, diversion structures, PVC pipe, gated pipe, flexible tubing, and culverts—can increase the on-farm water use efficiency because they will cut diversion losses, reduce seepage, allow more uniform distribution of water on the farm, and allow a better distribution system. The Ecuador IRD project plans on making these types of improvements to improve the on-farm water use efficiency in 4 000 hectares in the Salcedo area.

ii. Land Leveling and Contouring

The topography of the cultivated area in the Salcedo area varies from no slope at all on some of the land near the bottom of the valley to slopes near 20% on some of the higher, more marginal land. Irrigation is practiced on all of these lands and current practices are fairly effective in distributing water without causing erosion. On lands with slopes greater than 5 or 6% the farmers use what may be called contoured furrows. The design of these furrows combined with the low application rates of water limits erosion to almost nothing, but the application uniformity suffers. In the lands with less than a 5% slope, the farmer generally uses simple flood or furrow irrigation. The application efficiency is also low in these plots.

The terracing or leveling of the lands with higher slopes is a major task and much beyond the scope of this project. Some pilot areas should be terraced to determine the benefits versus costs of this type of change. A more feasible improvement in areas of this type where a gravity fed irrigation system is possible is to install low pressure sprinklers. The areas with a slope less than 6% can be a better location for leveling or contouring. An almost flat field can have a much higher uniformity of application and subsequently a higher water use efficiency.

iii. Small Farm Sprinkling Systems

The broken topography and small landholdings in the Salcedo area eliminate the possibility of large sprinkler systems. The most feasible system would be small, perhaps individual, gravity fed sprinklers. Much of the area in the project could be irrigated by gravity fed systems if the water were well filtered and put in pipes at a sufficiently high elevation. A similar type of irrigation system in Guatemala, small gravity fed systems obtaining water from small springs and streams and applying the water by small garden type sprinklers, has had a significant effect in increasing the yield in the farms where it has been implemented. The proposal for the Salcedo area is to implement pilot irrigation systems that will irrigate a total of 160 hectares.

iv. Pumps

In many locations the amount of land being irrigated could be increased by using pumps to lift water above the elevation of the canal or ditch. There are many exploitations above the elevation of the canals that receive a very limited amount of water or receive no irrigation water at all. Small gas powered pumps could allow the farmer to irrigate his land if the water was available.

v. Estimated Costs of Improvements

Headgates and Diversion Structures:

Within the target area of 4,000 hectares, it is estimated that approximately 1,600 small farm or parcel level diversion works can be replaced or improved. The average cost per diversion structure is estimated to be \$50.00. This gives a total cost of \$80,000.00.

Gated Pipe:

It is estimated that there will be a demand and reasonable locations for approximately 8,000 feet of gated pipe. This pipe, along with associated connections and valves, would be priced at \$5.00 per foot. The total price for the gated pipe would be \$40,000.00.

Flexible Poly Pipe:

This pipe can be used for on-farm water conveyance and should reduce on-farm water seepage or runoff greatly. There is a potential of 100,000 feet in the target area. The price with connections for this amount of flexible 2-inch tubing would be \$60,000.00.

Canvas and Plastic Dams:

The estimated demand for canvas and plastic sheeting to be used for irrigation purposes in the target area should be equivalent to material worth \$10,000.00.

Pumps:

An estimated 60 pumps could be used in the target area to lift water above its present level and irrigate more land. The estimated cost of a pump with its intake and output pipes is estimated to be \$500.00. This gives a total cost of \$30,000.00.

Land Leveling and Contouring:

To create some small pilot areas of land leveling and contouring, the estimated cost is \$12,000.00.

Culverts:

There is an estimated need for 4,000 feet of 12-inch corrugated culvert and 2,000 feet of 24-inch culvert. At a price of \$6.16 per foot for the 12-inch culvert and \$11.16 for the 24-inch culvert, the estimated total cost, including contingencies, is \$50,000.00.

PVC Pipe:

A large amount of PVC pipe will be required for farm level diversions, farm distribution and even some secondary distribution purposes. The estimated length required is 40,000 feet of 12-inch, 75,000 feet of 8-inch, 100,000 feet of 6-inch, 100,000 feet of 4-inch and 200,000 feet of 2-inch. The estimated cost of this pipe together with connections and filtration devices is \$500,000.00.

3.1.2 On-Farm Water Management***i. Cultivation Practices***

Studies have shown that a change in cultivation practices can increase the water use efficiency and also yield. In an AID funded study in the Aconcagua Valley of Chile, farmers growing irrigated corn were able to double yields by combining these methods:

- a. Furrow irrigating rather than flood irrigating.
- b. Conserving spring moisture by better seedbed preparation.
- c. Adjusting fertilizer application rates (sometimes downward).
- d. Adjusting planting rates.
- e. Incorporating crop residue in the soil surface to increase infiltration rates.

Comparisons of production under furrow and sprinkler irrigation have been made in El Salvador. Table 3.1 indicates kilograms of production per cubic meter of water applied for three different crops.

TABLE 3.1
THE PRODUCTION OF CORN, MELON AND PEANUTS PER UNIT OF WATER
APPLIED UNDER FURROW AND SPRINKLER IRRIGATION

Crop	Irrigation	Production Kg/M ³ of Water Applied
Corn	Furrow	0.51
	Sprinkler	1.07
Melon	Furrow	9.53
	Sprinkler	12.25
Peanuts	Furrow	0.28
	Sprinkler	0.15

Source: Utah State University.

It can be seen that for peanuts, furrow irrigation gives a higher production rate per cubic meter of water applied than sprinkler irrigation. The opposite is true for corn and melon. There are similar differences in other crops.

This type of information needs to be disseminated to the local farmers through technical assistance. New practices should be introduced and the farmers should be made aware of the benefits of applying these new techniques. Where farming practices have been essentially the same for hundreds of years there are many changes that can be introduced that will have a significant effect on the efficiency of water use and crop production.

ii. Water Management for Intercropping

Intercropping has many advantages to the peasant farmer trying to feed a family with produce from a small farm or garden. This is the most intensive type of farming. It makes the best possible use of growing time and space. It gives the family a variety in the diet and may provide protection against complete mono-crop failure.

Many of the farmers that can use the system are in tropical and semi-tropical climates where the soils have a high fertilizer requirement and also need lime. The fertilizers, if not utilized by the crops, are soon fixed by the soil or are leached from the root zone. This intensive system of farming enables the grower to recover a greater proportion of the expensive fertilizer and lime he purchases. There are, however, some hazards that accompany this type of crop culture. If there are periods of drought, the crops on intensively cultivated land suffer more damage than would most single crops. Because of this hazard, the practice should be adopted only where the probability of adequate rainfall is very favorable or where irrigation can be provided. Where irrigation is necessary, the acreage should not be expanded such that water requirements of the crops exceed the supply. One problem in comparing the demand and

supply lies in the fact that little information is available on the water requirements of various crop combinations at the various stages of their growth. A study that would indicate the water requirements under a multicrop system would be very useful for the designed of any irrigation system that would supply water to farms with this type of cultivation.

iii. Irrigation Scheduling

When irrigation water is at a premium, as in the Salcedo area, irrigation scheduling becomes very important. To simplify, irrigation scheduling means deciding how much water to apply and when to apply it for the highest water use efficiency. The calculation of irrigation scheduling takes into consideration the soil water holding capacity, the root depth of the crop, the stage of growth of the crop, crop variety, and the climate. The average farmer in the Salcedo area does not consider irrigation scheduling at all. He will take the water when he can and will try to apply it to all his crops. The amount of water he applies will be according to his own judgment. When he applies the water will depend upon the irrigation schedule on the canal from which he gets his water. These schedules are usually set up for fair distribution of the water, not according to the water requirements of the crops. On most of these canals there is a need for a complete reorganization of the water distribution system.

Agriculture in the Salcedo area is dependent upon the precipitation and irrigation water received. Crops in this area are planted according to traditional planting times which may not be the best time to plant them. The farmer should consider his irrigation schedule and probable rainfall patterns when planting. The main reason for this is to avoid the critical periods for soil water stress. A lack of water in these periods can cause a major decrease in yield that would not be so severe if the stress occurred at another period in the plant growth. Table 3.2 gives these critical periods for some crops.

For the small-scale peasant farmer who cannot schedule his irrigation but must irrigate when the water is delivered, having some flexibility in when he plants his crops to avoid stressing them at critical periods can make a big difference in the yield obtained. There are many factors to be considered when planting—the fertilizer-water-variety interactions are complicated. Very few farmers in the area are familiar with these problems; they really don't have the time or the interest to find out new techniques, varieties, etc. This emphasizes the need for good technical assistance.

4.1 SURVEY METHODOLOGY

4.1.1 Area Frame Sample Selection

The universe was defined as all farms falling inside the Cantón of Salcedo. The boundaries of the cantón were defined on a 1 to 50,000 map. This area was stratified and portions taken out of the universe because of high elevation and/or very sparse habitation. From within the remaining sections of the cantón a sample was drawn by making a random selection of the one kilometer square grids that are on the map. Ten 1 kilometer square grids were selected this way. The next step was to mark these grids on a series of 1:25,000 maps that covered the same area. On these maps the sample areas were selected by finding one or

TABLE 3.2
CRITICAL PERIODS FOR SOIL WATER STRESS FOR DIFFERENT CROPS

Crop	Critical Periods
Alfalfa	Just after cutting for hay and at the start of flowering for seed production.
Apricots	Period of flower and bud development.
Barley	Early boot stage > soft dough stage > onset of tillering or ripening stage.
Beans	Flowering and pod setting period > earlier > ripening period. However, ripening period > earlier if not prior water stress.
Broccoli	During head formation and enlargement.
Cabbage	During head formation and enlargement.
Castor Bean	Requires relatively high soil water level during full growing period.
Cauliflower	Requires frequent irrigation from planting to harvesting.
Citrus	Flowering and fruit setting stages; heavy flowering may be induced by withholding irrigation just before flowering stage (lemon).
Cotton	Flowering and boll formation > early stages of growth > after boll formation.
Groundnuts	Flowering and seed development stages > between germination and flowering and end of growing season.
Lettuce	Requires wet soil, particularly before harvest.
Maize	Pollination period from tasselling to blister kernel stages > prior to tasselling > grain filling periods; pollination period very critical if no prior water stress.
Oats	Beginning of ear emergence possibly up to heading.
Olives	Just before flowering and during fruit enlargement.
Peaches	Period of rapid fruit growth prior to maturity.
Peas	At start of flowering and when pods are swelling.
Potatoes	High soil water levels; after formation of tubers, blossom to harvest during period of root enlargement.
Sunflower	Possibly during seeding and flowering — seed development stage.
Small Grains	Boot to heading stage.
Sorghum	Secondary rooting and tillering to boot stage > heading, flowering and grain formation > grain filling period.
Soybeans	Flowering and fruiting stage and possibly period of maximum vegetative growth.
Strawberries	Fruit development to ripening.
Sugarbeet	3 to 4 weeks after emergence.
Sugarcane	Period of maximum vegetative growth.
Tobacco	Knee high to blossoming.
Tomatoes	When flowers are formed and fruits are rapidly enlarging.
Turnips	When size of edible root increases rapidly up to harvesting.
Watermelon	Blossom to harvesting.
Wheat	Possibly during booting and heading and two weeks before pollination.

Source: FAO I & D Paper No. 24 (6).

two areas within each of these grids that would be identifiable in the field. The areas were identifiable because they were bounded by roads, canals, rivers, or some other physical boundary. A total of 17 different areas were selected in this manner.

4.1.2 Questionnaire

The questionnaire used in the survey field work is found on the following two pages.

4.1.3 Survey Field Work

The field work for the survey was done on the 5th, 6th, and 7th of June. Interviews were conducted by Karl Hancock and members of the Ministerio de Agricultura who work in the PIDA-Salcedo area. The Salcedo area is divided into five sections by the Ministry of Agriculture—each section has an agronomist assigned to it. The agronomist is familiar with the area and knows many of the individual farmers. In each of the survey areas the agronomist assigned to that section and one or two others always went into the field to conduct the survey. The presence of someone familiar helped the interviewee feel more at ease and able to respond without fear. In the course of the field work, only one area was not visited, segment 16, because time did not allow it.

The total number of interviews obtained was 86. This number was less than expected because a lot of the farmers were not at home when the interviewer stopped because of some celebrations that were occurring. Some problems occurred relating to the questionnaire. It was hard to determine what crops were irrigated because the farmer felt that if he had ever put water on the crop then it was irrigated. There was also some difficulty in estimating yields, particularly alfalfa, because it is usually just grazed. The quality of the data corresponding to farm size, crop mix and credit is considered to be very good. The data corresponding to area of crops, crops irrigated and irrigation water is considered good. The yield information is only fair.

The sample was expanded to the universe by breaking the observations into farm sizes and then calculating expansion factors from available information on the number of farms and total hectares in each farm size.

Entrevistador _____ Segmento N° _____ Lugar _____
 Duración de la encuesta _____

SECTOR DEL AGRICULTOR

1. Tamaño total de la finca _____
2. Area Cultivable _____
3. Area Regable _____

1. CULTIVOS IMPORTANTES DE LA FINCA

CULTIVO	HECTAREAS	RENDIMIENTO ULTIMA COSECHA	
		kilo por	Ha.

2 a) QUE CULTIVOS FUERON REGADOS:

ESTE AÑO		EN 1975	
CULTIVO	HECTAREAS	CULTIVO	HECTAREAS

Duración Turno Veces en el mes

2 b) Con cuánta frecuencia recibe agua de riego

	Lt/seg.

Qué cantidad de agua recibe?

2 c) Cuántos metros mide su acequia desde la fuente de agua hasta la finca? _____ M.

Cuánto paga por agua de riego? S/ _____ por _____

Puede comprar más agua si lo desea? Si _____ No _____

Tiene conflictos o problemas relacionados con sus derechos de agua? Si _____ No _____

Explíquelos: _____

3.Cuál sería su prioridad para conseguir más agua?

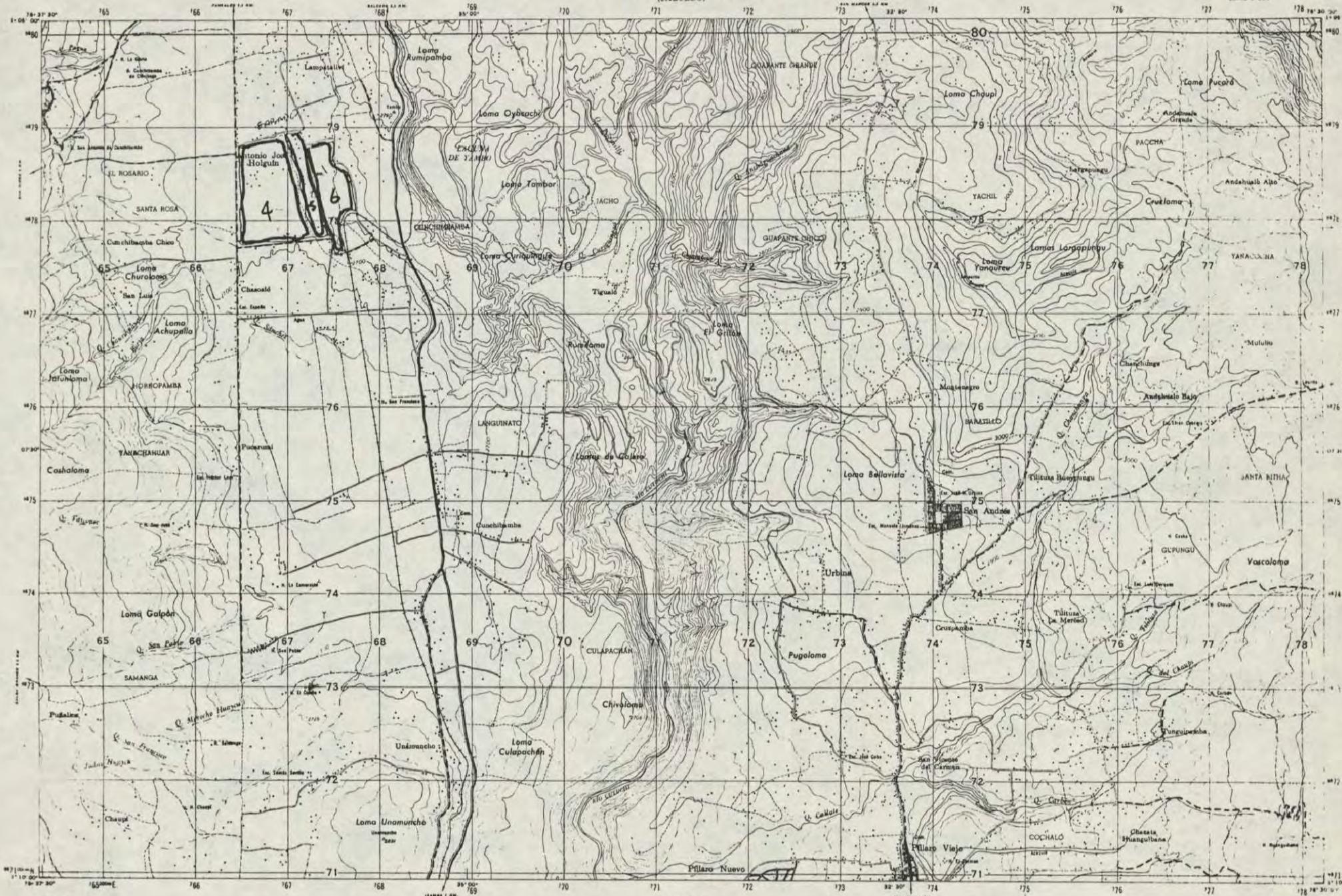
- Nuevas bocatomas
- Mejoramiento de bocatomas
- Revestimiento de la acequia
- Instalación de un pozo
- Cambiar sus derechos de agua
- Otras medidas

PRIORIDAD		
1	2	3
1	2	3
1	2	3
1	2	3
1	2	3
1	2	3
1	2	3

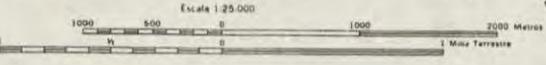
4. Qué haría para aprovechar más su agua?

- Nivelar la tierra o hacer terrazas
- Recaptación de escurrimiento superfic.
- Revestimiento de Acequias en su Finca

PRIORIDAD		
1	2	3
1	2	3
1	2	3
1	2	3



SERIE J821
Escala 1:25.000
Preparado por el Instituto Geográfico Militar (I.G.M.) en colaboración con el Interamericano Geodésico Survey (I.A.G.S.). Fotogrametría Aérea tomada en febrero de 1961; Control Horizontal y Vertical de 1.953 a 1.961; Demarcación por Método Fotogramétrico 1.967; Dibujo 1.970.



IMPRESO EN LOS TALLERES GRÁFICOS DEL INSTITUTO GEOGRÁFICO MILITAR
DERECHOS RESERVADOS CONFORME A LA LEY - JUNIO 1971

SAMPLE SURVEY SEGMENT MAP



SERIE 3822
Edición 1:1 G.M
Preparado por el Instituto Geográfico Militar (I.G.M.) en colaboración con el Interamericano Geodetic Survey (I.A.G.S.). Fotografías Aereas tomadas en Febrero de 1961. Control horizontal y Vertical de 1953 a 1961. Computación por Método Fotogramétrico (1961). Dibujo 1970.



IMPRESO EN LOS TALLERES GRAFICOS DEL INSTITUTO GEOGRAFICO MILITAR
DERECHOS RESERVADOS CONFORME A LA LEY N.º 4611 DE 1972

5. INSTITUTIONAL AND LEGAL FACTORS

5.1 DESCRIPTION OF THE CURRENT LEGAL AND INSTITUTIONAL FRAMEWORK

5.1.1 *The Water Law of 1972*

The enactment of the New Water Law by Executive Decree on May 18, 1972 was an important event in irrigation history in Ecuador. Up to this time there had been a Water Law of 1936 and an Irrigation and Drainage Law of 1944, both of which had regulated some aspects of water use and development throughout the country, though they were both limited in scope. Other laws also existed on the books which specified water use requirements for certain specific purposes such as mining, navigation, and the like.

The New Water Law of 1972 is based on three basic and fundamental principles, all of which represent radical changes from previous practice.

First, the law declares all waters to be national property for public use. This eliminates private ownership of water and water use rights. This provision is amplified by the declaration that the waters of rivers, lakes, lagoons, springs that rise and die within the same property, subterranean water regardless of where it is raised, snows, natural water falls and other water sources (mineral, thermal, etc.) are national property for public use. This public ownership cannot be lost nor transferred by any method of appropriation or prescription. No private rights of water ownership exist nor can they be acquired. All private water ownership rights that existed before enactment of the law have been abolished.

Second, all water use rights of any nature must be granted and authorized by the Ecuadorian Water Resources Institute, known as INERHI. This means that all irrigation use rights must be applied for, granted and registered by this agency. Riparian use rights heretofore recognized are abolished by the law.*

The third concept of the law is the centralization of authority in INERHI for the administration and adjudication of all waters of the state. The law gives INERHI the authority to control, administer, use and adjudicate all national waters, and gives this government agency wide powers and responsibilities. In other words, INERHI is charged with responsibility for the complete implementation, in every regard, of the new water law.

The current Water Law of 1972 and the existing Civil Code currently contain most of the substantive provisions related to water rights. A majority of the procedural type provisions related to water administration are also found in the new Water Law. In addition, the law creating INERHI as the basic water administrative organization for the country also contains both substantive and procedural provisions. There is also a set of written regulations (reglamentos) which define and amplify the basic concepts of the Water Law and which primarily set forth the procedures for its implementation.

*Riparian rights are preferred water use rights to landowners bordering streams or other water sources.

In addition, the following codes and laws also relate to water use in the areas suggested by their titles. They are Civil Procedure, Penal, Health, Mining, Agrarian Reform and Colonization, and Roads. However, the Water Law of 1972 is the overall governing legislation currently in force.

Some general considerations in current water regulating legislation are the following:

- a. The formation of water user associations (such as now exist in Salcedo) is mandatory when more than five water users have water use rights from a common water source. They are to be structured along general corporate lines and are subject to the technical, legal, and administrative supervision of INERHI. Previous to the new Water Law there was no such requirement.
- b. All water users are required to register their water use right with INERHI.
- c. All water use rights of any nature are defined as a right of water utilization and are a nontransferable administrative authorization. This right to the utilization of water may be acquired by anyone who possesses real property or by an industry in which the water will be utilized. Utilization rights are granted by INERHI through its regional agency offices.
- d. The principle of beneficial use is supported by stipulations in the law that water utilization rights be limited in quantity by the amount of water that can be beneficially used. Also, water use rights cannot be sold, rented, or transferred. Water use rights are limited to the availability of water and the actual needs of the user. All of this is to be regulated and controlled by INERHI.
- e. Water use right concessioners are required to pay an annual water use tax, to be collected by INERHI.
- f. Concessions for water utilization are granted in accordance with these priorities: (a) community supply, domestic needs and animal watering; (2) agriculture and livestock activities; (3) energy, industrial, and mining uses; and (4) other uses.

Most of these provisions are a direct result of the Water Law of 1972 and represent an abrupt shift in national water policy from previously existing legislation and practice. However, because they are deviations from past laws and customs, the actual implementation and administration of the law has been extremely time consuming and difficult to enforce. During the past eight years since the law's enactment INERHI has made some progress in insuring that the many provisions of the law are met. One must realize, however, that the Water Law, in many of its aspects, has not yet been fully implemented. Consequently, many water use rights are currently being exercised in the same manner as they traditionally had been prior to 1972. In the Salcedo area, for example, the law has had some impact on water use and distribution, though not nearly as extensive in reality and the law would suggest. By and large, water users along the traditional canals (acequias) in the Canton continue to divert, convey, distribute, and use irrigation water in the same fashion as they always have done.

5.1.2 *Ecuadorian Water Resources Institute, INERHI*

i. General Considerations

INERHI is a semiautonomous government institution attached to the Ministry of Agriculture but with independent control over its programs and revenue expenditures. It was created by executive decree on November 10, 1966, for the purpose of "executing the best possible beneficial use and protection of the water resources of the country, as an essential element for its (the country's) economic development."*

According to the law creating INERHI, it was given the following responsibilities and characteristics:

- a. Execute a National Irrigation Plan in conformity with the General Plan of the Economic and Social development of the country, in cooperation with the Director General of Agriculture and the National Planning Board.
- b. Plan, study, construct, and exploit irrigation and drainage systems on its own or in cooperation with other institutions or entities.
- c. Establish, according to forthcoming regulations, technical norms and specifications for persons constructing irrigation and land reclamation systems.
- d. Determine whether or not such construction projects are in conformity with these norms before construction begins.
- e. Promote organizations or entities consisting of water users; establish norms for the administration and conservation of irrigation canals; and approve the internal regulations governing Water User Associations in the country according to law.
- f. Carry out, in conjunction with the National Meteorological and Hydrology Service, the evaluation of the water resources of the nation; establish a complete inventory of these resources and maintain it current at all times.
- g. Collaborate with other entities for the beneficial use and protection of river basins.
- h. Promote the establishment of private and mixed irrigation enterprises, including capital assistance, and stimulate the investment of capital in irrigation works.
- i. Study and determine water requirement needs in irrigation and other water uses in order to establish just limitations upon water use rights and adjoining rights of way; set sufficient reserves for the irrigation of dry lands and for all other purposes necessary for the development of the country.
- j. Transact requests for water use right concessions.
- k. Maintain a register of water use concessions granted by the State.
- l. Lend technical assistance to public and private entities and to private persons as set forth in regulations.
- m. Contract loans with national, foreign, and international entities for the funding of works which the Institute (INERHI) must execute to fulfill its responsibilities according to legally existing directives.

*Decreto No. 1551. Ley de Creacion del Instituto Ecuatoriano de Recursos Hidraulicos. Quito, Ecuador. 1966. Chapter 1, Article 2.

- n. Levy a water use tariff on users for its (INERHI's) services, and fix the amounts of said tariffs.
- o. Exercise all other functions which may be established for INERHI by law.

In addition to the above responsibilities, INERHI was given even greater jurisdiction over Ecuador's water resources, including irrigation control, by the Water Law of 1972. Title XVIII, Article 79 of the law, places responsibility for its execution directly on INERHI. This law eradicated all previous water use rights of any nature, both legal and assumed, and declared all water resources to be the sole property of the State. Water use right concessions are granted to individuals or entities by the state through INERHI. This law also gives INERHI the legal authority and obligation to protect and study river basins and all other national water resources, direct and control irrigation water user entities, prevent the contamination of water resources, control the use of subterranean water, and ultimately, be the judge in first, second, and even final instances when any litigation over the law occurs.

As near as possible, this is a de jure description of INERHI'S legal duties and obligations.

ii. INERHI Organizational Structure.

INERHI's organizational structure as set forth by law and legal regulations is as follows (see INERHI Organizational Diagram, Chart 5.1):

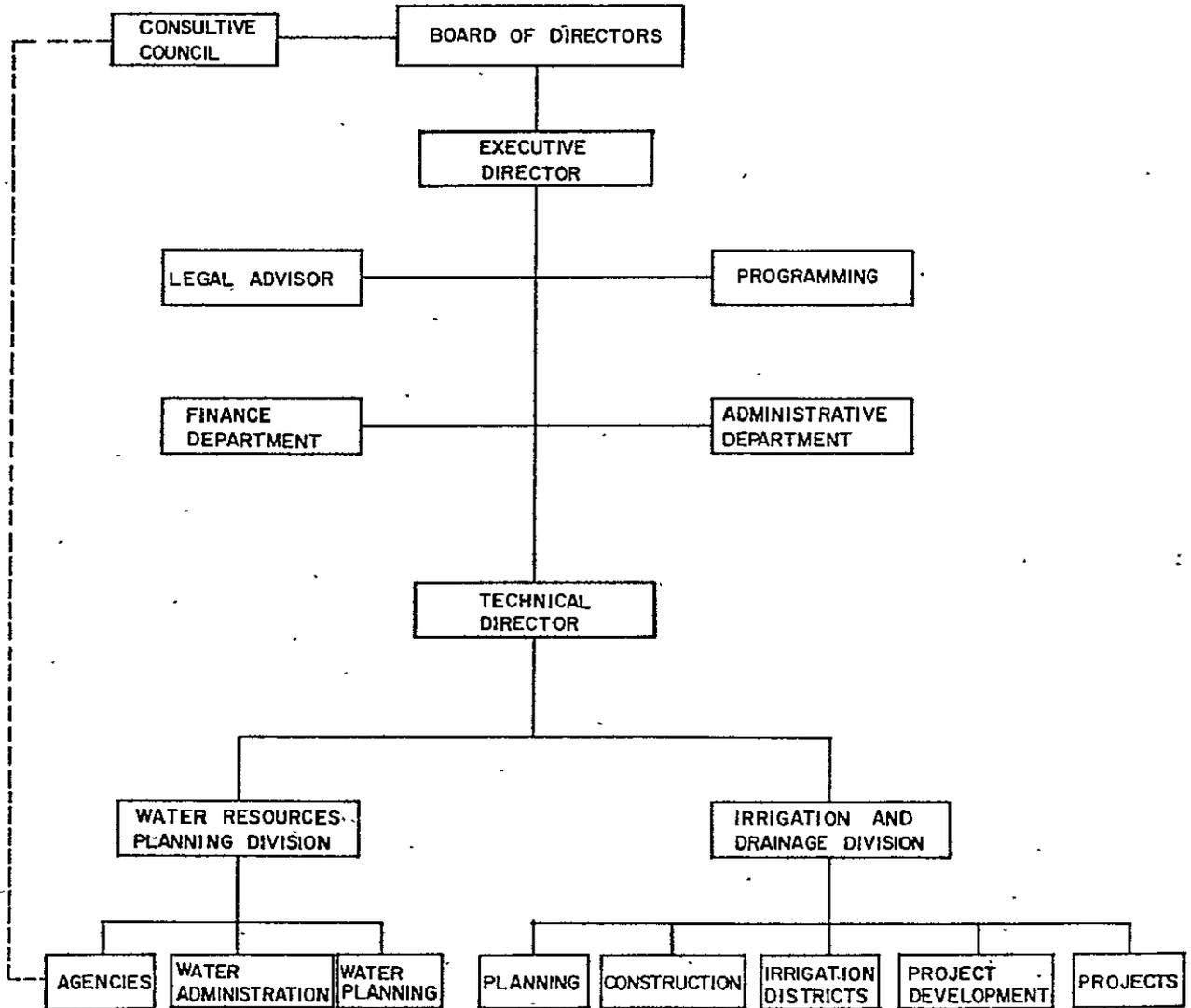
INERHI is governed by a five-man Board of Directors of which the President is the Minister of Agriculture. The other four members consist of: (1) a delegate from the National Planning Board; (2) the Executive Director of IERAC (Ecuadorian Agrarian Reform and Colonization Institute); (3) a representative from the agricultural business sector; (4) the Manager of the National Development Bank or his representative; and (5) two farm workers' representatives, one from the coast and one from the sierra. These latter two positions were added by Executive Decree No. 07 of January, 1976. The Executive Director of INERHI is selected by the Minister of Agriculture and serves as Secretary of the Board. In his capacity as Secretary, he gives information and counsel but has no actual voting power.

Principal duties of the Board are to: (1) establish and approve the general policies and programs of INERHI; (2) approve programs involving government funds in excess of S/.1,000,000 Sucres or contracts of major importance; and (3) approve permanent personnel recommendations made by the Executive Director.

Although the Board sets forth general program policy, the Executive Director is left with wide discretionary power over actual program implementation. The Board is not a policy-implementing body. According to statute, the Board should meet on a regular bimonthly basis, but this has not always been possible so the periods between sessions are often longer.

The Consultive Council of INERHI has no direct policy or program decision-making authority over the Institute but should be mentioned here. The primary responsibility of this body is to act as the judge of second and last instance in the adjudication of cases arising from the application of the Water Law of 1972. It consists of three voting members and a secretary. The members of the Council are the Executive Director (or in his absence he can delegate this duty to the Director of the Division of Water Resources Planning), and two members from the Board of Directors, one of whom is to be the agricultural business sector representative.

CHART 5.1
 ABBREVIATED ORGANIZATIONAL DIAGRAM: INERHI



INERHI's Legal Counsel acts as the Secretary to the Consultive Council but is not a voting member. This body was established by the Water Law of 1972, Title XVIII, Article 81.

The Executive Director is the chief official at INERHI. He is followed in line of authority by the Technical Director who oversees, on a daily basis, the programs, activities, and operations of the various divisions.

Each of INERHI's various offices, divisions, and departments can be classified as at either the administrative-support level, or program-operational level. The different administrative and support departments and offices handle the everyday administrative affairs of INERHI's central offices. They consist of Public Relations, Internal Auditing, Legal Counsel, Programming, Human Resources, General Finance, and General Administration as principal offices.

Operational level programs fall directly under the Technical Director. The two main divisions are the Division of Water Resources Planning and the Division of Irrigation, Drainage, and Flood Control.

The functions of the Irrigation, Drainage, and Flood Control Division are primarily the planning and study, construction, and exploitation of irrigation projects. Its five departments are Planning, Projects, Construction, Exploitation, and the fifth consists of the State operated irrigation districts. This division is responsible for most of INERHI's technical design and study operations.

The Division of Water Resources Planning consists of three main subdivisions. They are the Department of Water Resources Planning, the Water Administration and Protection Department, and the various regional agency offices throughout the country. The first of these is primarily responsible for river basin planning. The latter two are charged with the day to day execution of the Water Law of 1972.

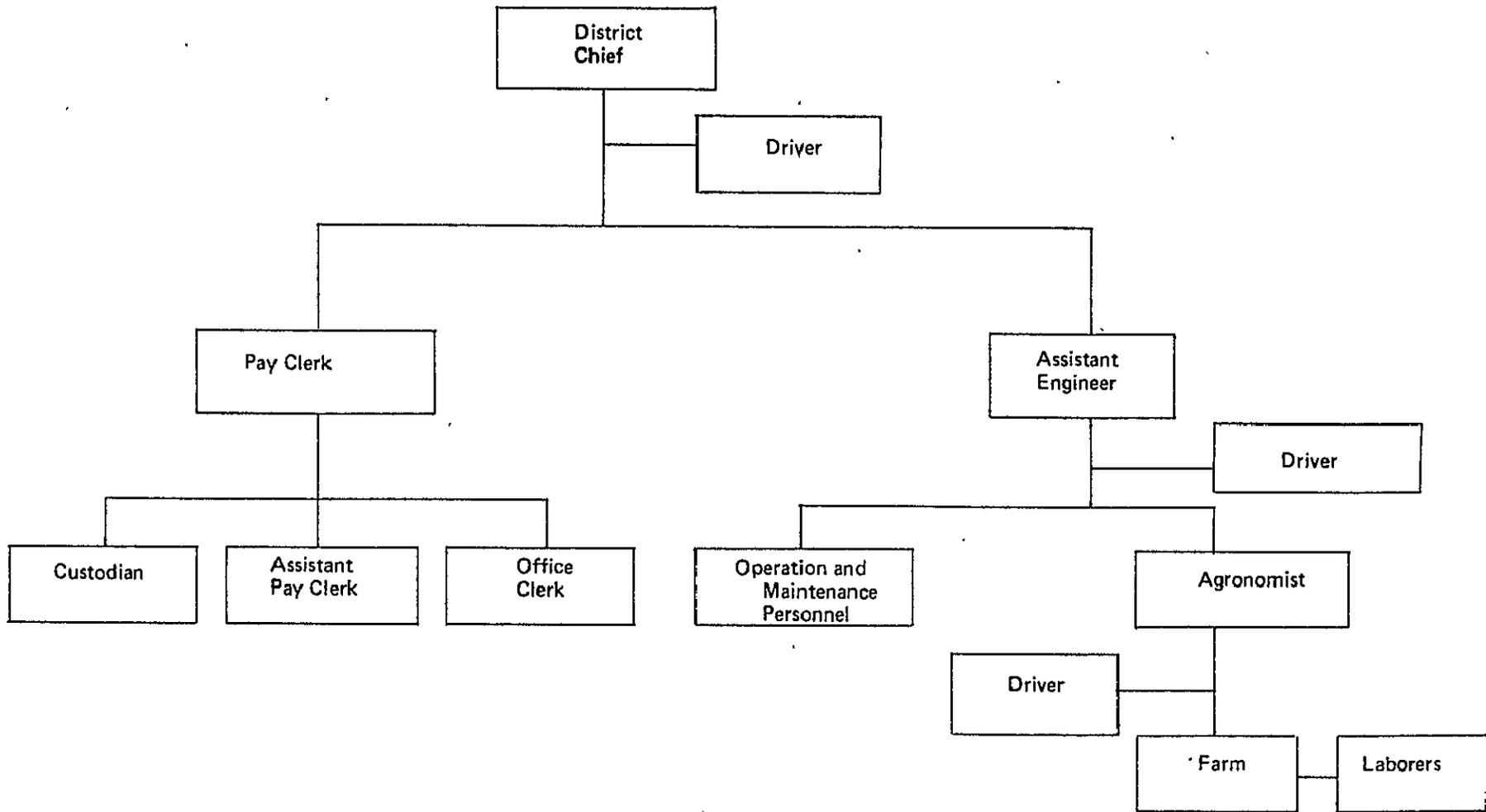
The area agencies (*agencias*), which number ten throughout the country, are the principal offices through which the Water Law is applied. The INERHI agency office responsible for the Salcedo project is located in Latacunga. These offices are responsible for carrying out the provisions of the Water Law in their respective geographic regions, and are INERHI's legal arm for implementing its responsibilities under the law regarding the granting of use right concessions, the charging of water tariffs, and the overall control of water use throughout the country. The agencies, however, do not construct, operate, or maintain irrigation systems or canals of any kind, as do the INERHI irrigation districts. Agencies act as judge in the first instance on any cases arising out of application of the law in their respective jurisdictions.

INERHI currently operates seven major irrigation districts located throughout the country. Five are in the sierra and two are in the Guayas Basin on the coast. Each of these districts has been constructed, and is largely operated and maintained, by state funding. Many were constructed in the late 1940's by INERHI's predecessor, the National Irrigation Bureau (Caja Nacional de Riego).

Operationally, each district diverts and distributes irrigation water through a system of primary and secondary canals to the user, who through his own private ditches or tertiary canals conducts the water from that point to the actual point of use. Water is administered and distributed on a rental-type basis through individual contracts between the district and the water users for a specified volume, price, and time of delivery. This is, of course, a very simple

CHART 5.2

STRUCTURAL DIAGRAM OF AN INERHI IRRIGATION DISTRICT



explanation of what is often a complicated operation considering the variety of circumstances and conditions which exist in each individual district.

All the districts are structurally organized in similar fashion with slight variations according to the needs and circumstances of each. An example of such structure can be seen in Chart 5.2.

In none of these districts does INERHI supply all the irrigation water used by every farmer located within the district. Neither do all potential users even irrigate. In other words, the districts themselves are not areas in which everyone employs irrigation practices. Not all property owners within the districts irrigate, and not all of those who do irrigate use water supplied by INERHI. The new Water Law now requires either mandatory use or tariff payment whether or not one uses water from the district's canal system. Through this method it is hoped that INERHI will be able to contract out all the water potentially deliverable. Related to this, another common feature of all the state operated irrigation districts is that they cost more to operate in one year than the income received from rental contracts. This has added to the financial burdens under which INERHI must function since cash transfers from the central office are required to keep the districts functional.

INERHI does not at present operate any irrigation districts within the geographical area of the Salcedo project. However, there are several INERHI projects in the area which will have an impact on future irrigation. These have been discussed previously but are recapped in the following section.

5.2 IRRIGATION INSTITUTIONAL FRAMEWORK IN THE SALCEDO PROJECT AREA

5.2.1 Private Irrigation Institutions

i. Historical Setting

Irrigation has long been practiced in the Ecuadorian "sierra." Since the pre-colonial period many Indians of the highlands have practiced irrigation in some form. Crude irrigation systems were constructed and operated by the Inca Empire, whose northern headquarters were located in Quito. Nearly all the old canals and ditches were later destroyed and virtually all the irrigation workers in operation today have been constructed in the post-colonial and modern eras.

Until 1944, irrigation development in Ecuador was entirely dependent upon the private sector. However, in August of that year an autonomous government entity called the National Irrigation Bureau was created to construct irrigation projects through public means. This was in compliance with the Water Law of 1936 and the Irrigation and Drainage Law of 1944, which placed certain obligations upon the state to develop irrigation. Currently, approximately 25 percent of irrigation in the country is through public projects.

Although irrigation methods have always been employed in numerous mountain valleys throughout the Ecuadorian sierra, they have been well known and practiced over a long period of development in the territory in the provinces of Turguragua and Cotopaxi, the province in which the canton of Salcedo is located. This is an area of traditionally less rainfall than others of the sierra and the need for irrigation has been greater. A brief description of the water

history of this region will aid in more clearly understanding the development of private irrigation practices and organizations.

Beginning several hundred years ago, much of the productive land in these areas was divided among very large *haciendas*. This type of landholding is termed *latifundia*,* the extreme opposite of *minifundia*. These haciendas were originally awarded to various people as a concession from the colonial government that was later passed on through inheritance.

Between 150 to 200 years ago the large land owners began to construct irrigation canals, utilizing the Indian labor from those people who lived and worked on the hacienda. Upon the completion of such canals the hacienda owners would rent or sell the water to the Indians who had built the canals or other users who would pay for it.

Two significant things have occurred during the last century. One is that many haciendas no longer exist today because they have been subdivided and fragmented into smaller units. Second, in many cases the water rights and land titles were sold separately and therefore do not necessarily correspond to one another. The relationship between land titles and water use rights has become, in many cases, confusing.

The unregulated history of water rights and land sale led to several serious conditions which are still evident in some areas. The first was the previously mentioned controversy over legal water rights and land titles. The second was the resulting high cost of obtaining a water right. Consequently, in the past, when a person bought a water use right, he made a considerable investment. He often recovered part of this investment by renting his water at extremely high prices to subsistence farmers who absolutely needed the water to survive. This exploitation of the rural poor is a social injustice which rose to alarming proportions in Ecuador. In an effort to bring this situation to a halt, the Water Law of 1972 absolutely prohibits the sale, purchase, or rental of water by private individuals.

ii. Water User Associations.

This history of water and land transactions has also left another lasting impression on irrigation development in the sierra. Fundamentally, this condition prompted many farmers, especially small landowners of *minifundistas*, to come together into groups for the common purpose of jointly acquiring water for irrigation and then administering that water among themselves. Clusters of users along a canal or section of canal began to organize in order to secure and administer an independent source of water which they would acquire and use as a group. This custom of banding together into private water distribution organizations is common throughout the sierra but has been most predominant in the provinces of Tunguragua and Cotopaxi. Table 5.1 is a listing by province of formal water user associations in 1973.

Many of these associations have been organized according to legal statute and are, therefore, recognized by the law as legal entities which have power to enter contracts and agreements. Others, however, have traditionally existed as informal organizations for many years,

*Latifundia are large farms with sufficient land to employ a group of workers much larger than the owner or the family of the owner.

TABLE 5.1
FORMAL WATER USER ASSOCIATIONS BY PROVINCE

Region	Province	Number
<u>Sierra</u>	Azuay	10
	Bolivar	0
	Canar	1
	Carchi	4
	Cotopaxi	50
	Chimborazo	23
	Imbabura	37
	Loja	3
	Pichincha	24
	Tungurahua	98
	<u>250</u>	
<u>Coasta</u>	El Oro	0
	Esmeraldas	0
	Guayas	0
	Los Ríos	0
	Manabí	1
	<u>1</u>	
<u>Oriente</u>	Morona Santiago	0
	Napo	0
	Pastaza	0
	Zamora Chinchipe	0
	<u>0</u>	
	Total	<u>251</u>

Source: Anderson, D. Craig. Irrigation Water Management in Ecuador. Unpublished Master's Thesis. Utah State University, Logan, Utah. 1973, p. 80.

and may or may not have internal operating statutes or regulations and are not legal bodies according to general laws governing such institutions.

The oldest of these water user associations date back to the 1930's, but they continue to be created even at the present time. They are most commonly known as Directorios de Agua or Juntas de Usarios, hereafter referred to as water user associations, and serve much the same purpose as canal companies in the Western United States. These user associations have become very important as irrigation distribution organizations in Ecuador, and they are by far the most numerous of any formal irrigation institutions, public or private. For the most part, water user associations function well and are responsible for the delivery of a great deal of irrigation water.

It would be impossible to describe the varied circumstances under which every water user association functions, for there are over 250 such organizations throughout Ecuador which have been legally formed. It would be nearly impossible to estimate the many additional ones which exist but which have no legal or formal by-laws. The following paragraphs, however, present a general picture of what these organizations are and how they operate.

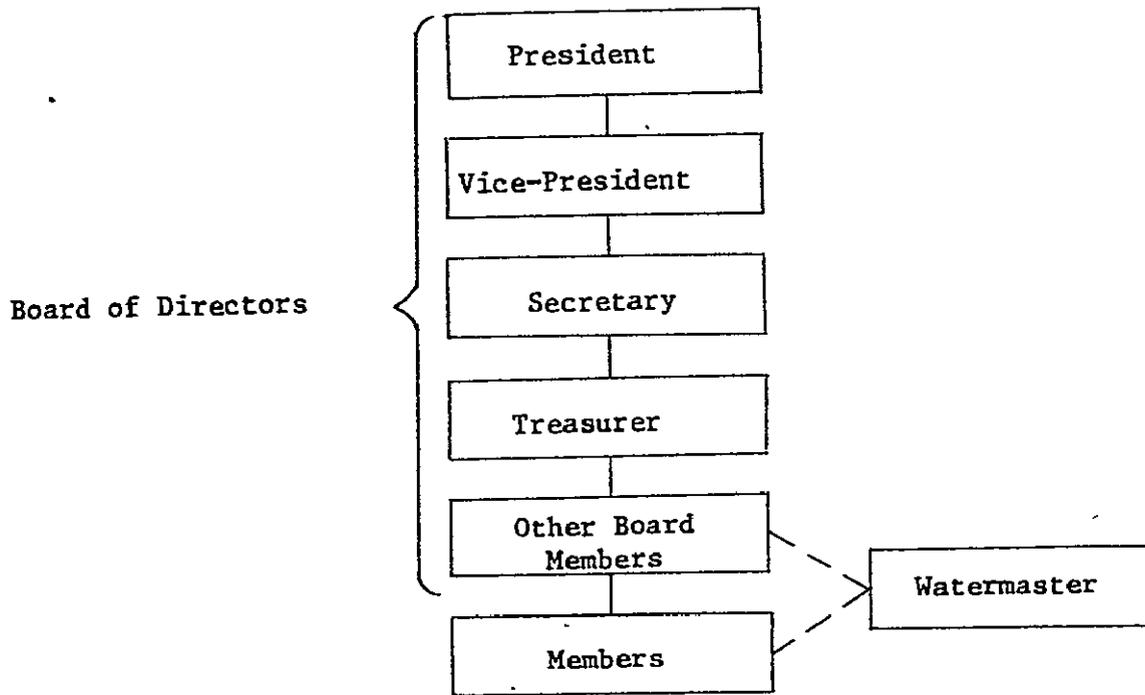
Section 5.4 contains a translated copy of the Statutes and Regulations (by-laws) of one typical user association located near the area of the Salcedo project. Since many of these organizations were formally created under the provisions of Article XII, of the Water Law of October 6, 1939, each one is structured and formed in much the same fashion as the example. Water user associations may vary in size from just a few shareholders to several thousand. Some may be more formalized in their operation than others, but each operates in the same general pattern.

Water user associations are governed by a Board of Directors, charged with managing general administrative affairs, and a General Assembly composed of all shareholders in the association. The duties of each of these bodies and respective Board members are set forth in statute, as can be seen in the example in the Appendix. In other words, the structure, offices, duties, and procedures of user associations are universal with modifications to fit diverse existing circumstances (see Chart 5.3).

At present, the steps in establishing a legal water user association are as follows:

1. Establish a general assembly of all interested users and elect a provisional Board of Directors.
2. Elect or assign a commission, generally three persons, to write statutes for the association.
3. Present the statutes to a general assembly of potential users on two different occasions for discussion and approval.
4. Upon approval, send the statutes to INERHI along with certified minutes of all previous sessions, and a formal petition for approval.
5. They are studied and approved by INERHI, which has the right to make any changes, with or without the consent of the provisional association. (Previously, INERHI could only study the statutes, made recommendations, and send them to the Minister for approval.)
6. The statutes are approved and published in the Official Register of the government.

CHART 5.3
ORGANIZATIONAL COMPONENTS OF A TYPICAL WATER
USER ASSOCIATION IN SALCEDO



7. A permanent Board of Directors is elected and the association begins to function legally.

Under Title XVI, of the Water Law of 1972, all former user associations, regardless of their legal status, continue to exist and new ones may be formed upon approval of INERHI.

Water user associations are entirely financed through assessments levied upon each shareholder according to a set rate on the volume of water he uses or the number of hours specified in his use right. The amount of this fee varies with each organization and is usually fixed by the Board of Directors. One important point is that this individual assessment is generally very low. These organizations generally operate on low budgets with relatively few expenses. Consequently, the cost per shareholder per year is not burdensome. This is characteristic of the water user associations in Salcedo.

The economic effect of the supplemental labor provided by each associate for infrastructure maintenance must also be taken into consideration. The labor assessment is generally minimal and is also calculated on the volume of water corresponding to each use right. User association members only pay in cash the amount necessary for basic administrative matters. They provide voluntary labor for the cleaning and maintenance of the distribution works and most association officers serve without monetary remuneration. These factors help keep the cost of operation down. These organizations were originally created for acquiring and delivering water, and to do it at a reasonable price. For the most part, they do this quite effectively.

The principal characteristic of the irrigation networks utilized by these associations is their simplicity. They are generally not too large or extensive, have rudimentary diversion works and unlined ditches, and distribution and use is non-technical. Water is usually distributed by hours, which is the total volume of water in the ditch for one hour every so many days. The number of hours needed is calculated by the size of the plot to be irrigated and/or past customary practice.

iii. Water User Associations in the Salcedo Project Area.

There are currently five (5) formally organized water user associations which are operative in the Salcedo project area. Each is a legally recognized organization with formal statutes and by-laws approved by INERHI through its regional office in Latacunga. These organizations were thus approved by INERHI beginning in 1975 in accordance with the provisions of the Water Law of 1972. Each of them, however, was operational for years prior to the time of their approval in the same fashion as many other such organizations in the area. These associations administer water delivery and use for five (5) of the twenty-two (22) private irrigation canals (some with laterals) in Salcedo. (See Table 5.2 for a listing of these canals and various of their characteristics.)

The other 17 ditches which divert and distribute irrigation water are also operated and administered by water user associations. However, these have not yet been legally approved by INERHI. Some may not even have pre-existing statutes and by-laws. One project objective will be to identify, contact, and work with many or all of these organizations to at least assist them in formalizing and legalizing their status. As legal entities they are more capable of entering contracts and receiving outside assistance through government or private loans or other assistance measures.

TABLE 5.2*
PRIVATE CANALS IN THE SALCEDO IRD PROJECT AREA

Canal Name	Source	Characteristics
Martínez	Nagsiche River	Services 4 comunas. 186 1.p.s. Irrigates 886 has. 501 users. 17 km long.
Marquez	Nagsiche River	Main canal. 3 laterals. 419 1.p.s. Irrigates 1,486 has. 39 km long. 737 users.
Chiriboga	Nagsiche River	Main canal. 2 laterals. 577 1.p.s. Irrigates 577 has. 13 km long. 300 users.
Aulestia	Nagsiche River	Irrigates 260 has. 1.5 km long. 1 1.p.s. 34 users.
Playa Quebrada Grande	Nagsiche River	Irrigates 90 has. 1.5 km long. 1 1.p.s. 12 users.
Playa	Nagsiche River	Irrigates 90 has. 45 km long. 2 laterals. 25 1.p.s. 2 users.
Playa Nagsiche	Nagsiche River	Irrigates 210 has. 1 km long. 67 1.p.s. 157 users.
Universidad	Cutuchi River	Irrigates 470 has. 8.8 km long. 188 1.p.s. 547 users.
Hidalgo	Cutuchi River	Irrigates 188 has. 31.8 km. 130 1.p.s.
El Recreo or Molina	Cutuchi River	Irrigates 110 has. 4 km. 390 1.p.s. 3 users.

TABLE 5.2 Continued.

Canal Name	Source	Characteristics
La Primavera or Argentina	Cutuchi River	Irrigates 270 has. 3.4 km. 1 1.p.s.
Dávalos-Chiriboga	Cutuchi River	Irrigates 630 has. 3.5 km long. 600 1.p.s.
Vásconez	Pumacunchi River	Irrigates 431 has. 2.5 km long. 647 1.p.s.
Hidalgo	Pumacunchi River	Irrigates 300 has. 7.5 km long. 250 1.p.s.
(Name unknown)	Yanayacu River	16 km long. Services 2 areas.
(Name unknown)	Yanayacu River	Main and 2 laterals. 12.5 km and 10 km long. Services 3 areas.
(Name unknown)	Yanayacu River	9 km long.
(Name unknown)	Yanayacu River	2.5 km long
(Name unknown)	Yanayacu River	Main and 4 laterals. Services 4 areas. 14.5 km long.
(Name unknown)	Yamayacu River	Main and 3 laterals. Services 4 areas. 15.5 km long.
Pucara-Chaupi Palama	Yamayacu River	Services 1,000 users. 218 1.p.s.
(Name unknown)	Isinche River	Services 2 areas. 8 km long.

*Source: Diagnóstico PIDA-Salcedo, pp. 21-23.

It should be pointed out here that all but four (4) of the canals listed in Table 5.2 have insufficient stream flows to satisfy the water demands of their users. None of them has permanent diversion works nor any form of canal lining or protection from landslides which are common in the volcanic soils of the area. Water loss through seepage is extremely high. In addition, at present, no canals exist above the 2,800 meter mark, a situation which severely restricts irrigated agriculture potential above that altitude.

iv. Public Irrigation in the Salcedo Project Area.

INHERI has a regional agency office located in Latacunga. Agency offices such as this one have responsibility for exercising jurisdiction in the first instance over petitions for use right concessions, resolving conflicts over water use, and imposing sanctions and penalties for violations of the Water Law and its regulations. In addition to its agency office, which exists primarily to implement the Water Law, INERHI is also directly involved in planning and constructing irrigation delivery systems in the Salcedo project area. Four (4) such systems are at some stage of study, planning, or implementation at present.

The Latacunga-Salcedo-Ambato project is an extensive project under construction with external funding from IDB. It is located west of Salcedo (town) and is only partially completed. However, INERHI has just recently begun to deliver some water through this system. It will still be some time before it is completely operational. When complete, it will service some of the target group population.

The Dávalos-Chiriboga project is now partially constructed by INERHI and the Salcedo IRD project will provide funding to help finish its distribution system and thereby increase water availability for a number of project recipients. INERHI has two additional projects in the area, both of which require further technical feasibility studies. They are Chaupi-Palama and Nagsiche. It is anticipated that feasibility studies for Nagsiche will be financed through the Salcedo IRD project.

To summarize, there is currently no significant public (INERHI) sponsored irrigation delivery within the influence of the Salcedo project. The Latacunga-Salcedo-Ambato canal is beginning to deliver water but since the project is still incomplete it is not yet in full operation. Other public projects are underway or planned for the zone, and when completed, will increase public controlled irrigation significantly, whereas at present virtually all irrigation in Salcedo is controlled and operated on strictly a private basis. Once the public projects are functional it can be expected that INERHI will operate them much as it has the State irrigation districts currently under its control.

5.3 INSTITUTIONAL AND LEGAL FEASIBILITY

5.3.1 Summary

INERHI will be, through formal contract with the Salcedo IRD Project, the government entity responsible for the actual implementation of all irrigation development and improvement activities within the project. This includes pursuing its own irrigation projects in the area, as have previously been identified, as well as working with private sector water user associations

in carrying out improvements in their systems. This is viewed as a positive move in supporting INERHI in fulfilling its role as the custodian of water and water development in the country.

The traditional water user association prevalent in the region will be the primary recipient level institution through which most irrigation activities in the project will take place. They will have a direct participatory role and will each select a promoter from their membership to serve as a liaison with the project personnel. This procedure will provide the greatest potential for success.

Appropriate training will be offered at several levels: (1) for INERHI personnel; (2) the water user association promoters; and (3) for the water user association members themselves. This training will be of various kinds and levels according to the requirements of the particular group and the specific purpose or training objectives. The central IRD project modern media center will be utilized for the preparation and production of training aids for institution building and irrigation improvement as well as for other IRD project objectives.

The irrigation specialist assigned full time as an advisor to the overall IRD Project for all irrigation development and improvement activities will identify institution building requirements and programs as a part of his assignment. He will be aided in this regard by the Project Leader and INERHI personnel as he coordinates with them the activities undertaken through the project.

5.3.2 The Water User Association – Primary Irrigation Institutional Mechanism

The primary IRD Project Paper details at length the justification and feasibility for using the native "comuna" organization as the vehicle for development activities in the Salcedo IRD project area. Instead of the "comuna" as the sole form of project implementation, water user associations will be utilized for all activities concerning irrigation related improvement activities.

There are currently five (5) very formal water user associations and a significant number of others, more informal in nature, already in existence in the Project area. Each operates independently from the others, much as would an individual comuna, but as a group they are responsible for and control nearly all current irrigation activities within the project's target population. Any development activity which would enhance irrigation in any way should certainly be done through these organizations. To do otherwise would tend to detract from very viable and stable organizations already in operation.

Water user associations have enjoyed a long history in the Ecuadorian sierra and especially in the Salcedo region. They have been freely accepted and supported by area residents. They operate on the basis of mutual cooperation and donated (voluntary) service—a traditional trait of the people of this region. Consequently, there is a high degree of social legitimacy and acceptability associated with these water users' associations.

Irrigation improvements, as a major thrust of the proposed IRD project, can only be effectively carried out by capitalizing on the water user groups. For example, in most cases the existing canals derive water from a source located other than in the immediate vicinity of the point of use. One canal may traverse areas not under the immediate ownership or control of the members of the association who utilize the water. Also, the membership of any one association may be comprised of residents of more than one communa or other group. The project, therefore, will emphasize the water user association in irrigation activities since it is this group, and not a particular comuna, that will receive the benefits of irrigation improvements.

The association shareholders are the individuals who jointly maintain the main canal, and any laterals, and are the only ones who truly have an interest in its operation as a result. Since one of the major irrigation improvement subactivities will be the improvement of existing small irrigation systems, it would be folly to contemplate such activity without the direct and complete involvement of the irrigator's associations which control them.

Through the above recommended action, the project will not be creating new, unfamiliar, and therefore untrusted organizations in the area. Conversely, it will build up, strengthen, and benefit from existing institutions, thereby having the greatest chance for success. Moreover, these organizations have indicated a desire for assistance to project personnel and repeatedly to the PCI team (Hancock, LeBaron and Anderson) during their field work in Salcedo.

To summarize, a number of water user associations now exist, they are currently operating fairly successfully, they want project assistance, and they are organizations capable of contributing, to a high degree, to the success of project irrigation improvement components.

5.3.3 INERHI -- The Project Implementing Agency

Irrigation development and improvement activities in Salcedo will be performed by INERHI primarily through its project level personnel. As detailed in the main IRD Project Paper, this will be accomplished by legally binding contract. A formal contract will be written between the IRD Project and INERHI in which INERHI will become the government agency through which all irrigation related activities are to be performed. It will represent the Project Leader in all such activities and will coordinate with him as implementation occurs.

This is necessary for several reasons. One, INERHI currently has a great deal of expertise and experience in irrigation activities. For another, it is responsible, through the agency office in Latacunga, for monitoring and regulating water use in the region. Thirdly, INERHI is going to become increasingly involved in direct irrigation delivery in the future as its four projects in Salcedo are developed.

In addition to the above points, INERHI, through the law stipulating its creation as a national entity, is required to: (1) promote organizations or entities consisting of water users, (2) collaborate with other entities (such as the Salcedo IRD) for the beneficial use and protection of river basins, and (3) promote the establishment of private and mixed irrigation enterprises, including capital assistance. It is these latter points which have been difficult for INERHI to achieve to date. By having INERHI direct and perform the irrigation improvement activities in the Salcedo IRD project, utilizing the existing water user associations as has been discussed, the project would be building INERHI capabilities and assisting it in performing its legal responsibilities. The project would not only be able to capitalize on INERHI's expertise but would be able to help INERHI by placing emphasis on new types of technical assistance programs.

Using INERHI as the initiator of irrigation development programs in the private sector is a new concept. The issue is raised here because this government agency has heretofore not been involved in such activities. Any canal and other infrastructure construction or improvements it has performed have been for its own irrigation districts and projects. The Salcedo IRD

project proposes to have INERHI be responsible for both the public oriented irrigation activities (the four INERHI projects) as well as the numerous irrigation improvement programs destined for the private sector only (upgrading existing canals, small scale ground water development, etc.). INERHI, by law, should be the government agency to perform these functions. This project will enhance its ability to do so.

5.3.4 Training of INERHI Personnel

Even though INERHI is equipped with a corps of technically trained and qualified engineers and agronomists, few have been oriented in their training toward small irrigation systems and practical small farm water management techniques. If INERHI is to be expected to assist water user associations in improving their existing water delivery systems, and in enhancing the ability of small farmers to manage this scarce resource more effectively, the INERHI technicians assigned to the Salcedo project will require a certain degree of reorientation and training in these areas. Otherwise, they would not be nearly as effective in their roles as they could be.

Several kinds of training and practical experience are planned for project personnel to enhance their expertise. One is short-term visits to successful small scale irrigation projects now underway in El Salvador and Guatemala, with Peru as an additional possible visit site. In El Salvador they should become familiar with successful USAID sponsored projects dealing with small scale system canal lining and appropriate technology for diversion works. A current project in Guatemala involves simple sprinkler irrigation systems for very small farm units (minifundia) on hilly and broken ground. Some 19 of the 23 total subsystems in this project consist of gravity flow systems, while the remaining four are pump fed. These are both systems which may have a great deal of potential for development in Salcedo, especially in the heretofore unirrigated higher elevation areas in the project. Incidentally, each of the 23 systems in Guatemala is self-administered by small mutual companies much along the same lines as the water user associations in the Salcedo project area.

The second type of training for INERHI personnel would be various types of short courses to be conducted in-country. These would consist of seminars, field days and similar activities, and would be organized and conducted by external technicians. Examples of short course subjects would be on-farm irrigation methodology and management, small irrigation system design, irrigation requirements for various crops, erosion control, and management and administration of irrigation organizations.

Medium term training outside Ecuador is the third type of recommended activity. For example, this would consist of attendance at reputable centers or institutions such as the International Irrigation Center located at Utah State University where courses and training are offered in Spanish. They are for periods of one month or perhaps more and include field demonstrations and practical exercises.

It is anticipated that a solid group of well trained technicians with an orientation toward improving, upgrading, and managing small system irrigation water delivery and use will result from these training activities. The possibility also exists that if this effort is successful, a special unit could eventually be created within INERHI to specialize and work exclusively in the area

of small irrigation systems nationwide. This would certainly aid INERHI in promoting private irrigation development in the country. Salcedo should be viewed as a pilot effort in that direction.

5.3.5 Implementation of Institutional Improvement Activities

It has now been established that the primary private sector mechanism through which irrigation development actions will be implemented are the water user associations prevalent in the area. Also, that INERHI will be the government agency responsible for coordinating and conducting these actions, and will be trained accordingly. INERHI will also be responsible for several of its own projects which will not involve private irrigation organizations. This section addresses the means by which INERHI will work with selected water user associations.

First, it is imperative that a correct determination be made as to the exact number and location of every water user association within the project, whether formal or informal. Once this study has been completed, an initial contact is made with each organization by the Salcedo Project Leader. The purpose of the visit will be to find out any basic information about the organization which may be lacking and investigate the level of interest in participating in programs to improve its irrigation delivery system and use. If, at that point, an organization expresses a willingness to participate (as most are expected to do), INERHI project personnel will be notified and a representative will be sent to further discuss the matter with the organization. This individual will explain the various possible improvement actions or options available to a particular group. In some circumstances, a field visit may also be necessary to accurately determine what the real needs of the organization may be.

Once a particular course of action has been selected for an organization, by mutual agreement with INERHI project personnel, that association must commit itself to full collaboration and cooperation in carrying out the activity. As a demonstration of this commitment, an organization will select one of its group to function as the local project promoter for the activity. This individual will work in close cooperation with his water user association and INERHI personnel. This liaison role is most important since this individual will be responsible for educating the other shareholders in his association, appraising them of project progress, and acting as a general liaison between INERHI (in representation of the Salcedo project) and his water user association. The goal is to make him the local irrigation expert and the funnel for information flowing in and out of the organization.

A certain degree of training will be required for these promoters. This would consist of some technical training in the field of irrigation as well as group interaction type training to enable him to transfer the knowledge he gains on to his peers. The training would educate him on how he can influence and educate others. In this way he can motivate others to positive action.

This pattern of working with an irrigation organization is almost identical to the process recommended for implementing the nonirrigation related project activities detailed in the IRD Project Paper. This same pattern should be incorporated and adapted here for the same reasons as stated in that document. The project has the most chance for success if it taps into a viable institution, elicits a firm commitment for collaboration, and then utilizes the resourcefulness and assistance of a respected member of that organization in implementing project actions.

Two additional points should also be considered. By following the above recommended plan the individual water user association becomes directly involved as a *participant* in the development process, not merely the *recipient* of the process. Through its commitment it obligates itself to assist in activities from which it will directly and visibly benefit. Through the appointed promoter as liaison, the organization is able to be part of the decision-making process, and can provide feedback to project level personnel as work progresses. The other point is that the system will be entirely consistent with the process proposed for the overall IRD Project. The only basic difference in this case is the nature of the recipient/participant organization. In this instance it is a water user association instead of a comuna which will become the basic target group institution.

5.3.6 *Technical Assistance for Water User Associations*

A key part of the effort to improve the capability of private water user associations will involve technical assistance and training at the association level for all associations in the project area. This includes both the formal, legal organizations which have been approved by INERHI, as well as those which have not. Even if a certain association is not participating in an infrastructure type improvement action through the project, it should be able to receive assistance directed at improving and enhancing nontechnical operations; for example, its internal finances.

Since INERHI is the implementing State agency, one major thrust should be the formalization, registration, and approval by INERHI of those organizations which heretofore have not been processed. Helping them reach the point of becoming legal entities under the law is certainly a worthwhile goal since without such status they cannot legally enter binding contracts, take out loans in the name of the association, and are prohibited from participating in other similar activities.

Examples of the types of institution-building assistance the project should offer to irrigation associations are:

- a. Internal financial matters
- b. Water pricing and tariffs
- c. Record and bookkeeping functions
- d. Water scheduling techniques
- e. Parliamentary procedure or other rules of order
- f. Leadership skills

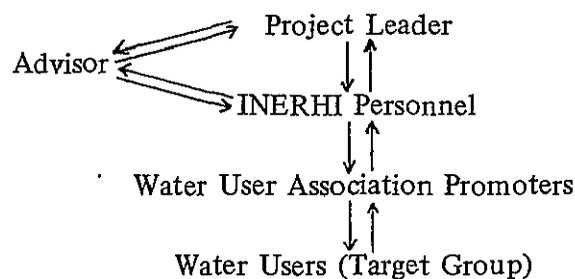
The project will, of course, be able to utilize the IRD Project media center and its various modern communications techniques to help perform these training functions. The most appropriate means should be employed according to the needs of the particular organization and the subject matter to be presented.

The INERHI personnel working with irrigation development in Salcedo will also assist in forming, organizing, and legalizing new water user groups which could be created as a result of project activities. These may include groups formed as a result of development of new sources of surface water, the exploitation and use of groundwater sources, and possible pilot sprinkler irrigation systems. This will require a coordinated effort between INERHI's project people working in the field and its Latacunga regional office, as well as the group of new water users themselves.

In addition to the training of private irrigation organizations and their shareholders, appropriate training will also be offered to water users who receive their water from INERHI, for example, from the Latacunga-Salcedo-Ambato canal. Even though they are not shareholders per se in the delivery system, appropriate training will assist them in better managing and utilizing the water under their control and in general becoming more informed and alert water users. This feature can certainly contribute to INERHI's success in dealing with these individuals and therefore enhance INERHI organization-wise.

5.3.7 External Technical Assistance

One irrigation engineer will be assigned to the overall IRD Project for a period of two years and will split his time between Quimiag-Penipe and Salcedo. His task will be to provide technical assistance to all facets of irrigation development in the Salcedo project, including those activities directed at enhancing the institutional capabilities of the various organizations involved. He will be able to identify specific training needs and requirements, provide technical assistance in questions of a technical nature as they arise, and in general be a driving force in promoting irrigation improvements. From time to time he may need to call on other experts in specialized technical fields to assist him in his role. This may be particularly true of organization-related problems in which he may not be trained. Since institution building and enrichment are integral components of project irrigation objectives, specialization may be required in identifying ways and means to assist various organizations, INERHI as well as private user associations, in improving their operations and ability to carry out specific project goals. The irrigation advisor will of necessity work closely with the Project Leader and with INERHI project personnel. He will be their "advisor" on the irrigation component of the project. Beginning with this individual, the channel of communication for irrigation actions within the project will be:



5.4

Example of a Typical Small Farmer Water User Association
By-Laws and Statutes

Translated by,
D. Craig Anderson, PCI

5.4.1 STATUTES*CHAPTER I**The Association*

Article 1. Be it officially established in the village of _____, in the jurisdiction of the _____ Parish, the Water User Association of the _____ Canal, which will be composed of legally accredited citizens who are property owners of said waters; bought by direct purchase from Sr. _____ and _____; waters that originate from the snows of _____ and the springs known as "_____" and other sources; and the slopes of the points known as "_____" "_____" and "_____" all these with their respective water sources.

*CHAPTER II**Purposes of the Association*

Article 2. The purposes of the Association are the following:

- a. Watch over and assure the good conservation of the canal for the conveyance of the irrigation water;
- b. Dictate the required measures necessary to avoid those illegal activities which would constitute an attempt against a property right;
- c. Defend the ownership right of each user in the use and possession of said waters.

*CHAPTER III**The Shareholders*

Article 3. The Shareholders shall consist of:

- a. The founders; and
- b. Those who, after the formation of this Association, express a desire to belong to it and who are accepted by the Association.

Article 4. The founders of the Association are all those citizens indicated in Article 1, who concurred in the designation of the members of the Provisional Board of Directors for the Association.

- Article 5.** The rights, duties, and obligations of the shareholders are:
- a. Attend the regular and extraordinary sessions of the general assembly of users;
 - b. Elect and be elected as officers in the Association;
 - c. Loyally carry out the charges given them by the general assembly or Board of Directors;
 - d. Be heard by the general assembly or Board of Directors in those claims and actions which may be presented by them;
 - e. Pay, when due, the tariffs established in this statute and in the internal regulation, and those that the general assembly or Board of Directors may impose from time to time; and,
 - f. Contribute, on the day indicated by the Board of Directors for the cleaning of the canal, two day laborers for each hour of water they possess and five for each functioning mill, or in the place thereof, S/_____ sucres for each day laborer not thus provided, when required for canal cleaning and other such maintenance necessities.

CHAPTER IV

The General Assembly

- Article 6.** The general assembly will be composed of all shareholders and will meet regularly and extraordinarily. Regular meetings will be between the 20th to 30th of December each year. It will meet on an ordinary basis as soon as these statutes are approved by Executive Power and the general assembly convened for the purpose of designating the members of the permanent Board of Directors; and, when the President of the Board, on his own motion or by written petition of four or more of its members, calls for such.

- Article 7.** The General Assembly will meet both regularly and extraordinarily with a majority of the shareholders attending. If the session does not have such, for lack of quorum, it will be deferred to another day, on which date it will conduct its business with whatever number of shareholders may be present.

In the extraordinary sessions, there will be an order of preference of business according to the purpose for which said sessions were called to order.

- Article 8.** The attributes of the General Assembly in the regular sessions are:
- a. Review the annual written report presented by the President of the Board to the General Assembly, dealing with all matters related to the administration of the canal; the financial state of Association funds; investments made by the same; the measures which may have been taken on the order of maintenance of the canal; the solutions given to claims presented by the shareholders; and of the defense of property rights and any attempt or claim which may have occurred against those rights;

- b. Verify the annual election of new members of the Board of Directors, which election will be by secret vote. The voting results shall be verified to the President and Vice-president in writing and communicated orally to the other newly elected members of the Board of Directors.
- c. Approve the annual and periodic tariffs that, according to the number of hours of water each possesses, each shareholder must contribute for the functioning of the Association;
- d. On its own recommendation, or that of the Board of Directors, amend the Statutes or by-laws, which amendments will take effect upon the approval of the Executive Power;
- e. Approve the budget, earnings, and expenditures formulated and carried out by the Board.
- f. Audit, by means of special commissions, the investment of funds;
- g. Study and appraise, by special commissions, the general fund balance sheets, which balance sheets should be presented by the treasurer eight days prior to the meeting of the General Assembly;
- h. To agree by common consent on the most efficient means for the just administration of the waters by the Board of Directors;
- i. Discuss and resolve the matters of business submitted for its consideration by the Board of Directors or any shareholder; and,
- j. Delegate its functions to the Board of Directors.

CHAPTER V

The Board of Directors

Article 9. The Board of Directors shall consist of a President, Vice-President, Secretary, Assistant Secretary, four members of the Board, four alternate members of the Board, and a Manager/Administrator.

Article 10. The attributes and duties of the Board are:

- a. Formulate the Association's Internal Regulation and submit it for approval by the Executive Power;
- b. Submit, for the consideration and approval of the General Assembly, statutory reformations, if and when they are deemed to be necessary;
- c. Take to its charge the administration of the water controlled by the Association according to the norms established in the Internal Regulation; for which purpose a registry of the shareholders will be formed, indicating the number of hours of water corresponding to each and the schedule of distribution;

- d. Designate a water master to manage the maintenance of the canal and distribution of the water at its diversion point in the community of _____;
- e. Formulate the budget and report of earnings and expenditures to submit to the General Assembly for approval;
- f. Supervise the collection and investment of funds, as well as impose extraordinary tariffs on the shareholders when circumstances so require;
- g. Impose the sanctions established in the Internal Regulation on those shareholders who neglect to fulfill their obligations or who have not paid the tariffs referred to in sub-paragraph "c" of Article 5, or who are involved in the fraudulent privation of water, none of which will preclude just civil legal action on the matter;
- h. Determine the date on which the shareholders should provide labor for the cleaning of the canal or any other work deemed necessary; and
- i. Exercise the functions delegated to it by the General Assembly.

Article 11. The Board will function for a one year period and any or all of its members may be reelected.

CHAPTER VI

The President

Article 12. The duties and attributes of the President are:

- a. Convene and preside over the sessions of the Board of Directors and the General Assembly of users;
- b. Represent the Board of Directors in its external relations;
- c. Authorize all acts of the General Assembly and the Board of Directors, correspondence, pay orders and other documents related to the administration of the canal;
- d. Supervise the collection of funds and the correct investment of the same, and in that regard, frequently examine the financial records and verify the cash accounts when he deems necessary;
- e. Present, at the termination of his office, the report referred to in sub-paragraph "a" of Article 9;
- f. Resolve any urgent matter corresponding to the Board of Directors and inform the same of such action in its following session;
- g. Comply with and require strict compliance to the Statutes and Internal Regulations and other resolutions established by the General Assembly or Board of Directors; and
- h. Deliver to the Treasurer a financial statement of the funds which should be collected.

Article 13. The President cannot be absent for a period of more than sixty days, in which case, the Vice-President shall convene a general assembly of users for the purpose

of designating a person to replace him. But the new President will only function until the next regular meeting of the General Assembly, as elaborated by Article 7.

CHAPTER VII

The Vice-President

Article 14. In the absence of the President the Vice-President will perform his functions. In the absence of the Vice-President, he will be succeeded by the members of the Board of Directors in the order of their appointment.

CHAPTER VIII

The Secretary

Article 15. The obligations of the Secretary are:

- a. Compile and authorize the acts and correspondence of the Board of Directors and supply copies which may be solicited by prior order of the President.
- b. Give an account during Board sessions of the correspondence received, and transact all resolutions adopted by the General Assembly or Board of Directors.
- c. Present to the respective persons any appointments designated by the Board of Directors or General Assembly;
- d. To give notice, by order of the President, of sessions of the Board of Directors and of the General Assembly;
- e. Present and justify to the Treasurer the periodic or extraordinary tariffs and fines which should be collected;
- f. Have in his charge the minute books and correspondence;
- g. Prepare the Registry of Water Rights according to the information given by the Board of Directors or the General Assembly; and
- h. Look after the records of the Board of Directors and present the same to his replacement. This action must be authorized by the President and the member of the Board who at the time is the ex-officio controller.

CHAPTER IX

The Assistant Secretary

Article 16. The Assistant Secretary shall assist the Secretary and replace him in his duties in the case of his absence.

CHAPTER X

The Treasurer

- Article 17.** The duties and obligations of the Treasurer are:
- a. Produce a fidelity guarantee secured by a mortgage, proportionate to the amount of funds in his charge and acceptable to the Board of Directors, before discharging the duties of his office. This guarantee remains in effect until such time it is declared that there has been no mishandling of funds on his part. If this guarantee is not so produced, the President will convoke a General Assembly to designate a person to replace him. The costs and/or premiums required by the guarantee will be paid from Association funds;
 - b. Collect the annual and periodic tariffs, fines, and other earnings that for any reason may belong to the Association. These funds will be deposited in a banking institution of the province as soon as they are collected and cannot be withdrawn except by order of the President and the approval of the ex-officio controller;
 - c. Keep, with precision and clarity, the account books indispensable to his office, in which he will carry a detailed and documented account of the funds earned and expended;
 - d. Pay the expenditures authorized by the budget and other such expenditures as ordered by the Board of Directors or General Assembly, always with the approval referred to by sub-paragraph "b" of this Article;
 - e. Present to the Board of Directors each month an exact account of the cash movements of Association funds, and the general balance sheet according to sub-paragraph "g" of Article 9 of these statutes; and
 - f. Present to the Board of Directors, for legal action, a list of any shareholders delinquent in their payments and who refuse to pay such.

CHAPTER XI

The Members of the Board of Directors

- Article 18.** Duties of Members of the Board of Directors are:
- a. Punctually attend the meetings of the Board of Directors and General Assembly;
 - b. Serve, on a monthly rotation basis, and in the order in which they have been elected, as ex-officio controller;
 - c. Faithfully carry out the duties placed upon him; and
 - d. Succeed the President in the manner expressed by Article 15.

CHAPTER XII

The Ex-Officio Controller

- Article 19.** Duties of the Ex-Officio Controller are:
- a. Review and approve pay orders and the withdrawal of deposited funds from the banking institution chosen for this purpose, accordingly set out in sub-paragraphs "b" and "d" of Article 18; and
 - b. Take note of the general development of the Association and report the same to the President.

CHAPTER XIII

The Manager/Administrator

- Article 20.** Duties and obligations of the Manager/Administrator are:
- a. Exercise the function of the legal representative of the Association in all juridical and non-juridical matters of business in which it is involved;
 - b. Give his opinion with respect to any matter laid to his charge by the General Assembly or Board of Directors, and inform the same of the state of such matters eight days prior to the regular session of the General Assembly; and,
 - c. Carry out all the duties corresponding to the Administrator as referred to in Article 13 of the Internal Regulation.

CHAPTER XIV

The Association Funds

- Article 21.** The following shall constitute the funds of the Association:
- a. The amount of S/_____ sucre for each hour of water owned or used by each shareholder;
 - b. The amount of S/_____ sucres annually for each mill powered by such waters;
 - c. The periodic tariffs imposed by the General Assembly or Board of Directors as circumstances may require; and
 - d. The fines which may be imposed by the Board, for an infraction of these statutes or of the Internal Regulation.

CHAPTER XV

General Provisions

- Article 22.** As soon as these statutes take effect as having been approved by the Executive Power, the Provisional President will convene a General Assembly for the purpose of electing the members of a permanent Board of Directors.
- Article 23.** At its convenience, the Board of Directors will formulate and send to the Ministry of Development, for its approval, the Internal Regulation, which describes the administrative proceedings of the Association in the management of the irrigation water.
- Article 24.** The duration of the Association is indefinite, but in the case of its dissolution by a written petition of a majority of the shareholders for failure of the Association to comply with its purpose, all of the real and personal property collectively owned by the Association will be distributed among the shareholders proportionately, according to the number of hours of water each may have.
- Article 25.** The positions of Manager/Administrator and Secretary will be remunerated according to their responsibilities and may be conferred upon any person within or outside of Association membership, as designated by the General Assembly or the Board of Directors. All other positions will be without remuneration.
- Article 26.** Administrative costs and costs necessary for the functioning of any special commission, will be paid by the Association.

For legal purposes, I hereby certify that these statutes have been discussed and approved in first, second, and third readings on the dates of the _____, _____, and _____ of this month of _____, respectively, in which it was decided that they be sent to the Executive for his approval, for the purpose of establishing a legal entity.

_____, the _____ day of _____, 19____.

Secretary

5.4.2. *INTERNAL REGULATION*

The Water User Association of the _____ Canal, in use of the authority granted by Article 12 of the Law of _____, 19____, and the Articles of its own Statutes, approved by Executive Decree No. _____, 19____.

DICTATES

The Following Internal Regulation

TITLE I

Article 1. For purposes of administration and use of the water belonging to the shareholders of the _____ Canal, said Canal is divided into four sections, being:

- a. _____;
- b. _____;
- c. _____;
- d. _____.

These sections correspond to the distribution of the volume of said water. Properties, and in general all water rights, are established by the respective title of ownership, lease, benefits, etc.

Each section will be represented in the Association by a Member of the Board of Directors and an alternate, who will be elected from among the shareholders of that section in the General Assembly accordingly prescribed in the Statutes. In the event of a tie in voting for Board members their nomination will be decided by the drawing of lots.

Water and/or land lessees will represent the respective owner with their vote.

The General Assembly

Article 2. The General Assembly will meet regularly and extraordinarily.

Article 3. The regular sessions will be held quarterly on the date designated by the Assembly. In the children's local of the village of _____, jurisdiction of the _____ Parroquia, which building was acquired and constructed by the majority of the shareholders of the Association. In these sessions preference will be given to the reports presented by the Board of Directors.

Accordingly stipulated in the Executive Decree of _____, 19____, the General Assembly will session each year, on a fixed day, between the _____ to _____ of _____, for the purpose of electing a new Board of

The extraordinary sessions will take place when the President convokes the same by petition of at least four members or when the Board of Directors believes it necessary to handle matters of major importance.

Article 4. The regular session cannot function without the quorum indicated in this Article, without prejudice to that prescribed in Article 6 of this same Regulation.

It will be understood that a legal quorum will consist of half the shareholders plus one.

Article 5. For the purposes prescribed in the above Article 4, those persons will be considered members of the Association who justify their rights over these waters or who, in the capacity of renters, users, etc., represent the owner in conformity with the terms prescribed in Article 1.

Article 6. The extraordinary sessions will take place with whatever number of shareholders attend after the second notice of an extraordinary session is given. Those who neglect to attend and who were legally notified will have no right to oppose what was approved by the Assembly in said session.

Article 7. Notices for the regular and extraordinary sessions will be given by written order of the President of the Association or by the Secretary with the authorization of the President. Said order and notice will be given designating the location, day, and hour of the session to the respective Board member representing each section, who in turn will notify the shareholders in that section.

The Board members commissioned to give such notice will be responsible for any absentees from his section which are due to his failure in giving appropriate notice of the session.

The Board of Directors

Article 8. The Board of Directors, in conformity to the Association Statutes, will consist of a President, Vice-President, Secretary, Assistant Secretary, Treasurer, Manager/Administrator, four members of the Board, and four Alternate Members of the Board in representation of the four sections in which the canal is divided.

Article 9. The Board will meet regularly and extraordinarily when convened by the President. Notices to this effect will be signed by the Secretary who will take charge of giving such notices.

Common Provisions for the General Assembly and Board of Directors

- Article 10.** It is the duty and obligation of the General Assembly and Board of Directors to respect and comply with the Statutes, and be subject to any other rules not expressly stated in said Statutes but which are stipulated in the Executive Decree of _____, 19____.
- Article 11.** The General Assembly and Board of Directors may impose special commissions upon their respective members and even upon any other member, commissions that should be obligatorily complied with under the penalty prescribed in Article 23 of this same Regulation.
- Article 12.** Only the General Assembly is given the power of interpreting the Statutes and the Board of Directors that of interpreting this Regulation.

The Administrator

- Article 13.** The canal will be watched over in its total extension by a general administrator who, accordingly as stipulated in Chapter XIV of the Statutes, will be the Manager/Administrator.
- Article 14.** The duties and obligations of the Administrator are:
- a. Watch over and personally dispose of the work of the day laborers supplied by the shareholders, indicating to them the work location and the materials necessary to perform the work;
 - b. Require each user to strictly comply with such labor quotas;
 - c. Watch that the waters are not obstructed and flow freely in the canal;
 - d. Traverse the section of the canal on the days that, according to the scheduled community water distribution, correspond to each shareholder for use of the water that day for those users who, in conformity to that prescribed in Article 1 of this Regulation, show proof of ownership;
 - e. Formulate the pay rolls for the day laborers, and when necessary carry an accounting of the same for social security purposes with respect to the employer and employee shares;
 - f. Have under his responsibility all the work materials and tools received by inventory. Without prejudice to the Manager/Administrator's responsibility, the workers under him will answer for all the tools and goods in their charge and for losses of the same;
 - g. Distribute the tools in his charge to the workers on the canal and gather the same; and
 - h. Strictly comply with the orders of the Board of Directors or the President.

The Members of the Board

- Article 15.* Each Board member will answer for the correct working order and condition of the canal for the section he represents. It is his obligation to watch over and inform to the Board of Directors the labors of the Manager/Administrator and make any suggestions which good service may demand.
- Article 16.* No payment relative to the workers can be effected without the approval of the respective Board member.
- Article 17.* The Members of the Board have the authority to solicit from the President the imposition of fines on the shareholders in their respective sections, with reference to the terms prescribed in Article 23 of this Regulation.

The President

- Article 18.* The duties and obligations of the President are those prescribed in Article 13 of the Statutes.
- Article 19.* The President may administratively authorize expenditures up to S/_____ sures monthly, with the responsibility of informing the Board and always with the approval of the ex-officio Controller.
- Article 20.* The Vice-President, in those cases in which he substitutes for the President as determined in the Statutes, will enjoy the same authority as the President.

TITLE II

The Association Funds and Their Collection

- Article 21.* To accomplish the collection of the tariffs prescribed in Article 22 of the Statutes, the following procedure will be carried out. The President will issue assessments corresponding to the tariffs which will be signed by the Treasurer. These same assessments will enter into the Treasury and will be recorded in the Accounting Book carried by the Treasurer. The Treasurer, with such documents, will proceed to immediate collection, employing for the same, every measure believed appropriate. The Treasurer will answer for all funds not collected due to his negligence.
- Article 22.* All tariffs or amounts to be collected will be accomplished through the issuing of assessments, which are printed by order of the President.

The Sanctions

Article 23. Every member of the Association that, having been summoned accordingly as prescribed in this Regulation, does not attend the respective session, without justifiable cause and upon the consideration and approval of the President, will be sanctioned by a fine of S/_____, sucres. This same sanction will be applied to those members of the Board of Directors who fail to attend its sessions without due cause.

Any person who accepts to serve on any special commission and who fails to satisfy his charge will be fined in the same manner as described above. If, for this failure to comply, the interests of the Association suffer, the President will obligate to said person the repayment of the damages incurred and the same will be written in a book which will be kept for that purpose.

Article 24. Whoever is found behind in the payment of the tariffs and fees referred to in Chapter XV of the Statutes will be fined _____ percent of the amount owed plus the costs required to carry out such action.

Article 25. Those who steal water will be sanctioned in accordance with Article 13 of Executive Decree of _____, 19____. If the violator is a shareholder of the Association his use of the water will be suspended by _____ percent for the first offense, and if on a second occasion this violation upon the water rights enjoyed by the shareholders occurs, the sanction will be increased. This sanction or penalty will be left to the judgment of the Board of Directors, without prejudicing civil juridical action.

TITLE III

Salaries and Remunerations

Article 26. Only servants, wage earners, workers, the Manager/Administrator, and the Secretary or his replacement will receive a salary or remuneration for their services. All other offices will be discharged without compensation. Said salaries and remunerations will be paid in conformity with the amounts assigned by the respective budget line item.

TITLE IV

Formation of the Registry

Article 27. The carrying of the Title and Registry will be to the charge of the Secretary, who should give to the Board of Directors detailed reports concerning all annual modifications, with which a list will be formed indicating the names of the shareholders and their rights with relation to the day and number of hours of water corresponding to each.

TITLE V

General Provisions

Article 28. After _____ o'clock in the afternoon on _____, only those users who have contributed the necessary labor for the maintenance of the water infrastructure will have a right to the use of remnant waters.

Article 29. Decisions can only be revoked by a two-thirds vote of the members of the Association.

Article 30. Conveyance of the water of the Community of _____ in this canal is prohibited.

Article 31. He who, not being an Association shareholder, steals these waters will be sanctioned by a fine of S/_____ sucres for each hour of water and _____ days in jail for the first offense. For the second, S/_____ sucres and _____ days, which sanction will be imposed by civil judicial action.

Article 32. The Secretary and the Treasurer, unless they are shareholders or representatives of such, shall have all the rights of a shareholder except the right to vote in general assemblies. The Board of Directors will act as a consulting body but without the right to vote in general assemblies.

Article 33. These statutes will be regulated by the measures determined in the Executive Decree of _____, 19____, in which case the sessions will be conducted by generally accepted parliamentary procedure.

Article 34. This regulation will take effect after its approval by the respective civil authority.

5.5

The 1972 Ecuadorian Water Law

Translated by

Dr. David R. Daines

and

D. Craig Anderson

OFFICIAL REGISTER

ORGAN OF THE GOVERNMENT OF ECUADOR

ECUADOR HAS BEEN, IS AND WILL BE AN AMAZON COUNTRY
ADMINISTRATION OF THE HONORABLE BRIGADIER GENERAL GUILLERMO RODRIGUEZ LARA,
PRESIDENT OF THE REPUBLIC

YEAR 1 QUITO, TUESDAY MAY 30th 1972 -----Number 69

GENERAL GUILLERMO RODRIGUEZ LARA

President of the Republic

CONSIDERING

That the National Revolutionary Government in its general Plan of Action declares that one of its proposals is to exercise rights over the natural resources in a manner most effective for establishing, in a real and definite form, the national sovereignty over the territorial waters, the soil and the subsoil;

That water is a vital element, indispensable for human subsistence, activities and development and that, through the increase of the population there has been a parallel increase in its needs, making it indispensable that the water be administered according to technical criteria;

That the water basins, for lack of maintenance of their forests and control in their exploitation have been subject to erosion, thus cancelling out the natural recharge of the sources that supply the rivers and also resulting in the flooding of the lower areas;

That the existence of various laws regulate the use of waters has brought as a consequence the intervention of different organisms of the State and raised conflicts and differences which are prejudicial to the national interest;

In view of the favorable opinion of the Council of Government;
and, by virtue of the powers that have been vested;

DECREES:

THE FOLLOWING WATER LAW

TITLE I

Fundamental Dispositions

Art. 1.--The dispositions of this Law regulate the utilization of maritime, surface, subterranean and atmospheric waters of the national territory in all of its physical states and forms.

Art. 2.--The waters of rivers, lakes, lagoons, springs that raise and die in the same property, snows, natural water falls and other sources, and subterranean waters, whether or not they raise on private property, are national property for public use. They are outside of commerce and this ownership is inalienable and imprescriptible; they are not susceptible to possession, accession or any other method of appropriation.

Rights of ownership over water do not exist and cannot be acquired, and pre-existing rights are limited in their use to the extent that they are efficient and in accordance with this Law.

Art. 3.--For the purpose of this Law, we declare also to be property of the state for public use, all waters, including those that have previously been considered as private property. The previous owners may continue to enjoy use of the water only as title holders to a utilization right in accordance with this Law.

Art. 4.--Also as national property for public use are the beds and subsoil of the interior and territorial sea, lakes or lagoons, gullies, streams and other permanent courses or impoundments of water.

Art. 5.--A right of utilization is defined to be the non-transferable administrative authorization for the use of waters in accord with the requirements prescribed in this Law.

Waters destined for use on real property or in an industry can be used by the possessor of such property or industry, under the same conditions and with the same limitations that apply to the holder of a right of utilization.

Art. 6.--The concessioner of a water utilization right inherently possesses the power to establish rights of way for transit, canals and related rights of way. He is obligated to construct the works which are necessary to exercise these rights.

Art. 7.--The concession of a water utilization right will be conditional on the availability of the resource and the real needs of the objective to which it is destined.

Art. 8.--The persons that have acquired rights to the utilization of waters may not oppose the use of waters from the same source by other interested persons, and therefore such interested persons are permitted to place their diversion points in locations that do not prejudice earlier possessors.

The limitation and regulation of the use of the waters by the title holders of a utilization right, is vested in the Ecuadorian Institute of Water Resources in conformity with article 3 i of Decree No. 1551 of November 10, 1966 and this Law.

Art. 9.--The owners of lands which border on public streams may place defenses against the water in their respective banks, by means of plantings, walls, pilings, retaining works, etc. Before constructing such works they must inform the Ecuadorian Institute of Water Resources, who, based on a previous inspection, grants or denies the authorization.

Art. 10.--Private lands which have been covered by flood conditions continue to be private property during and after such flood conditions exist.

Art. 11.--When a lagoon or river changes its course, with preference to the adjacent riparian properties, the owner of such properties, with authorization of the Ecuadorian Institute of Water Resources, may make the works necessary for returning the waters to the customary bed. The part of the area that as a result of the work remains permanently dry reverts to the contiguous properties in conformity with the provisions contained in the Civil Code. For the exercise of this right, the interested parties shall have a period of two years, beginning with the date of the change of course of the stream.

The same right can be exercised to construct, with the permission of the Ecuadorian Institute of Water Resources, works of defense in the beds of streams or water deposits that tend to cause damage to the owners of bordering riparian properties.

Art. 12.--The state guarantees to the individuals the use of the waters, with the limitations necessary for its efficient utilization in favor of production.

Art. 13.--In order to promote the utilization of water resources the Ecuadorian Institute of Water Resources is vested with the following responsibilities:

- a. plan the improved use and development of water;
- b. make evaluations and inventories;
- c. define the water protection zones;
- d. declare states of emergency and dictate the measures that are necessary to protect the waters; and,
- e. carry out the protection and development of river basins.

Art. 14.--Only through a concession of a utilization right may they utilize the waters, with the exception of waters that are required for domestic service.

Art. 15.--The beneficiary of a water utilization right is obligated to construct the diversion, conveyance, use, control, and measuring works so that he receives only the amount of water conceded. They must be constructed so that they cannot be modified or destroyed when the period of the concession expires, except with the authorization of the Ecuadorian Institute of Water Resources.

The unit of measurement of water quantity is the liter per second or its multiple, the cubic meter per second. The unit of measurement of volume is the cubic meter.

Art. 16.--The conservation, preservation and increase of water resources are works of national character.

Art. 17.--The state and other juridicial persons of public right shall collect from the beneficiaries the value of water works and the costs of operation and maintenance of works that are executed with its funds.

The investments that were made for reasons of social service and that do not influence the economic production of a work shall not be considered in determining the chargeable value.

The collections shall be made in the form determined in the respective regulation.

Art. 18.--For the concessions of water utilization rights granted by the state, the Ecuadorian Institute of Water Resources shall collect the tariffs that are fixed in the regulations both for natural and legal persons or entities.

The concessions of water utilization rights for potable water will be exonerated from payment.

Art. 19.--The collectable values and the rights of concession which the two previous paragraphs refer to, will be in the proportion and conditions that are established in the Regulation formulated by the Ecuadorian Institute of Water Resources and will be expedited by the Executive Authority.

TITLE II

The Conservation and Contamination of Waters

CHAPTER I

The Conservation

Art. 20.--In order to attain the maximum availability of water the Ecuadorian Institute of Water Resources shall, to the extent possible, prevent the reduction of water supply, protecting and developing the water basins and making the necessary studies related to these goals.

Art. 21.--The user of a utilization right shall use the waters with the greatest efficiency and economy, and must contribute to the conservation and maintenance of the works and installations that are available for his use.

CHAPTER II

The Contamination

Art. 22.--The contamination of waters that affect human health or the development of flora or fauna is prohibited.

Ecuadorian Institute of Water Resources, in collaboration with the Ministry of Public Health and the other State Entities, shall apply the policies that permit compliance with this disposition.

TITLE III

The Acquisition of a Utilization Right

CHAPTER I

Art. 23.--The concessions of a water utilization right are:

- a) "Occasional," over excess resources;
- b) "Of a fixed period," for irrigation, industry and other productive labor; and,
- c) "Of undetermined period," for domestic uses.

Art. 24.--The authorization for the utilization of waters will be subject to compliance with the following requirements:

- a) that they do not interfere with other uses;
- b) that the waters are sufficient in quality and quantity;
- c) that the studies and works necessary for its use have been approved by the Ecuadorian Institute of Water Resources.

Art. 25.--When the water available is not sufficient to satisfy multiple requirements, preference shall be given to those that serve the best social-economic interests of the country.

Art. 26.--In the same concession, two or more rights of water utilization for multiple use may be granted.

Art. 27.--In the authorization of a right of water utilization, the goals and places to which the water is destined shall be specified.

Art. 28.--In order to comply with the objective of this Law, the Ecuadorian Institute of Water Resources is obligated to register all concessions of water utilization rights.

Art. 29.--When works must be constructed for the conservation and improvement of rights of way for canals and other related rights of way, the Ecuadorian Institute of Water Resources may order the temporary suspension of the use of the waters.

Art. 30.--In the concessions of water utilization rights that are related to navigation and flotation, approval of the Naval Forces must be obtained; and, if they affect the national security, they require in addition, the favorable report of the Joint Command of the Armed Forces.

Art. 31.--The Ecuadorian Institute of Water Resources may cancel, suspend or modify a water concession when the user does not utilize it in an efficient form, or uses it in a different manner or for another purpose than is fixed in the concession. In no case will there be indemnification for existing works.

Art. 32.--The rights of water utilization lapse at the termination of the objective for which they are conceded, at the termination of the authorization, or for a reduction of the water resource which makes the water use impossible.

TITLE IV

The Uses of Water and Preferences

Art. 33.--The utilization of water is subject to the existence of the resource, the needs of the communities, the farms or industries, and the priorities fixed in this Law.

Art. 34.--The concession of rights for the utilization of water are granted in accord with the following order of preference.

- a) for community supply, for domestic necessities and cattle watering;
- b) for agriculture and livestock raising;
- c) for energy, industrial and mining uses; and
- d) for other uses.

In cases of social emergencies and while these persist, the Ecuadorian Institute of Water Resources may change the order above mentioned with the exception of that fixed in sub-paragraph (a).

Art. 35.--Every change in point of diversion or transfer of water rights in natural or artificial channels may only be accomplished with the authorization of the Ecuadorian Institute of Water Resources. Such authorization is also required for the construction of dams.

Art. 36.-- If various users conduct their waters through a common canal, each of them can divert, in the most convenient place, the water that corresponds to him, provided that in so doing, the right of way is not made more burdensome to the servient property, that it does not prejudice the rights of the other users, and that indemnification is paid for any damage the diversion may cause.

On the petition of an interested party, the users are obligated to place a measuring device at the point of water diversion to insure

that they receive only the quantity of water to which they have a right and to allow the excess to pass through the common channel.

These claims are processed according to the regulations of this Law.

TITLE V

Concessions of Water Utilization Rights for Domestic and Sanitation Uses

Art. 37.--The concessions of water for human consumption, domestic uses and sanitation of communities, will be granted to Municipalities, Provincial Councils, Organizations of Public or Private Rights, and individuals in accordance with the dispositions of this Law.

TITLE VI

Art. 38.--The concessions of water utilization rights for irrigation will be granted exclusively to those who justify the need under the terms and conditions of this Law.

Art. 39.--Waters destined to irrigation can be extracted from the subsoil, glaciers, springs, natural and artificial channels when the necessity exists and in the amounts technically determined by the Ecuadorian Institute of Water Resources.

TITLE VII

Waters for Energy, Industrial and Mining Purposes

Art. 40.--Rights for utilization of waters shall be conceded for the generation of energy destined to industrial and mining activities, especially to such activities as are contemplated in the General Development Plan of the Country.

The waters destined to the generation of energy and working mines must be returned to a public channel, with the concessioner having the obligation to treat them if the Ecuadorian Institute of Water Resources deems it necessary.

TITLE VIII

Concession of Rights for Utilization of Subterranean Waters

Art. 41.--No one may explore for subterranean waters without the authorization of the Ecuadorian Institute of Water Resources, and in the case of their discovery the concession of rights to utilize them is subject, in addition to the conditions established in Art. 24, to the following:

- a) That the raising of the water does not damage the conditions of the aquifers nor the superficial area included within the influence of the well or collection area; and,

- b) That it does not produce interference with other wells, collecting galleries, or sources of water, and other pre-existing wells in general.

Art. 42.--The authorizations for works for raising subterranean waters may be granted in lands of third parties, which third parties have preference as concessioners of water excesses.

Art. 43.--At any time the Ecuadorian Institute of Water Resources may provide, on its own accord or on the motion of another party, the modification of methods, systems or installations which are inadequate for raising subterranean waters.

Art. 44.--Natural or legal persons who engage in well drilling to raise subterranean waters are obligated to obtain a license from the Ecuadorian Institute of Water Resources and to provide the studies and technical data that have been obtained.

TITLE IX

Mineral, Thermal and Medicinal Waters

Arts. 46.--The Ecuadorian Institute of Water Resources has in its charge the study and control of the exploration and exploitation of mineral, thermal and medicinal waters, and shall within the periods fixed in the respective regulations, inventory, classify and evaluate the therapeutic, industrial and tourist utility of said sources in coordination with the General Office of Tourism and the Ministry of Public Health.

Art. 47.--Mineral, thermal and medicinal waters will be exploited by the State, municipalities, or through concessions of rights of utilization to individuals, and also through contracts of association in order to supply these waters to rehabilitation centers, bath houses, bottling plants, etc.

The present users may continue to enjoy the utilization right until they are granted concessions as provided in this Law.

At the end of the period of the concession, or before this if they fail to exploit the waters referred to in this article, the works and installations become the property of the State without any indemnification.

TITLE X

Concession of the Rights for Utilization of Remnant Waters

Art. 48.--Anyone may claim and acquire rights to the utilization of remnant waters or waste waters of a property or industry.

The point of diversion of the remnant waters will be determined by the Ecuadorian Institute of Water Resources. The point of diversion may be either within or outside the farm or industry from which the waters are derived.

TITLE XI

Irrigation and Drainage of the Soil

Art. 49.--The irrigation of the dry lands of the country and the drainage of the soil in flooded zones are declared to be works of national character.

The Ecuadorian Institute of Water Resources, as the executive organism of the Ministry of Natural Resources and Tourism, will approve and supervise the studies and construction of irrigation and drainage works, as well as of their subsequent utilization.

Art. 50.--The Ecuadorian Institute of Water Resources shall determine the availability of waters from rivers, lakes, lagoons, running waters or detained waters, rain waters, surface or subterranean and all others contemplated in this Law, as appropriate for irrigation purposes.

TITLE XII

Obligatory Irrigation

Art. 51.--The utilization of waters for irrigation conducted through irrigation canals constructed with State funds is obligatory.

The properties under the influence of the above mentioned canals that have a slope of less than a twenty percent grade are subject to the obligation covered in the previous paragraph.

Art. 52.--Excluded from this obligation are:

- a) lands whose soils do not permit efficient agricultural production, until such lands have been recuperated; and,
- b) lands which already have sufficient available water.

In those cases contemplated in subparagraph b) the irrigable surface and the available water shall be taken into account. If the available water is insufficient to irrigate all irrigable lands the owner of the land is obligated to utilize the difference from the State owned canal.

These exceptions will be further defined by the Ecuadorian Institute of Water Resources.

Art. 53.--The persons obligated to utilize the water must pay the respective tariff whether or not they utilize it. The following factors shall be considered in establishing the said tariff: the amortization of the capital invested in the canal and complementary works; the costs of operation and maintenance; and the period of its utility. These proportions and conditions will be fixed in the Regulation, which when prepared by the Ecuadorian Institute of Water Resources, must be expedited by the Ministry of Natural Resources and Tourism.

Art. 54.--The National Development Bank will annually establish special lines of credit for the goals contemplated in this Title based on previous studies and calculations from data supplied by the Ecuadorian Institute of Water Resources.

TITLE XIII

Marginal Properties

Art. 55.--The marginal border of land that shall be obligatorially maintained on the properties bordering natural stream beds, canals, etc., in order to facilitate navigation, transit and other services, will be fixed by the Ecuadorian Institute of Water Resources, and shall be without indemnification. The users are responsible for the damages caused by their improper use.

TITLE XIV

Studies and Works

Art. 56.--The works that allow the exercise of a water utilization right are subject to the technical and general specifications, studies, and projects approved by the Ecuadorian Institute of Water Resources. Non-compliance will be sanctioned with the suspension, destruction, modification, reconstruction or reconditioning of the works or installations.

Art. 57.--The Ecuadorian Institute of Water Resources shall order the capping or closing of wells or galleries when they interfere with the subterranean flow that supplies others of prior date.

Art. 58.--Everything included in the cases mentioned in the preceding articles must comply with the orders of the Ecuadorian Institute of Water Resources within the period that it fixes, and if they fail to comply, the Institute may do so and charge the costs to the interested party. The interested party will be responsible for any damages which may occur.

Art. 59.--The water users that within the fixed period do not construct the works or carry out the installations which are ordered by the Ecuadorian Institute of Water Resources, will have their concessions suspended until such works are executed.

Art. 60.--No land owner can oppose the construction of defense works in the margins of rivers and other natural streams or water beds, when such works protect other property or goods from the action of the waters.

TITLE VX

Rights of Way

CAPITAL I

Natural Rights of Way

Art. 61.--Lower properties are subject to receiving waters that naturally descend from higher property without the hand of man altering their course.

With authorization of the Ecuadorian Institute of Water Resources the property owners of the mentioned properties can change the course of the water, provided that it does not cause damage to third parties.

CAPITAL II

Forcefully Imposed Rights of Way

Art. 62.--All property is subject to a right of way for a canal and its related rights of way such as for diversion works, construction of dams, extraction works, conduction works, drains, soil drainage, transit and vigilance, lining, protection of the banks, etc., in favor of another property that needs the water.

The owners of the servient properties may not pasture animals infected with contagious diseases next to the canal that crosses their lands, nor discharge sewage or infected waters into it.

These rights of way, as well as the modifications in those that now exist and those that will be constituted, are enforceable by law and will be established as such.

The Ecuadorian Institute of Water Resources shall authorize the occupation of lands for the execution of the works that are referred to in this article.

There will be a right to the payment of indemnification when lands of greater than ten percent of the total area of a property are occupied or when they cause a devaluation that exceeds five percent of the value.

Art. 63.--Also as a part of the right of way for a canal is the right of passage that is exercised in the form necessary for the policing, cleaning and other purposes established in this Law.

Art. 64.--Everyone that enjoys the use of a right of way that crosses public ways or installations is obligated to construct and conserve the necessary works so that the right of way does not cause damage.

Art. 65.--If in order to exercise a water utilization right it is necessary to utilize an existing canal, the beneficiary must contribute proportionally to cover the costs of maintenance and construction of the necessary works. He must also pay all the damages caused thereby.

Art. 66.--Any modification of an established right of way must be authorized by the Ecuadorian Institute of Water Resources.

Art. 67.--In case of the division of lands, the rights of way necessary for the use of the waters shall be established through the intervention of the Ecuadorian Institute of Water Resources.

Art. 68.--The owner of the servient property has a right to demand the avoidance of filtrations, overflows or any other damage that can be imputed to defects in the construction, conservation, operation and preservation of the works. The Ecuadorian Institute of Water Resources shall order the necessary construction or repair and establish the period within which it must be completed.

Art. 69.--The Ecuadorian Institute of Water Resources shall prevent plantings, construction and in general new works on the banks of a canal when it affects the security of the canal.

Art. 70.--The owner of the servient property does not acquire any rights over the waters that flow through it but may use them only for domestic needs and cattle watering without damming, diverting or contaminating them.

Art. 71.--The rights of way that allow the exercise of a water utilization right, lapse in the following cases:

- a) If he that solicited the right does not construct the ordered works within the period conceded;
- b) When without just cause, it remains without use for more than two consecutive years;
- c) At the conclusion of the objective for which it was authorized;
- d) If the right of way is used for a purpose other than that for which it was authorized;
- e) At the conclusion of the period of a temporary right of way.

Art. 72.--When a right of way is revoked, the improvements and exclusive ownership and use revert to the servient property.

Art. 73.--The constitution of the rights of way established in this title in favor of institutions of the State, in addition to being forceful, are also preferred.

TITLE XVI

Common Utilizations and Water User's Associations

Art. 74.--If two or more persons conduct water through a common canal, each one can divert the amount that strictly belongs to him in the place most convenient to his interest, provided that it does not damage the rights of other users.

If there is not an agreement between the users the dispute will be resolved by the Ecuadorian Institute of Water Resources.

Art. 75.--The users of a canal shall contribute proportionally according to their rights to the cleaning, repair and administrative costs of the same, as well as the constructions and other necessary works for its improvement and conservation.

Art. 76.--If more than five persons have rights to the common use of waters they shall organize a Water User's Association.

Their statutes, approved by the Ecuadorian Institute of Water Resources, shall determine their organization and functioning as well as the division, exploitation and conservation of the waters.

The Ecuadorian Institute of Water Resources shall intervene in all of the conflicts that occur within the User's Associations to determine the measures required to insure compliance with their functions and attributes.

TITLE XVII

Infractions and Penalties

Art. 77.--Anyone who commits an infraction of this Law, or its Regulations, will be sanctioned with a fine of not less than Five Hundred Suces, according to the gravity and circumstances of the infraction, and not greater than 100% of the benefit obtained by the illicit act, or 100% of the damage occasioned by the act.

Reoccurrence will be sanctioned, in addition, with the temporary suspension of the use of the waters.

Art. 78.--Without prejudice to the provision of the previous article, the violator must remove the work and return things to their earlier state, replace the natural or artificial protection and pay the costs of this replacement. In every case he will be responsible for the damages caused.

TITLE XVIII

Jurisdiction and Procedure

Art. 79.--The jurisdiction over matters to which this Law refers is vested in the Ecuadorian Institute of Water Resources.

The administrative organization for the exercise of this jurisdiction will be determined in the Regulation that will be approved by the Ministry of Natural Resources and Tourism.

Art. 80.--The Chiefs of Agencies or Districts of the Ecuadorian Institute of Water Resources will exercise jurisdiction in their respective zones for processing and resolving, in the first instance, the claims and matters which refer to this Law in accord

with the norms covered in the previous article.

Art. 81.--In the second and final instance these matters will be heard and resolved by the Consultive Council of Waters which is composed of two delegates from the Board of Directors of the Ecuadorian Institute of Water Resources named from its membership, and the Executive Director of said entity, and by his delegation the Chief of the Division of Hydraulic Resources.

Art. 82.--Anyone who considers himself prejudiced by the resolutions referred to in the previous paragraph may appeal to the Administrative Tribunal, when the resolution becomes final.

Art. 83.--Anyone who want to obtain a concession of a water utilization right and rights of way, shall make his petition in the form determined by this Law.

Art. 84.--In the petition the following elements shall be determined.

- a. Name of the river, source, Parrish, Canton, and Province from which they will divert the waters;
- b. The quantity that is needed and the place from which the water will be diverted or raised;
- c. The names and domiciles of the known users;
- d. The object to which it will be destined;
- e. The works and installations that will be constructed to utilize the waters;
- f. The time within which the works will be executed;
- g. The studies and technical plans that justify and define the petition to the extent determined in the corresponding regulations.

Art 85.--The Chief of the Agency or District determines if the petition conforms to the Law and if it does he orders the following:

- a. That they notify the users, both known and unknown, by the press, through the publication of an extract from the petition, for three times with a period of eight days between each publication, and by posting notice in three of the most frequented places in the Parrish seat where they propose to divert or raise the water, without prejudice to the necessity of serving personal notifications on known users;

The publications by the press will be made in the newspaper that the Chief of the Agency of District designates. If none are published in the respective Canton or Capital of the Province, then in one of those in Quito, Guayaquil or Cuenca.

- b. That one or more experts, to be designated from the technical personnel of the Ecuadorian Institute of Water Resources shall make a study of the matters referred to in the petition and;
- c. The obligation of the interested parties to fix their domicile within the fixed period.

Art. 86.--After a period of twenty days from the last publication in the press, if there is no opposition presented, the Chief of the Agency or District shall make a resolution within a period of 5 days.

If opposition is presented, a hearing of conciliation shall be convened, and if there is no agreement reached between the parties, then in the same hearing the proceedings are opened for the receipt of evidence for a period of ten days.

After the conclusion of the period of proof, the Chief of the Agency or District of the Ecuadorian Institute of Hydraulic Resources makes a resolution within a period of thirty days.

Art. 87.--The reforms to the concessions of water utilization rights can be resolved as an incident to the same case.

Art. 88.--Forceful rights of way covered by this Law must be obtained through a petition to the Chief of the Agency or District of the Ecuadorian Institute of Water Resources in the place where the real property is located that is to be subjected to the right of way.

If the property is in various jurisdictions, the petitioner may elect between the Chiefs of the Agency or District of his choice.

Art. 89.--For the establishment or modification of rights of way the procedures covered in the previous article apply, with exception of the publication through the press and the posting of notices.

Art. 90.--Within the period of two days from the notification of the parties of the resolution in the first instance, they shall have a right to recourse of appeal or nullity or both before the Consultive Council of Waters, which resolves the matter on its merits.

The Consultive Council of Waters shall expedite its resolution within a period of thirty days from the receipt of the appeal.

Art. 91.--The procedure for the indemnification for damages and damages originating in rights of way will be processed before the Common Civil Judges, in conformity with the respective laws.

Art. 92.--Without prejudice to the occupation of the real property, if a controversy arises over the delivery of the value consigned as indemnification, said value shall be placed at the disposition of the respective Provincial Judge so that it may be disposed of as the judge deems proper.

Art. 93.--The sentences and resolutions covered in this Law shall be recorded in the Registry of the Ecuadorian Institute of Water Resources.

Art. 95.--The Judges of the first and second instance shall apply the law with ample criteria of equity, review the proof in accord with the regulations of judgments in the absence of legislation, and may order, on their own motion, the proceedings and proof that they deem convenient.

Art. 95.--The judgement of the infractions and the imposition of the sanctions provided in this Law are under the jurisdiction of the Chief of the Agency of District within those areas they are committed, and said resolutions cannot be appealed.

Art. 96.--For the presentation and concession of the recourses provided in Article 90, the provisions of the Code of Civil Procedure and this Law apply.

Art. 97.--In no case will the application of this Law be sacrificed for the omission of formalities.

TITLE XIX

General Dispositions

Art. 98.--Every water user is obligated to register his use right with the Ecuadorian Institute of Water Resources specifying the source from which it is taken and the quantity that belongs to him.

This inscription, which shall be free of charge, shall be made within a period of one year. Non-compliance shall give rise to the sanctions provided in Article 78 of this Law.

Art. 99.--Anyone may store rain waters in tanks, cisterns or small reservoirs for domestic, irrigation, industrial or other purposes, provided that third parties are not damaged thereby. Plans for works to store water of more than 200 cubic meters in capacity must receive prior approval of the Ecuadorian Institute of Water Resources.

Art. 100.--The Ecuadorian Institute of Water Resources shall provide cooperation and necessary assistance to entities charged with the preparation and execution of development programs for the proper compliance of their functions.

Art. 101.--The attributes that are conceded to the Ecuadorian Institute of Water Resources by this Law shall be exercised without prejudice to those powers granted under the law of its creation.

Art. 102.--The Decree Law No. 113, of March 16, 1972 shall be applied to those who have illicitly benefited from the sale or rental of waters.

SPECIAL DISPOSITIONS

Art. 103.--Waters of the sea are governed by laws covering the subject matter.

Art. 104.--Coactive jurisdiction is conferred on the Ecuadorian Institute of Water Resources for the collection of tariffs imposed by virtue of this Law.

Art. 105.--The controversies over waters and related matters which are now pending, shall continue to be processed until their termination before the same tribunals, judges, and organizations that are now hearing them, but the judgments will be subject to the dispositions of this Law.

Art. 106.--All other legal dispositions are abolished which are in opposition to this Law and are related to waters, rights of way, and related matters existing in other laws, regulations and other dispositions.

Art. 107.--This Law shall take effect from the date of its execution and signing, without prejudice to its publication in the Official Register, and its execution shall be made by all of the Honorable Ministers of State.

Communicated and Published

Executed in the National Palace in Quito on this 13th day of May, 1972.