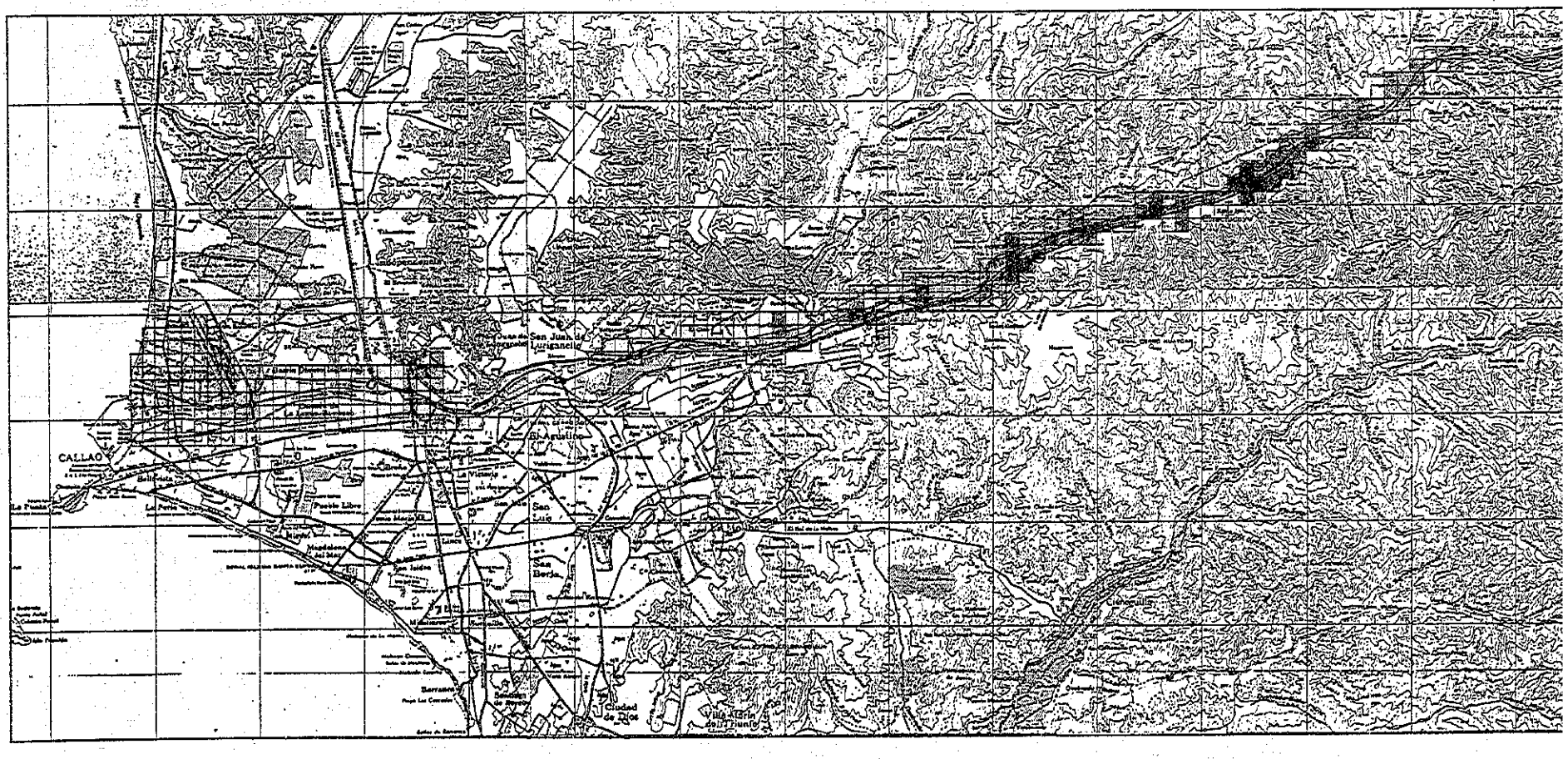


Fig. V-6-3 Inundation Area due to Probable Flood (10 year flood)

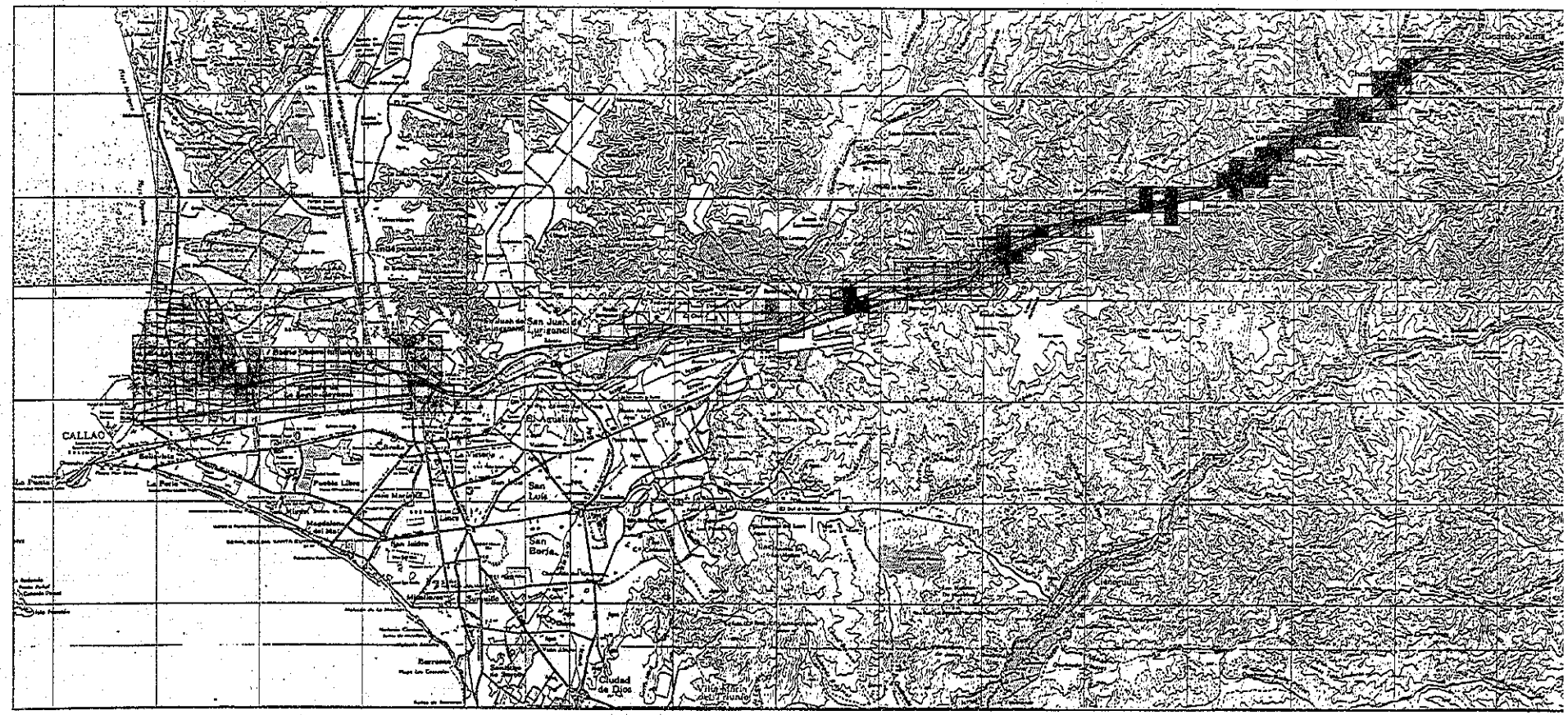


Fig. V-6-4 Inundation Area due to Probable Flood (50 year flood)

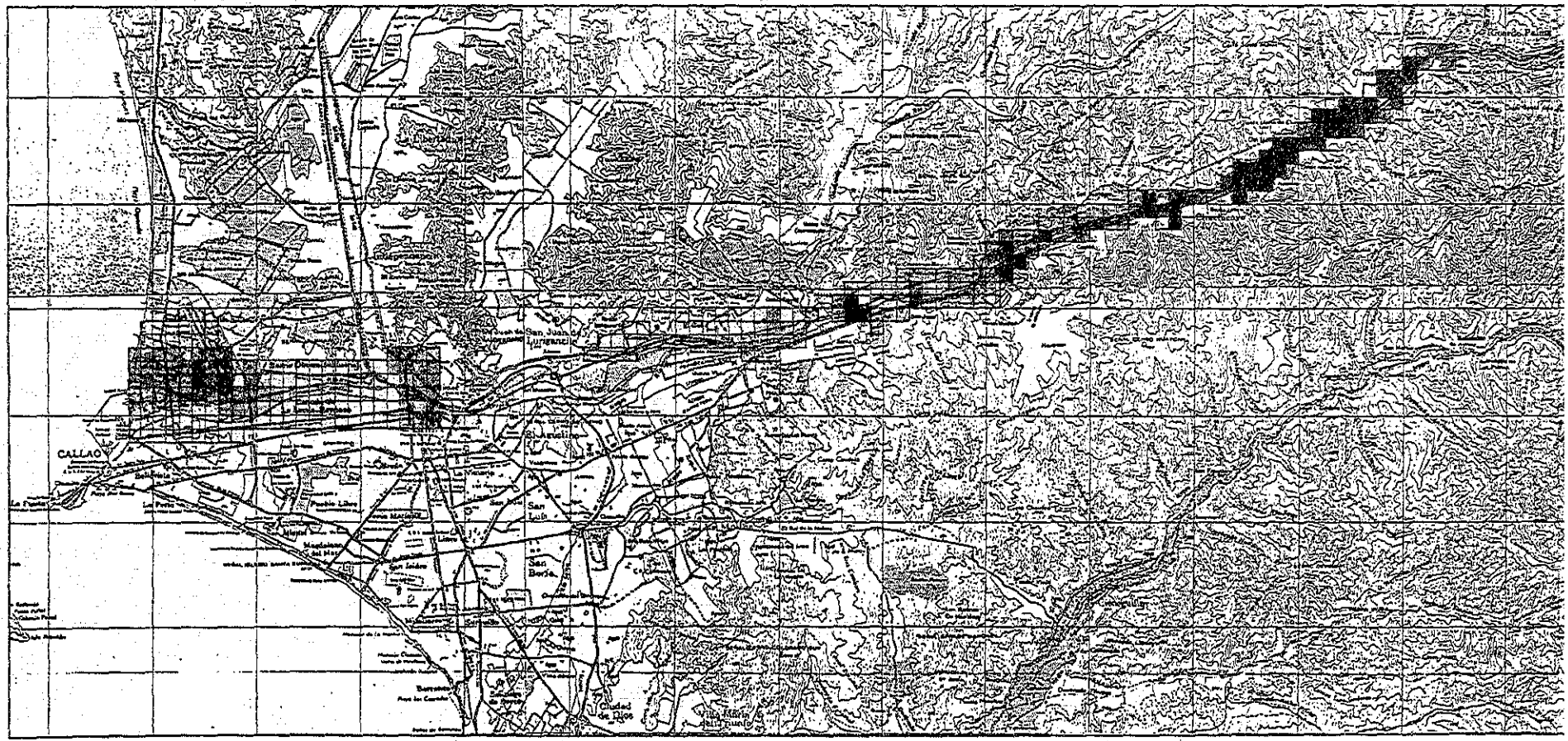
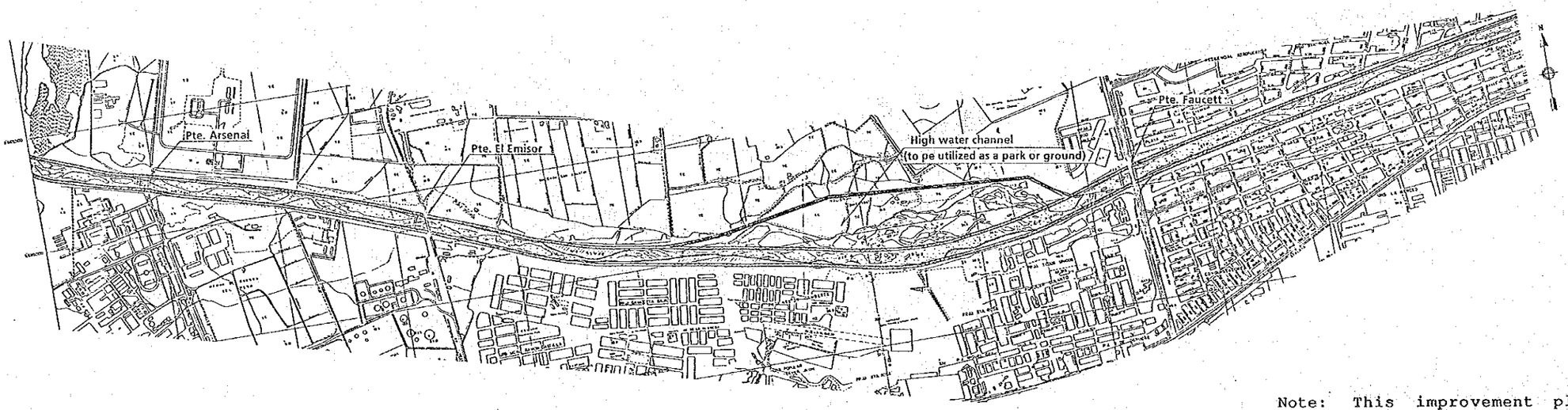


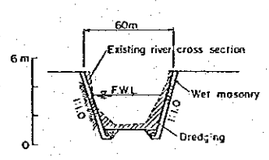
Fig. V-6-5 Inundation Area due to Probable Flood (100 year flood)



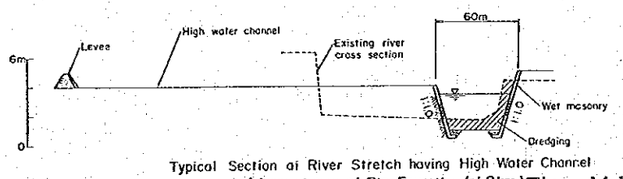
LEGEND

Proposed	Measure / Structure
	; River dredging
	; Enlargement of river channel
	; Levee construction
	; Concrete parapet wall
	; Revetment (Wet masonry)
	; Revetment (Gabion)
	; Revetment (Frame work)
	; Groyne
	; Ground sill
Existing	
	; Levee
	; Parapet wall

0 500m
Scale



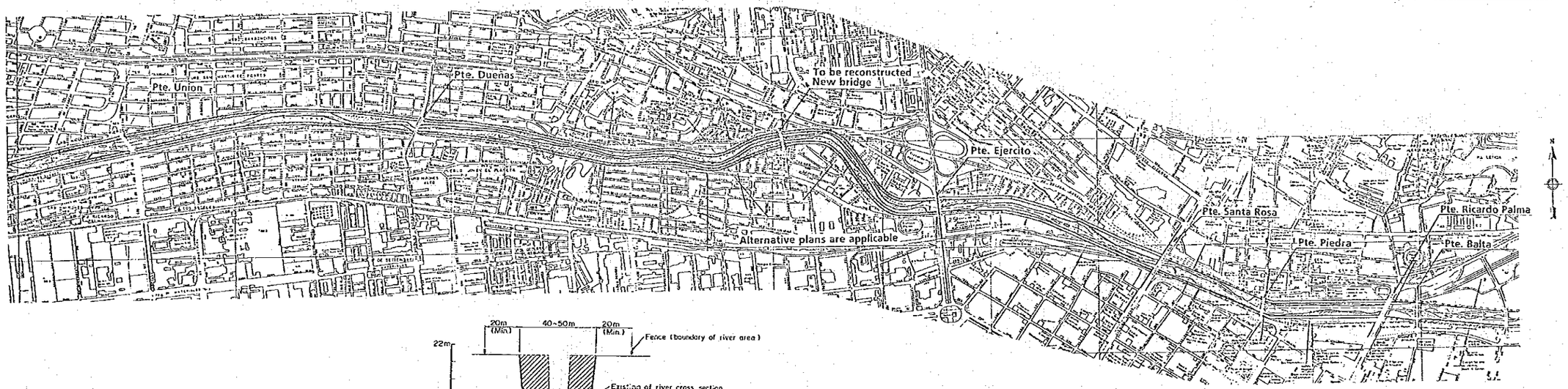
Typical Section
(River mouth - Pte. La Union)

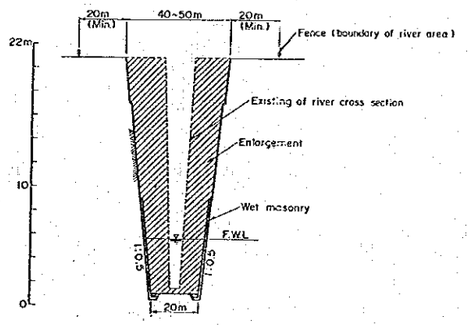


Typical Section at River Stretch having High Water Channel
(down stream of Pte. Faucett, ℓ=1.8km)

Note: This improvement plan is just prepared preliminarily at this master plan study stage, requiring further re-examinations on the basis of more detailed investigation and study.

Fig. V-7-1 Proposed River Improvement Plan (1/8)





Typical Section of Narrow Portion
(Pte. Dueñas ~ Pte. Ejercito)

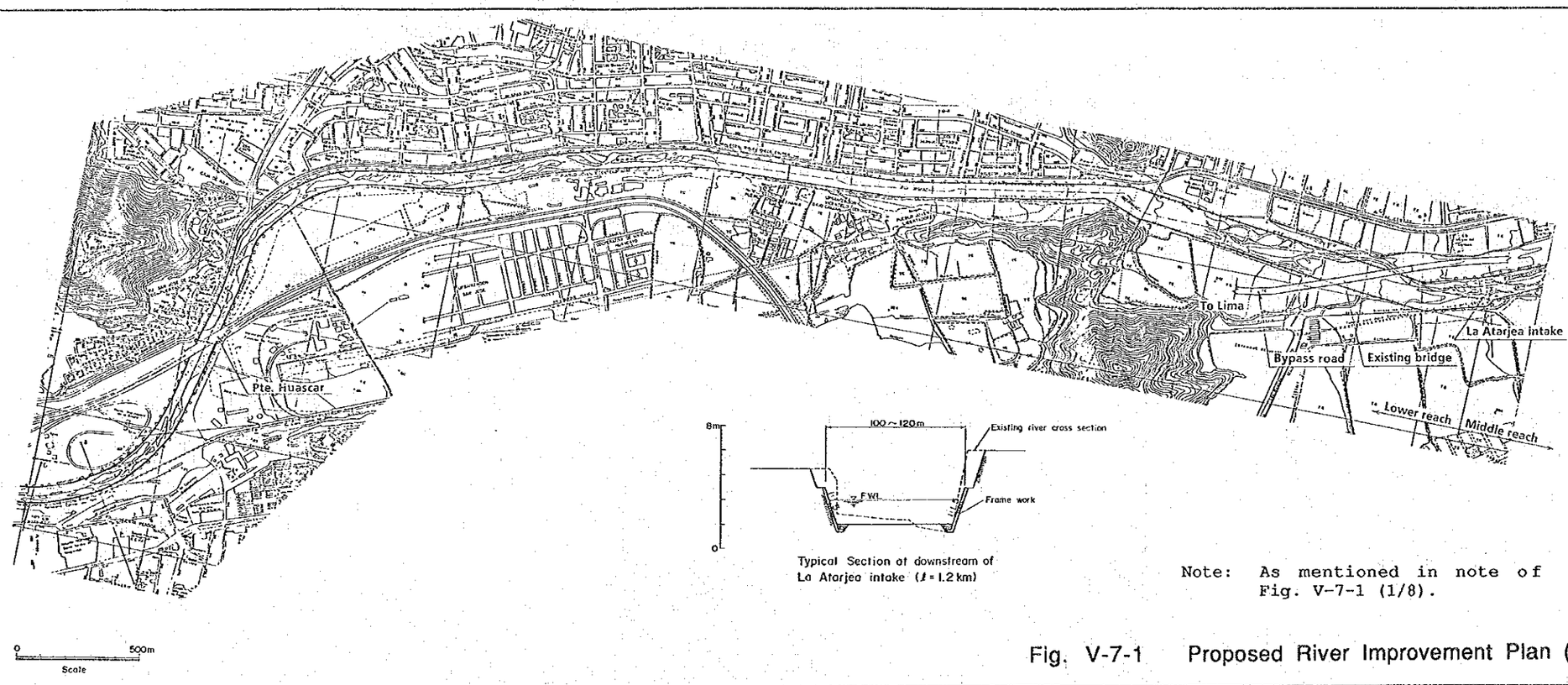
LEGEND

Proposed	Measure / Structure
	River dredging
	Enlargement of river channel
	Levee construction
	Concrete parapet wall
	Revetment (Wet masonry)
	Revetment (Gabion)
	Revetment (Frame work)
	Groyne
	Ground sill
Existing	
	Levee
	Parapet wall

0 500m
Scale

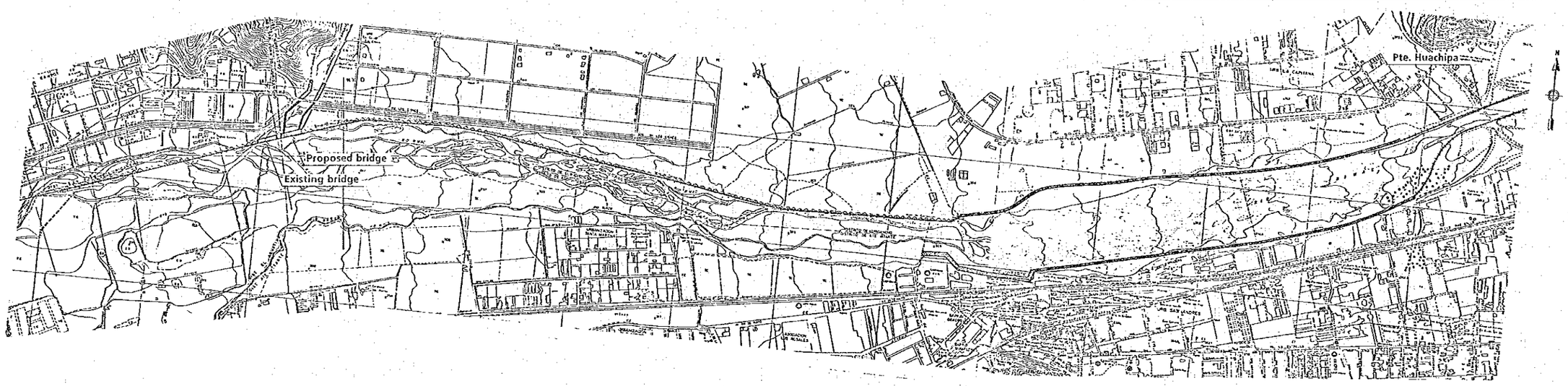
Note: As mentioned in note of Fig. V-7-1 (1/8).

Fig. V-7-1 Proposed River Improvement Plan (2/8)



Note: As mentioned in note of Fig. V-7-1 (1/8).

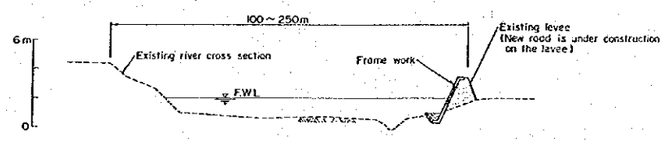
Fig. V-7-1 Proposed River Improvement Plan (3/8)



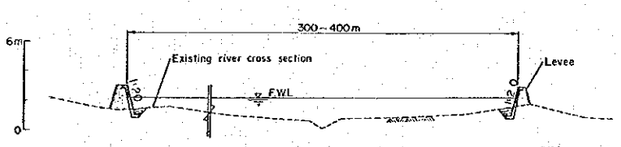
LEGEND

Proposed	Measure / Structure
	River dredging
	Enlargement of river channel
	Levee construction
	Concrete parapet wall
	Revetment (Wet masonry)
	Revetment (Gabion)
	Revetment (Frame work)
	Groyne
	Ground sill
Existing	
	Levee
	Parapet wall

0 500m
Scale



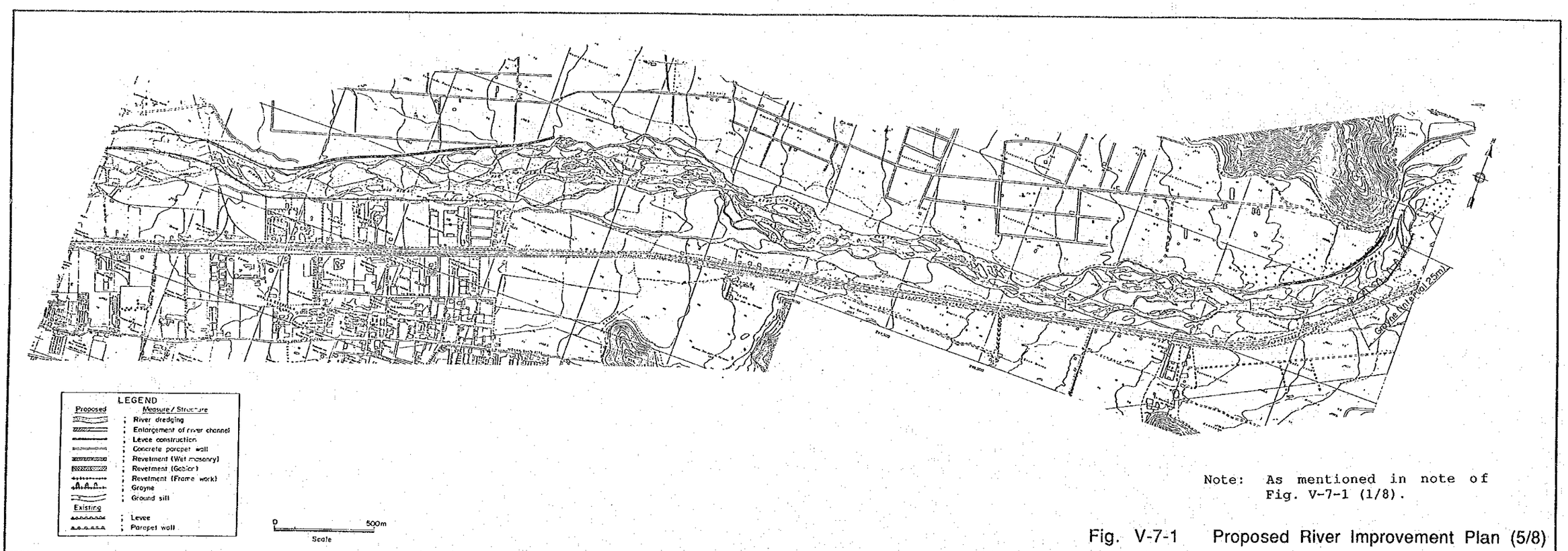
Typical Section at upstream of La Atarjea intake (ℓ=4.0m)



Typical Section at downstream of Pte. Huachipa (ℓ=2.2 km)

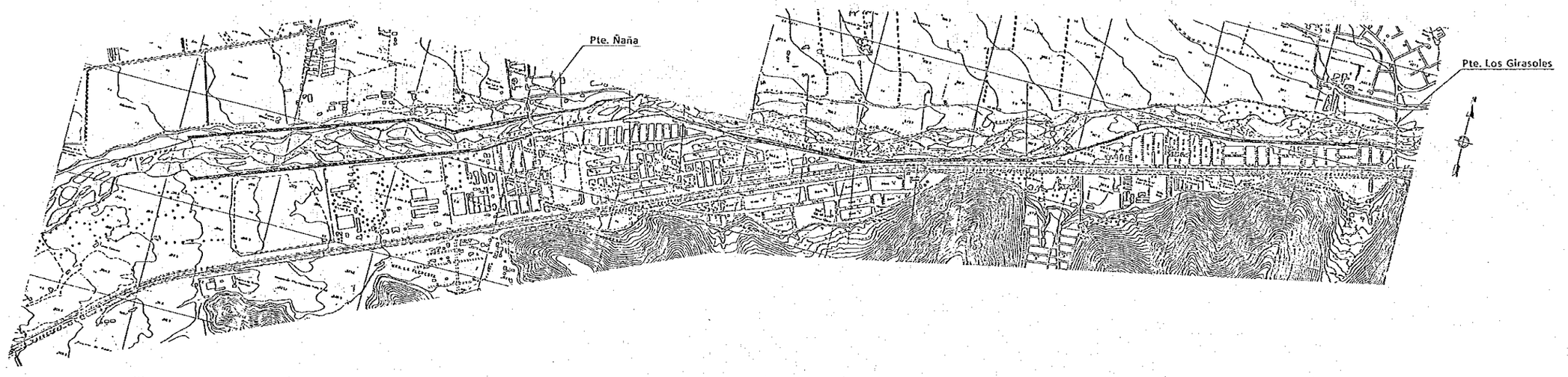
Note: As mentioned in note of Fig. V-7-1 (1/8).

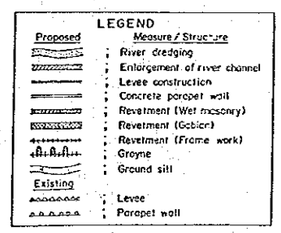
Fig. V-7-1 Proposed River Improvement Plan (4/8)

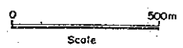


Note: As mentioned in note of Fig. V-7-1 (1/8).

Fig. V-7-1 Proposed River Improvement Plan (5/8)





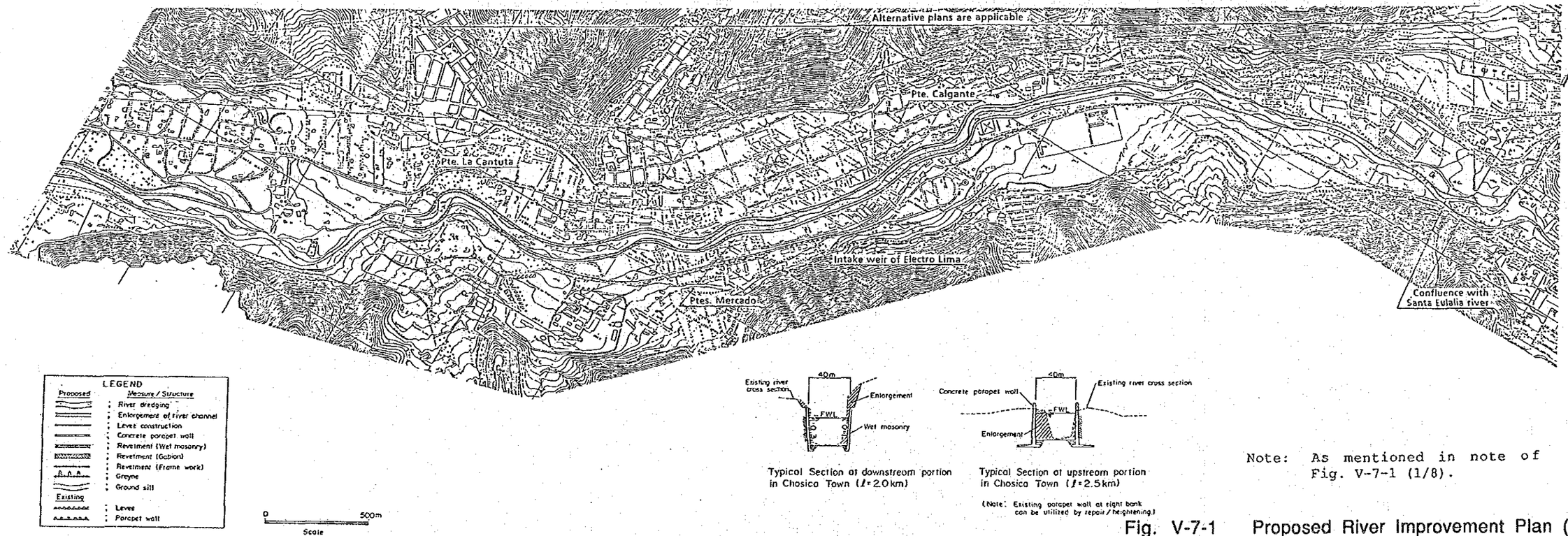


Note: As mentioned in note of Fig. V-7-1 (1/8).

Fig. V-7-1 Proposed River Improvement Plan (6/8)

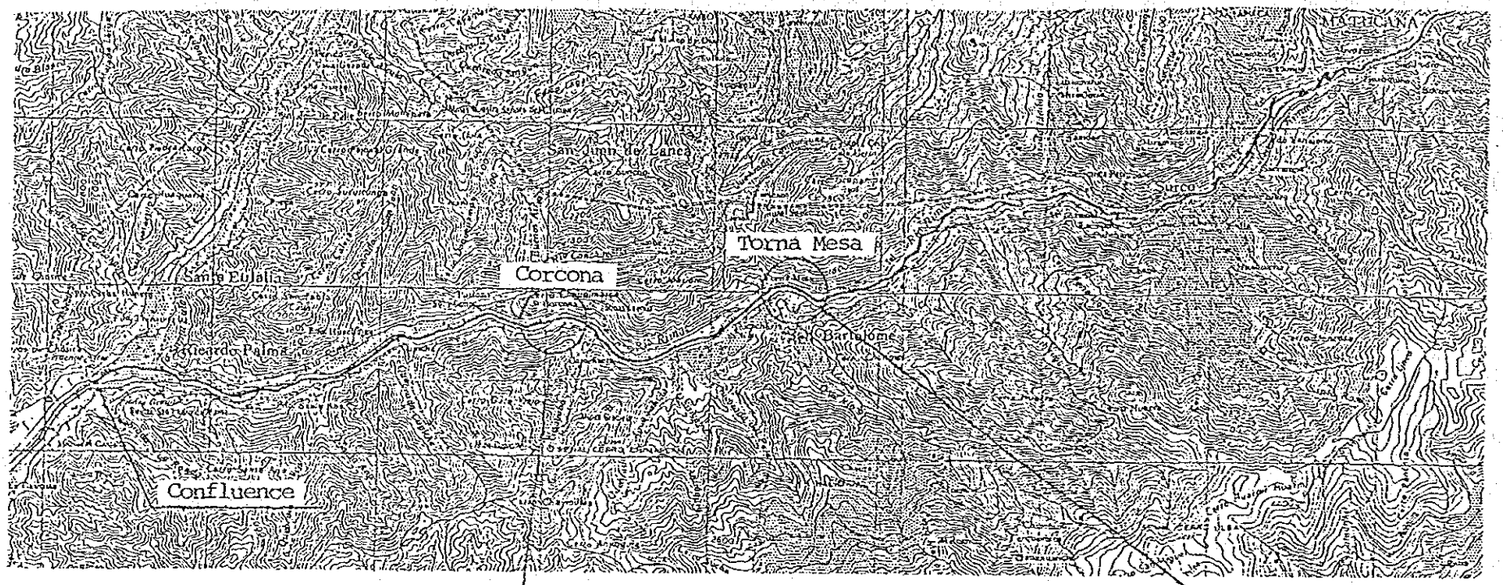
Note: As mentioned in note of Fig. V-7-1 (1/8).

Fig. V-7-1 Proposed River Improvement Plan (7/8)



Note: As mentioned in note of Fig. V-7-1 (1/8).

Fig. V-7-1 Proposed River Improvement Plan (8/8)



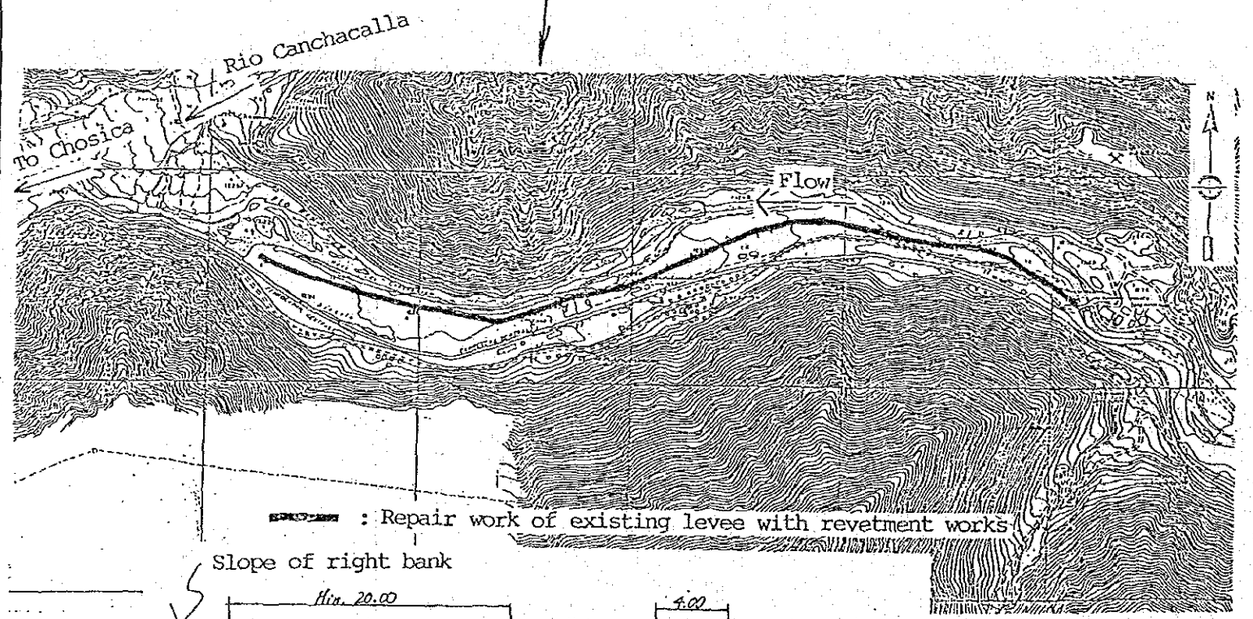
General Map

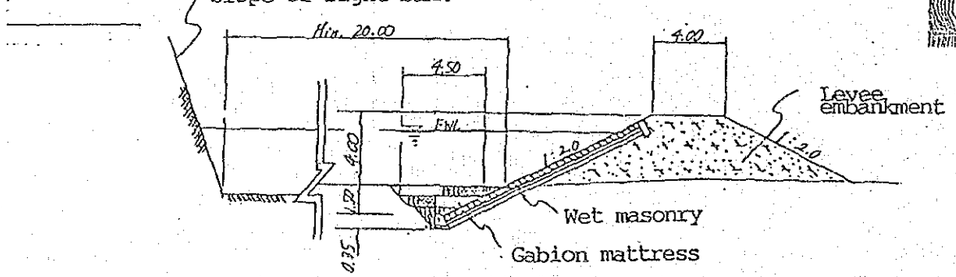
0 8km

scale

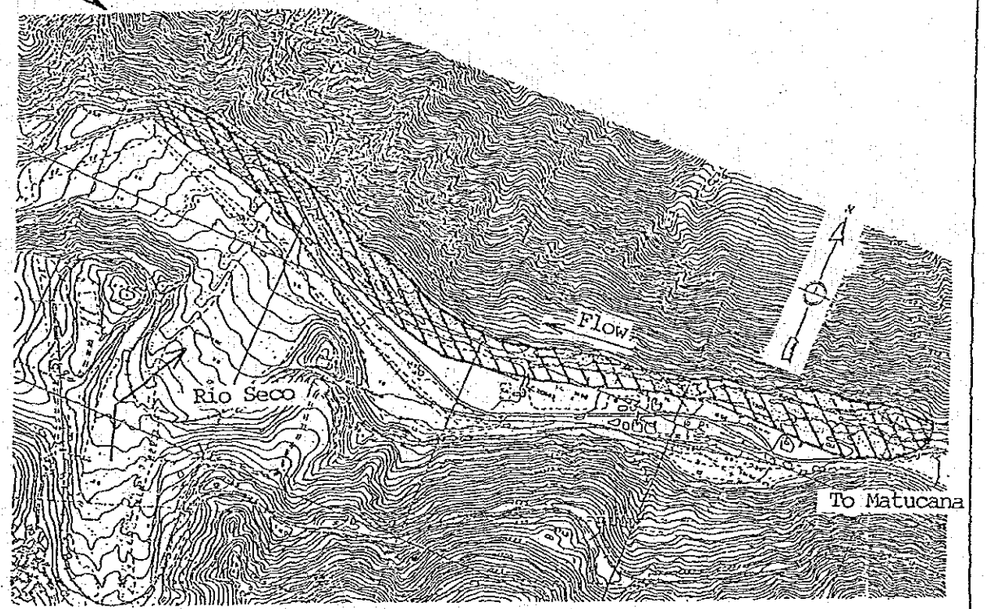
Approximate Work Quantity

1. Corcona area	
- Embankment (Repair work)	: 48,000m³
- Revetment	: 1,000m
2. Torna Mesa area	
- Dredging & Revetment	: 2,000m





Typical Section



: Dradging and revetment works for channel stabiligzation

0 500m

scale

Fig. V-8-1 Proposed Structural Plan for Group (B) (from confluence to Matucana)

VI. NON-STRUCTURAL PLAN FOR DISASTER PREVENTION

Table of Contents

List of Figures

CHAPTER VI NON-STRUCTURAL PLAN FOR DISASTER PREVENTION

1. NECESSITY OF NON-STRUCTURAL MEASURES

In view that the disaster is enhanced in accordance with the augmentation of damageable properties, it is prominently important in the disaster prevention to reduce the properties vulnerable to the disaster.

The non-structural measure, which may be possible to be attained at relatively less cost and time as compared with the structural measure, is most effective for the above purpose.

Following examples stress the necessity and efficiency of the non-structural measure.

- Insufficiency in the law or institution or lack of the regulation in land use accelerates the reckless encroachment into the dangerous areas, resulting in a drastic amplification of disaster.

- Insufficient management of the river permits the disordered disposal of garbage into the river and excavation of dike for transporting sands and gravels in the river which will seriously induce the danger of flood inundation.

- Establishment of warning and evacuation system or education to the inhabitants will largely relieve the tragic loss of lives.

- Various facilities such as the bridges and tunnels of railway and traffic roads which are improperly provided for the debris flows or flood inundation give rise to the disasters, originating from the insufficient contact with other departments.

- The past examples indicate that a satisfactory preparation and establishment of organization for the restoration of disaster significantly serve the reduction of damage due to disaster.

- The non-structural measure frequently serves the reduction of expense necessary for the structural measure if both measures are applied.

2. PROPOSED NON-STRUCTURAL MEASURES

2.1 General

The following six items of non-structural measures are proposed for the disaster prevention in the Rimac river basin in consideration of the present insufficient

administration and preparedness for the disaster prevention:

(1) Establishment of the regulation in land use of the dangerous area through the preparation of sound law and its execution,

(2) Reinforcement of river management through the preparation of sound river law and its execution,

(3) Sufficient preparedness for the disaster such as;

- the establishment of information system of disaster,
- the establishment of warning and evacuation system,
- the reinforcement of organization for the disaster in each regional area,
- the preparation of materials and equipment for the occurrence of disaster,
- the reinforcement of meteo-hydrological observation system, and
- the establishment of nationwide organization at emergency.

(4) Establishment of an authorized and responsible organization to put into execution the structural measures for disaster prevention.

(5) Establishment of an organization for operation and maintenance of river and facilities.

(6) Training of engineers

This chapter discusses in detail the necessity of the non-structural measures as proposed above.

2.2 Land Use Regulation for Dangerous Area

The insufficient regulation in land use for the dangerous areas conspicuously raises up the susceptibility to damage due to disasters, increasing the illegal encroachment of inhabitants into the dangerous areas in the basin.

The following fact endorses the above: that is, the damage by the debris flow near Chosica in March 1987 was so serious due to its high development. On the other hand, it is informed that the damage in the same area in 1925 was not so remarkable despite the debris flow in 1925 had an approximately same magnitude as that in 1987.

Such being the situation, it is proposed to designate the dangerous areas, for which its use is limited to the agricultural production and recreation purpose with the prohibition for any construction of residential houses and facilities. This regulation, as is recommended by UNDRO (United Nations Disaster Relief Coordination) and has been executed in various countries as well as Japan, will highly be effective for the damage reduction, especially for the debris flow disaster areas. As a matter of course, the regulation will effectively decrease the flood damage potential along the Rimac river.

The Government of Peru presently has a law which restricts the land use in the marginal district along the river or intends to improve the slum area. However, the illegal encroachment into the dangerous areas is already so remarkable in the basin. As such, it seems the law is not put in force actually. The reason why the law is not put in force is considered as follows:

- It is said that the Lima Municipality is in charge of the land use regulation for the dangerous areas. However, the Municipality seems not to be provided with a sufficient authority and responsibility, having no satisfactory functions to strictly execute the regulation.

- The law does not materialize distinctly the dangerous area or the respective matters which should be restricted or prohibited, making the actual execution of regulation difficult.

- A sufficient knowledge for the danger is not given to the people.

Since it is paramountly important to strictly enforce such a law as well as to prepare a satisfactory law, the following are stressed:

(1) It is required to prepare a new law to remove the inhabitants from and prohibit the further encroachment into the dangerous areas. The law should be complete with the definition of dangerous area, the detailed and clear provisions of respective matters which should be restricted or prohibited, and procedure for permission.

(2) It is important to establish a satisfactory function to execute the law, clarifying where the responsibility and authority lie.

(3) It is most important to strictly follow the law without any exception with a complete standard for permission. It is noted that an exception, once it is permitted, trends to be followed subsequently.

2.3 Reinforcement of River Management

Presently, various developments without any control are accelerated in the whole basin as recognized in the various examples such as the construction of road and railway in the river area, extensive slope excavation in road, railway or power waterway, artificial disturbances on the natural conditions for constructing bridges or tunnel, etc., uncontrolled development of mines and disposal of slag, and so on. Such a spoilage on the natural environment escalates the disaster in the basin as well as other various problems. Besides the above, various illegal actions such as the occupancy of river area for residence, disposal of garbage into the river and excavation of the existing dike for transporting sands and gravels in the river, etc. are left free, exposed to an extremely high danger to suffer from a serious disaster.

The unfavourable situation as mentioned above is attributed to the following;

- Now, the basin does not have a function to execute the overall basin control. The respective departments independently carry out their plan without any overall control, resulting in the remarkable increase of susceptibility to flood damage.

- The current water law under the Agricultural Ministry stipulates the ownership of land, limitation in the use of land and water, and necessary environmental conservation for the river bed, river bank and marginal strip as well as the definition of each area. However, the law does not work effectively without the satisfactory function to put it in force.

- In addition, the above law is not sufficient as one for the flood control, requiring the preparation of an additional law for the flood control.

Such being the case, the following necessities are emphasized:

(1) It is essential to establish an authorized and responsible organization to execute the overall river management so that the necessary river flow capacity and desirable environmental conditions can be maintained.

It is particularly important that the river management should comprehensively be made with a consistent consideration and system throughout the whole basin. Thus, a system to comprehensively carry out the

management of the whole basin including all tributaries should be organized.

(2) In view that the present water law is not enough for the flood control, a new river law aiming at the flood control should be prepared.
The law should definitely materialize the actions and matters, which should be prohibited, such as the occupancy of river area and disposal of garbage, etc. as well as to distinctly determine the river area. The law should also clarify the necessary procedure and responsible organization for the permission on actions made in the river area.

(3) It is required to prepare a standard for the permission and then, strictly follow the standard without any exception, since the subsequent administration is liable to be governed by an exception once it is allowed.

The Rimac river, which flows through the great capital city of Peru, requires a particularly strict law and regulation for the river management. Since it is considered the river law in Japan would be helpful in preparing a new law, an outline of river law in Japan is provided for reference in Appendix XII, Supporting Report III.

An example of organization considered desirable for the overall river management is given in Fig. VI-2-1.

2.4 Preparedness for Disaster

A sufficient preparedness for the disaster is indispensable to mitigate the disaster. Then, the following reinforcement of preparedness for the disaster is proposed:

- Establishment of information system of disaster,
- Establishment of warning and evacuation system,
- Reinforcement of organization for the disaster in each regional area,
- Preparation of materials and equipment for the occurrence of disaster,
- Reinforcement of meteo-hydrological observation system, and
- Establishment of nationwide organization at emergency.

The following details the necessity and effectiveness of the proposed preparedness for disaster.

(1) Establishment of information system of disaster

For avoiding or reducing the disaster, it is recommended to establish a system with which the detailed informations of disaster are promptly reported to the responsible agencies such as INDC, Meteorological Agency and River Management Office.

In the information system, each regional community should have an obligation to promptly inform to the responsible agencies of the unusual phenomena such as the occurrence of debris flow, damming up of the river by debris, occurrence of flood due to the collapse of the dam, abnormal rise of river water level, break of the dike and flood inundation etc. Responsible agencies shall immediately give a warning to the dangerous area so that the disaster can be largely diminished.

Some system to inform the situation of disaster already exists in Peru. However, the system should be improved so that it can be executed completely. For the purpose of the above, it is also required to make well-equipped the communication facilities in emergency.

(2) Establishment of waring and evacuation system

Prior to the occurrence of destructive debris flow, remarkable symptoms such as the abnormal climate, thick cloud before the heavy rainfall and unusual noise immediately after the heavy rainfall, etc. are detected in all of debris flow disaster areas. (It is noted the details of the each symptoms as mentioned are given in Appendix XII, Supporting Report III.)

The destructive debris flow breaks out after the continuation of the said unusual noise for about 30 minutes. As such, the establishment of warning and evacuation system based on the detection of the said symptoms will be possible. In view that its implementation is relatively easy compared with other measures in addition to the favorable effect on the damage reduction, the establishment of warning and evacuation system should positively be promoted in the areas vulnerable to the disaster.

The following are considered as the definite measures for establishing the warning and evacuation system;

- To establish a system with which the abnormal weather conditions, if any, be duly informed to the inhabitants by the Meteorological Agency.

- To educate the inhabitants for the necessity of attention to the thick cloud before rainfall or abnormal noise in the upper reaches of quebrada after rainfall.

- To install a warning instrument which will catch the symptoms prior to the destructive debris flow in the stage that the energy is being accumulated in the upstream reaches and then, automatically give an alarm to the inhabitants.

- To determine the place for evacuation beforehand and to execute periodically the training of evacuation.

- To install a waring instrument for flooding in the downstream reaches of Rimac river, which will catch an unusual water level rise in the upstream reaches and automatically give an alarm in the downstream reaches.

(3) Reinforcement of organization for the disaster in each regional area

As experienced in the past disasters, the disaster area is individually isolated at the occurrence of the disaster in a large scale. The support for the emergency is not expectable frequently, and therefore, it is essential in each regional area to establish an organization which has a function to tentatively counteract for the emergency. Such a function largely serves the mitigation of damage as evidenced by the past examples in other countries.

(4) Preparation of materials and equipment for the occurrence of disaster

As mentioned in the preceding section, the disaster area is frequently isolated, and, therefore, each area should respectively keep some essential materials, tools and equipment in emergency such as foods, water, clothes, medicines, tents and equipment for rescue and restoration, etc.

(5) Reinforcement of meteo-hydrological observation system

It is needless to say that the weather condition is the primary cause of the debris flows or floods and that an accurate forecast of weather will relieve the area from a serious damage. The accurate forecast results from a satisfactory meteorological observation system and study on the meteorology on the basis of a sufficient accumulation of data and informations.

On the one hand, the present observation system in the basin is in a rather poor condition to such an extent

that most of the meteo-hydrological observation stations are useless due to a damage or some other reasons. Such being the case, it is recommended to reinforce the system for the observation and study as well as the accumulation of data.

In reinforcing the system, it is recommended to take into consideration the introduction of radar rain gauge which will render very useful informations of heavy rainfall. It is noted that the weather forecast in Japan is now in the stage that an accurate forecast even for a local intensive rainfall will become possible soon.

As for the Rimac river basin, the necessity and possibility of the radar rain gauge system is studied considering the characteristics of geographical features and heavy rainfall causing disaster, and function of radar rain gauge. Consequently, forecasting and collecting of information about occurrence of heavy rainfall by the radar are judged to be necessary and possible based on the result of the above study attached to ANNEX in this main report. Therefore the implementation of further detailed study is recommended to the institution concerned.

(6) Establishment of nationwide organization at emergency

At present, a systematic relief system in a national level is not established yet, making a prompt action essential at emergency difficult. As such, in the event that the large disaster occurred in March, 1987, a disaster relief system was tentatively organized. It took much time to organize the above relief system, resulting in no immediate support to the disaster areas at the emergency.

It is essential to establish beforehand a systematic nationwide organization at emergency which will minimize the damage.

The preparedness for disaster in Japan, which is vulnerable to the disaster similar to Peru and is thus considered favorably referable, is outlined in Appendix XII, Supporting Report III for reference. Fig. VI-2-2 shows the organization at emergency in Japan.

An example of the organization at emergency in Peru, which is prepared in consideration of the present administrative organization of Peru on the basis of that in Japan, is also given as seen in Fig. VI-2-3 for reference.

2.5 Establishment of Authorized and Responsible Organization to Put into Execution the Structural Measures for Disaster Prevention

In various countries as well as Japan, a series of projects for preventing the disaster have been carried out with an organization under the control of ministry of construction or regional public body.

At present, Peru does not have such an organization. Since it is not possible to realize the disaster prevention measures without the organization, it is recommended to establish an authorized and responsible organization to put into execution the measures in accordance with a comprehensive plan.

It is important to put into execution the measures with a consistent consideration and system throughout the whole basin. Thus, the execution of measures should be controlled under one organization for the whole basin. As adopted in other various countries as well as Japan, it will be effective to provide the executive office in each District under the direct control of an organization such as Rio Rimac Committee.

An example of the conceivable organization is shown in Fig. VI-2-1 for reference.

2.6 Establishment of an Organization for Operation and Maintenance of River and Facilities

The river transports much sediment and deposits irregularly in various places, disturbing the smooth river flow. The disturbed river flow frequently attacks and destroys the river banks, causing the flood disaster in the surrounding area. A continuous maintenance work of the river for the matters as mentioned above is considered necessary.

The various facilities in the river as well as the various structures to be constructed in future also require the continuous operation and maintenance works. Otherwise, the disaster will occur due to such a defect. The durability of structures will also be lessened remarkably. The present operation and maintenance works are made individually by the respective community or privately without any consistent consideration. Such works will frequently result in an adverse effect for other places even if one place is favourably improved, requiring the establishment of an organization to carry out the operation and maintenance works for the whole basin with a consistent policy and system.

2.7 Training of Engineers

The well-trained engineers who proceed with the plan, design and construction works for the disaster prevention will be indispensable. On the other hand, the present situation of such engineers in Peru is as follows:

Number of civil engineers who graduate from the university or college is approximately counted at 200 to 300 per annum. These civil engineers work mainly in the transportation, housing, water supply and sewerage, and electric power sectors. Such being the case, the engineers have scarcely been trained in the field of disaster prevention.

In view that the engineers are not enough in Peru at present as mentioned, the necessity of training of engineers is stressed. Then, the establishment of a training center having a well-experienced lecturer, which is considered most efficient for the purpose, is recommended.

Figures

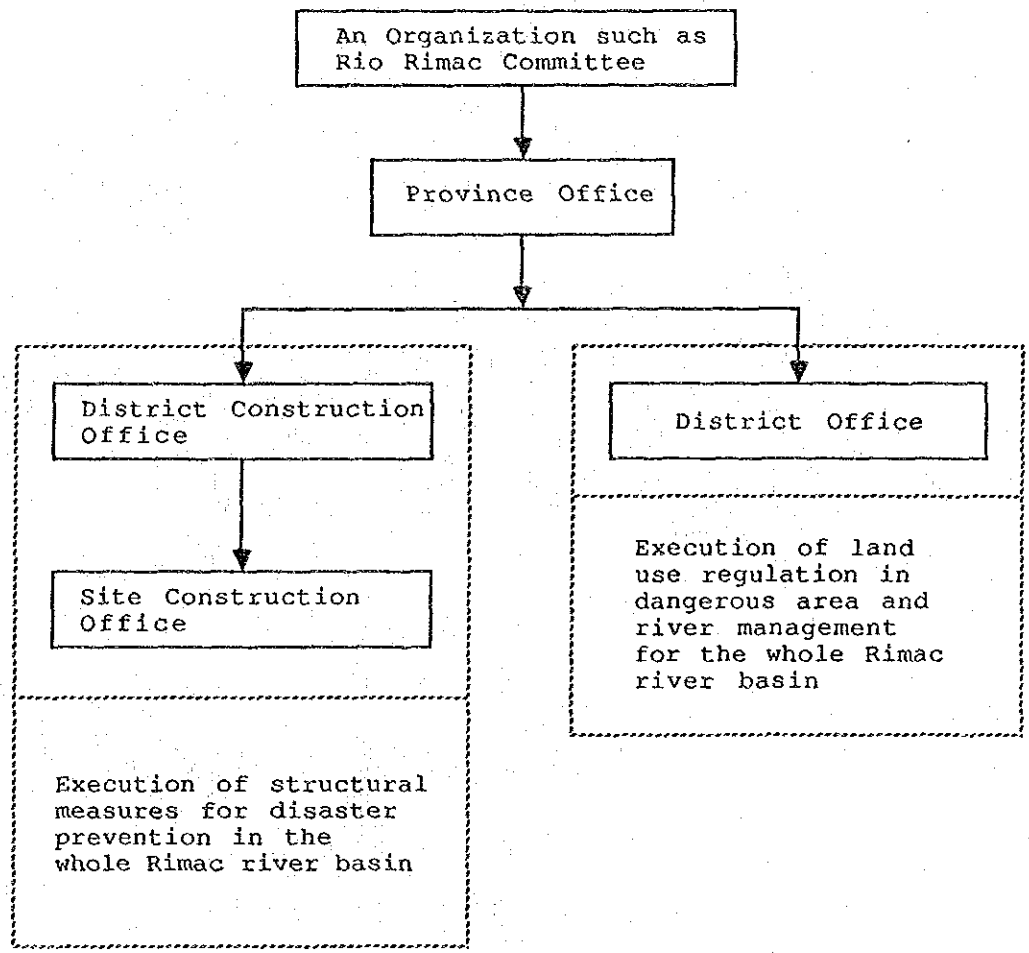


Fig. VI-2-1 An Example of Organization Chart for Land Use Regulation, River Management and Implementation of Structural Measures for Disaster Prevention

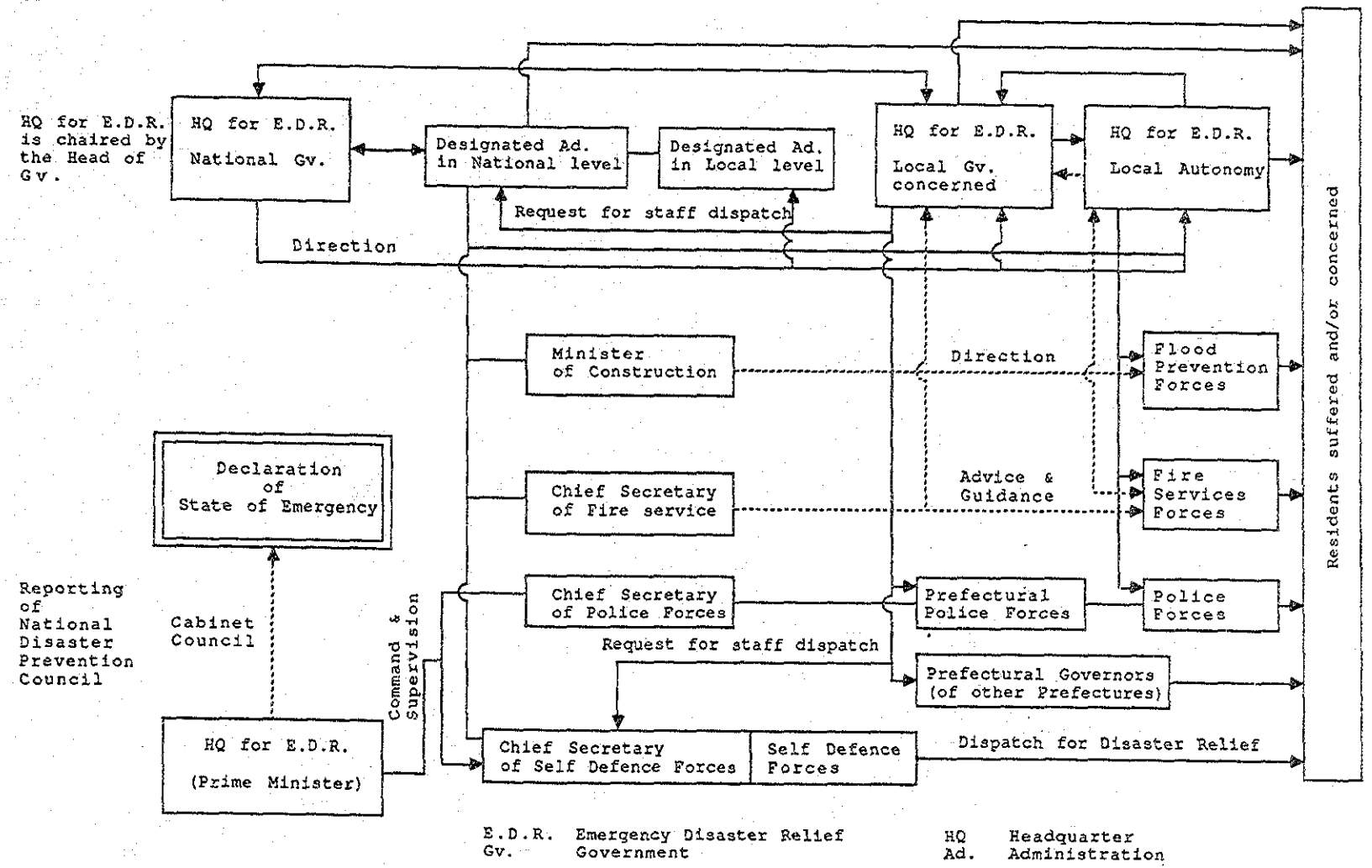


Fig. VI-2-2 Organization Chart for Emergency Disaster Relief in Japan

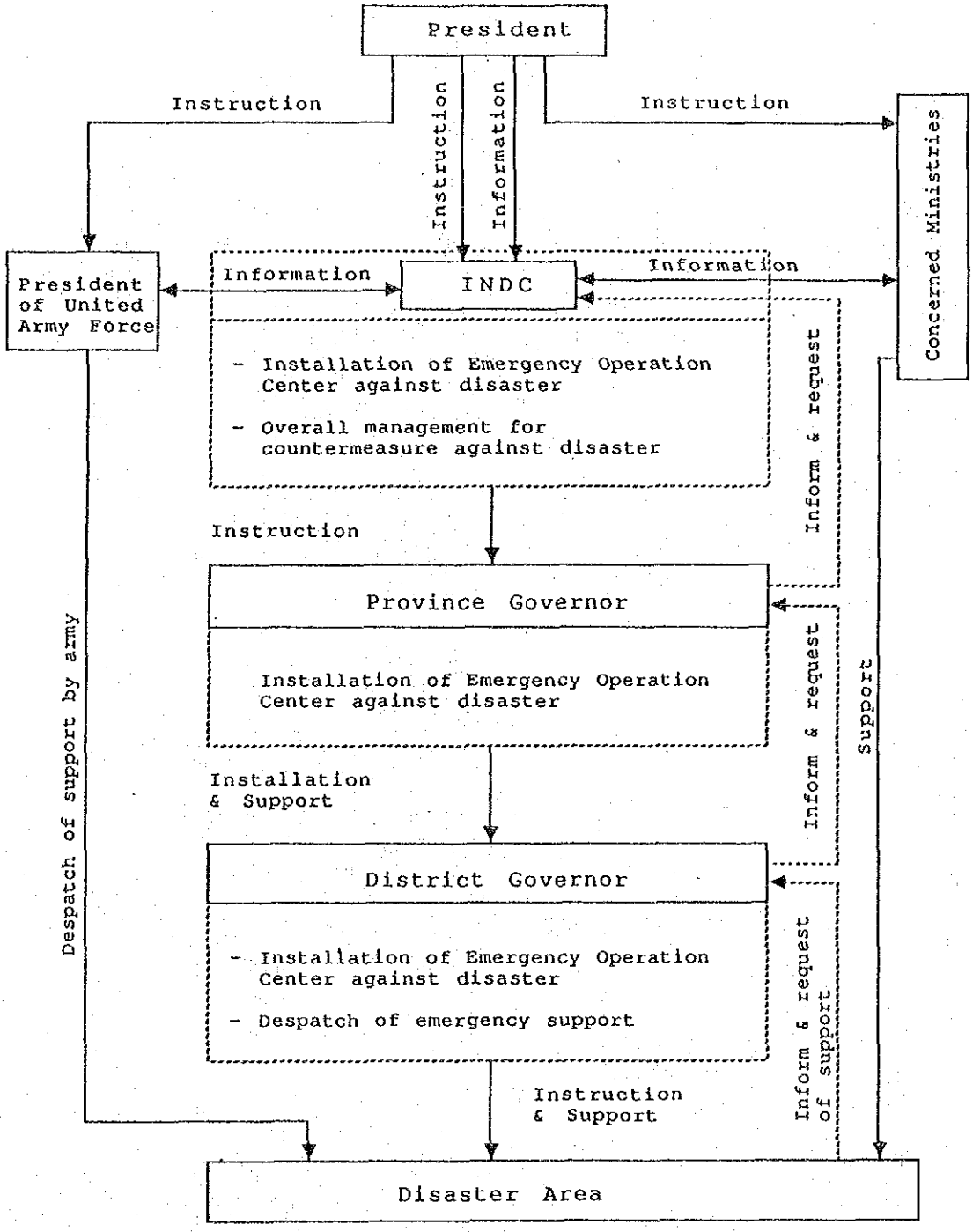


Fig. VI-2-3 An Example of Organization Chart for Emergency Disaster Relief

VII. SUMMARY OF MASTER PLAN FOR DISASTER PREVENTION

Table of Contents

List of Tables

List of Figures

CHAPTER VII SUMMARY OF MASTER PLAN FOR DISASTER PREVENTION

1. PROPOSED MASTER PLAN

The master plan for disaster prevention in the Rimac river basin has been examined and formulated from the structural and non-structural aspects.

This chapter summarizes the formulated master plan.

Table VII-1-1 summarizes structural plan of respective quebrada and slope areas for debris flow and slope failure disaster prevention with economic project cost and EIRR. Proposed river improvement plan for inundation disaster is summarized in Table VII-1-2. Table VII-1-3 summarizes the proposed non-structural plan.

Fig. VII-1-1 visually shows the type of structural plan of quebrada area. Fig. VII-1-2 shows combination of structures for each type with detailed figure of respective structures. In Fig. VII-1-3, proposed structures for slope area are illustrated in detail. Structural plan for inundation disaster prevention in each river stretch is shown in Fig. VII-1-4. The structures recommended in the river improvement plan is shown in Fig. VII-1-5.

2. EVALUATION ON PROPOSED MASTER PLAN

An overall economic analysis on the proposed master plan is made in Table VII-2-1.

The result of the overall economic analysis is as follows:

		EIRR (%)
- Debris flow/slope failure disaster prevention plan	:	5.4
- Inundation disaster prevention plan	:	15.5
- Whole structural plan	:	8.6

As seen above, EIRR of 8.6% is shown for the whole structural plan although that for the debris flow/slope failure disaster prevention is limited to 5.4%. Since the project with EIRR higher than 8.0% is considered feasible economically, the proposed structural plan is sufficiently justifiable economically. On the one hand, the proposed overall plan including the structural and non-structural measures involves an extremely high social merits such as

the prevention of loss of human lives and stabilization of public welfare. Thus, the proposed master plan is considered enough sound from the comprehensive aspects.

Note : Based on the standard prepared by the international fund such as World Bank, etc., opportunity cost of capital in Peru is set at 8% in this Study.

Opportunity cost of capital is defined as return from capital investment. Namely, that is equivalent to marginal return of the project to which capital investment is carried out last in case that the allocation is made in order from profitable project in the country.

Opportunity cost of capital is determined to each country according to the economic condition in the country. The project is evaluated to be viable in case that the EIRR is more than opportunity cost of capital.

Tables

Table VII-1-1 PROPOSED PROJECT FOR DEBRIS FLOW AND SLOPE FAILURE DISASTER PREVENTION

Description of Project Areas		Type of Stru.Plan	Proposed Main Structures						Economic Project Cost (x10 US$)	EIRR (%)
			Dam (No.)	Channel Works (km)	Dike (km)	Bridge (No.)	Tunnel (No.)	Retaining Wall (km)		
(A) Group A (First Priority)										
(a) Qda Area : 7areas										
R-6	Q.Quirio	A1	2	1.8	-	2	-	-	8,623.4	5.25
R-7	Q.Pedregal	A1	3	1.9	-	2	-	-	11,649.4	5.65
R-8	Q.Carosio	A2	1	0.3	-	1	-	-	1,432.7	9.85
R-9	Q.Corrales	A2	2	0.2	-	-	1	-	3,054.5	6.02
R-19	Q.Rio Seco	B1	-	-	1.5	2	2	-	3,145.9	10.12
R-32	Q.Paihua	C	2	-	0.5	-	-	-	6,442.1	5.09
S-1	Q.Cashahuacra	B2	1	0.4	12.5	1	-	-	3,057.4	4.15
(b) Spe Area : None										
(B) Group B (Second Priority)										
(a) Qda Area : 23 areas										
R-1	Q.Chacracayo	A1	3	3.3	-	-	-	-	9,448.2	8.99
R-2	Q.Chacrasana	A1	1	1.1	-	-	-	-	4,534.0	3.19
R-3	Q.California	A1	1	1.3	-	-	-	-	8,101.6	4.79
R-4	Q.Santa Maria	A1	1	1.0	-	-	-	-	4,436.3	3.39
R-5	Q.La Cantuta	A1	3	1.2	-	-	-	-	14,465.5	-0.24
R-10	Q.La Ronda	A1	4	1.3	-	-	-	-	8,677.1	2.31
R-11	Q.Santa Ana	B1	-	0.4	0.6	1	-	-	2,071.4	11.54
R-13	Q.Cupiche	B1	-	0.4	0.5	1	-	-	1,427.8	12.79
R-15	Q.Canchacalla	C	5	0.5	0.5	-	-	-	27,160.9	-2.09
R-16	Q.Guayabo	B2	2	0.4	-	1	-	-	1,101.2	14.94
R-17	Q.Agua Salada	B1	-	0.5	0.5	1	-	-	1,760.4	10.90
R-18	Q.Esperanza	B1	-	-	0.4	1	-	-	1,184.8	14.30
R-23	Q.Huacre	B1	-	0.5	0.5	-	-	-	575.6	3.75
R-24	Q.Matata	B1	-	0.5	0.5	1	-	-	1,135.1	3.71
R-25	Q.Cuchimachay	A1	2	1.1	-	1	-	-	2,946.7	2.90
R-31	Q.Chucumayo	B2	1	0.7	1.6	1	-	-	2,818.1	8.45
R-33	Q.Chacahuaro	B2	1	0.3	-	-	-	-	428.6	17.90
R-34	Q.Pancha	C	3	0.5	-	-	-	-	7,976.9	-1.07
R-35	Q.Viso	C	2	0.5	-	-	-	-	2,404.1	3.96
R-37	Q.Parac	C	3	0.3	-	-	-	-	15,033.6	-0.89
S-2	Q.Redonda	B2	1	1.3	1.3	1	-	-	1,959.7	4.12
S-3	Q.Infiernilla	B1	-	0.4	0.4	-	-	-	1,028.2	5.07
S-5	Q.Lucuma	B1	-	0.9	0.9	1	-	-	1,093.0	4.73
(b) Spe Area : 24 areas										
R--/0	River mouth - Jicamarca	-	-	-	-	-	-	15.00	15,535.0	0.68
R--/1	River mouth - Chacracayo	-	-	-	-	-	-	18.00	19,077.0	-0.04
R-0/2	Jicamarca - Chacrasana	-	-	-	-	-	-	2.00	2,453.0	-
R-1/3	Chacracayo - California	-	-	-	-	-	-	0.55	52.0	13.67
R-4/6	Santa Maria - Ronda	-	-	-	-	-	-	0.11	114.0	-2.42
R-6/7	Quirio - Pedregal	-	-	-	-	-	-	1.50	1,558.0	-4.06
R-7/8	Pedregal - Carosio	-	-	-	-	-	-	0.68	706.0	0.15
R-8/9	Carosio - Corrales	-	-	-	-	-	-	0.20	207.0	2.29
R-9/-*	Corrales - Confluence	-	-	-	-	-	-	0.20	207.0	0.45
R-10/-	La Ronda - Confluence	-	-	-	-	-	-	0.04	41.0	6.68
R--/11	Confluence - Santa Ana	-	-	-	-	-	-	0.32	333.0	6.23
R--/12	Confluence - San Juan	-	-	-	-	1	3	0.08	83.0	10.64
R-11/13	Santa Ana - Cupiche	-	-	-	-	-	7	0.00	3,319.0	5.22
R-13/16	Cupiche - Guayabo	-	-	-	-	-	2	0.66	4,049.0	3.64
R-16/17	Guayabo - Agua Salada	-	-	-	-	2	8	0.00	2,157.0	3.46
R-19/20	Rio Seco - Esperanza	-	-	-	-	2	13	0.05	5,723.0	4.39
R-20/21	Esperanza - Verrugas	-	-	-	-	2	8	0.01	6,373.0	4.50
R-21/23	Verrugas - Huacre	-	-	-	-	1	2	0.08	4,863.0	4.76
R-22/27	Linday - Yamajune	-	-	-	-	-	7	0.04	5,077.0	4.47
R-26/29	Chacamaza - Barranco	-	-	-	-	-	3	0.04	482.0	1.02
R-31/33	Chucumayo - Chacahuaro	-	-	-	-	4	4	0.90	1,124.0	3.50
R-37/40	Parac - Rio Blanco	-	-	-	-	-	-	1.12	2,340.0	8.92
S--/4	Confluence - Alcula	-	-	-	-	-	-	0.11	114.0	9.30
S-1/2	Cashajuacra - Redonda	-	-	-	-	1	5	0.11	429.0	3.02
S-2/3	Redonda - Infiernilla	-	-	-	-	-	4	0.09	345.0	2.86

* including S--/1 Confluence - Cashahuacra

Table VII-1-2 PROPOSED RIVER IMPROVEMENT PLAN FOR INUNDATION DISASTER PREVENTION

Division of River Stretch	Levee (m)	Parapet Wall (m)	Gabion (m)	Revetment		Groyne (Nos)	Ground Sill (Nos)	Bridge (Nos)	Economic Project Cost (US$10^3)	EIRR (%)
				Wet Masonry Wall (m)	Frame Work (m)					
(A) Group A (First priority)										15.5*
1. Main Stream										
- Upper reaches (A-2)	7,200	3,600	-	5,100	-	-	-	4	16,920	
- Middle reaches (B-1)	11,900	200	500	11,900	7,700	20	6	-	12,547	
- Lower Reaches (C-1)	1,600	3,000	-	23,100	-	-	5	2**	17,166	
2. Tributary										
- Lower reaches of Qda Jicarmica	400	-	-	200	-	-	-	1	599	
(B) Group B (Second priority)										
1. Main stream										
- Upper reaches	-	-	-	4,000	-	-	-	-	850	
- Lower raches	1,000	-	-	1,000	-	-	-	-	1,230	

Remarks: * EIRR of selected implementation plan of Groups (A) and (B)
** Including repair works for Pte. Ejercito.

Table VII-1-3 PROPOSED NON-STRUCTURAL MEASURES

(1) Establishment of the regulation in land use of the dangerous area through the preparation of sound law and its execution,

(2) Reinforcement of river management through the preparation of sound river law and its execution,

(3) Sufficient preparedness for the disaster such as;

- the establishment of information system of disaster,
- the establishment of warning and evacuation system,
- the reinforcement of organization for the disaster in each regional area,
- the preparation of materials and equipment for the occurrence of disaster,
- the reinforcement of meteo-hydrological observation system, and
- the establishment of nationwide organization at emergency.

(4) Establishment of an authorized and responsible organization to put into execution the structural measures for disaster prevention.

(5) Establishment an organization for operation and maintenance of river and facilities.

(6) Training of engineers

Table VII-2-1 OVERALL ECONIMIC ANALYSIS BY PROPOSED IMPLEMENTION PROGRAM

EIRR= 8.574%

RIVER TREATMENT : Accelerated Schedule
DEBRIS PREVENTION: Normal schedule

Unit : US$ 10^3

Year	Fisical year	Cost Stream: Cost Total	Cost Stream: Discounted Cost	Benefit Stream: Annual Benefit	Benefit Stream: Discounted Benefit	Net Present Worth
1	1990/1991	14,636	14,636	0	0	(14,636)
2	1991/1992	21,185	19,512	0	0	(19,512)
3	1992/1993	21,882	18,562	2,030	1,722	(16,840)
4	1993/1994	19,866	15,521	5,524	4,316	(11,205)
5	1994/1995	21,119	15,198	9,986	7,186	(8,011)
6	1995/1996	5,511	3,653	11,929	7,906	4,253
7	1996/1997	5,514	3,366	11,976	7,311	3,945
8	1997/1998	6,480	3,644	13,111	7,371	3,728
9	1998/1999	11,998	6,213	13,194	6,832	619
10	1999/2000	6,128	2,923	13,280	6,334	3,411
11	2000/2001	6,128	2,692	13,368	5,873	3,180
12	2001/2002	8,520	3,447	13,993	5,662	2,214
13	2002/2003	14,225	5,301	14,103	5,255	(46)
14	2003/2004	10,801	3,707	14,247	4,890	1,183
15	2004/2005	15,790	4,992	14,837	4,690	(301)
16	2005/2006	11,943	3,477	15,220	4,432	954
17	2006/2007	10,135	2,718	15,767	4,228	1,511
18	2007/2008	10,111	2,497	17,169	4,241	1,743
19	2008/2009	11,083	2,521	17,475	3,975	1,454
20	2009/2010	5,449	1,142	18,243	3,822	2,681
21	2010/2011	9,318	1,798	19,130	3,692	1,894
22	2011/2012	18,430	3,276	19,619	3,487	211
23	2012/2013	17,343	2,839	19,897	3,257	418
24	2013/2014	13,422	2,024	20,184	3,043	1,020
25	2014/2015	5,974	830	21,331	2,962	2,133
26	2015/2016	1,425	182	22,072	2,823	2,641
27	2016/2017	1,425	168	22,425	2,642	2,474
28	2017/2018	1,425	155	22,787	2,473	2,316
29	2018/2019	1,425	142	23,161	2,315	2,172
30	2019/2020	1,425	131	23,546	2,167	2,036
31	2020/2021	1,425	121	23,942	2,030	1,909
32	2021/2022	1,425	111	24,350	1,901	1,790
33	2022/2023	1,425	102	24,771	1,781	1,679
34	2023/2024	1,425	94	25,204	1,669	1,575
35	2024/2025	1,425	87	25,650	1,565	1,478
36	2025/2026	1,425	80	26,110	1,467	1,387
37	2026/2027	1,425	74	26,583	1,376	1,302
38	2027/2028	1,425	68	27,071	1,290	1,222
39	2028/2029	1,425	63	27,573	1,210	1,148
40	2029/2030	1,425	58	28,090	1,136	1,078
41	2030/2031	1,425	53	28,623	1,066	1,013
42	2031/2032	1,425	49	29,171	1,001	952
43	2032/2033	1,425	45	29,736	939	894
44	2033/2034	1,425	41	30,319	882	841
45	2034/2035	1,425	38	30,918	829	790
46	2035/2036	1,425	35	31,536	778	743
47	2036/2037	1,425	32	32,172	731	699
48	2037/2038	1,425	30	32,827	687	658
49	2038/2039	1,425	27	33,502	646	619
50	2039/2040	1,425	25	34,197	607	582
	Total	338,617	148,503	1,021,947	148,503	(0)

Figures

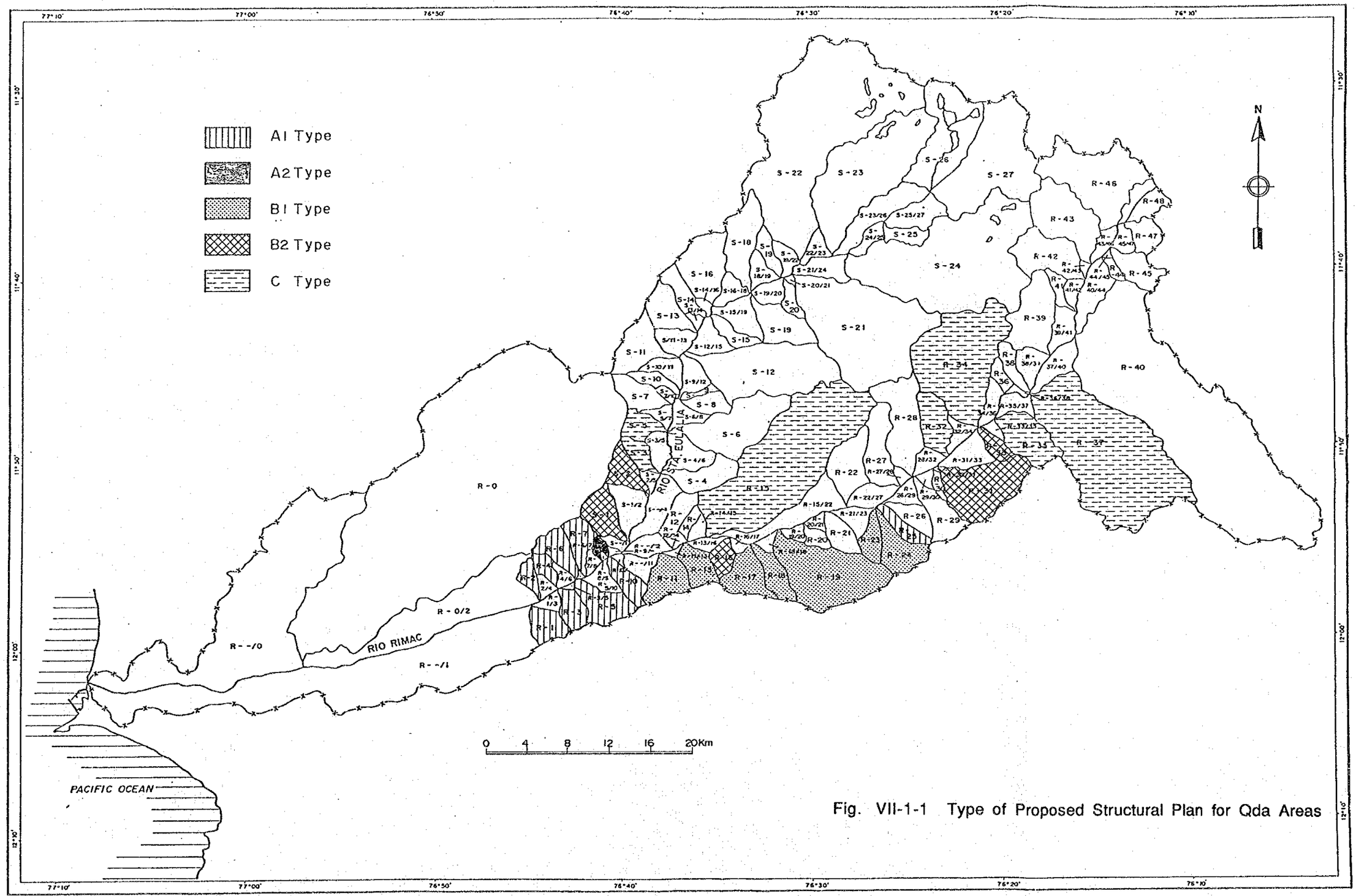


Fig. VII-1-1 Type of Proposed Structural Plan for Qda Areas