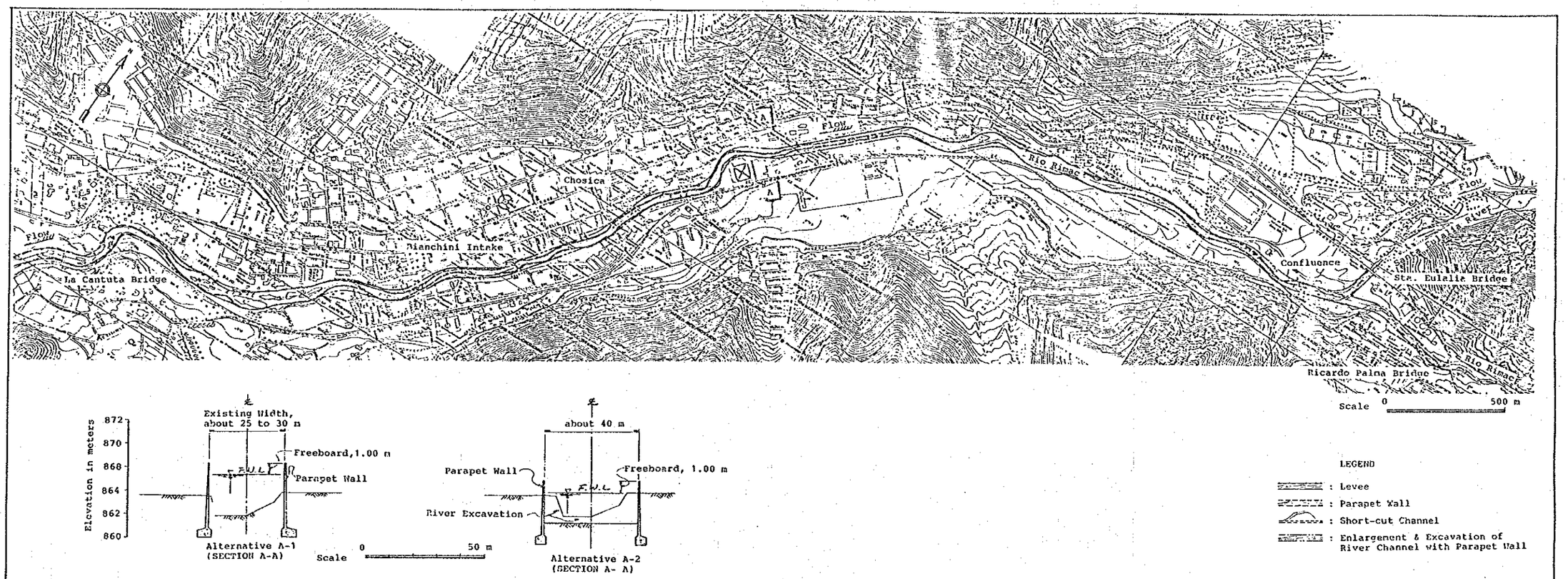
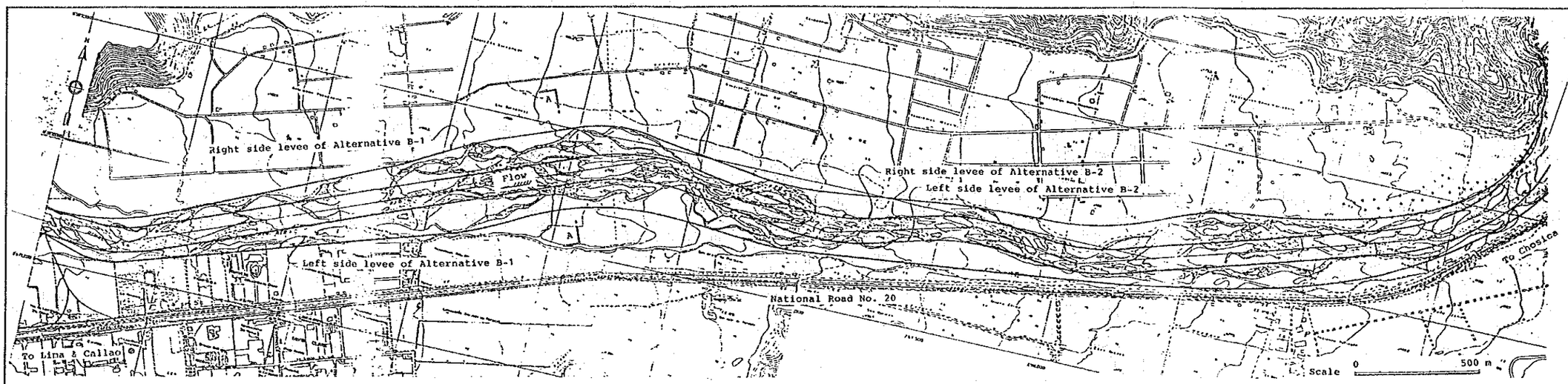
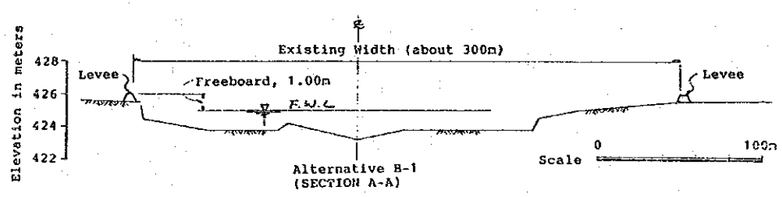
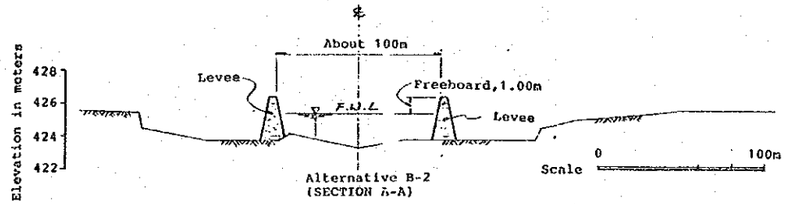


Fig. X1-5-4 Detail of Alternative Plans in the Upstream Reaches of Main Stream







LEGEND

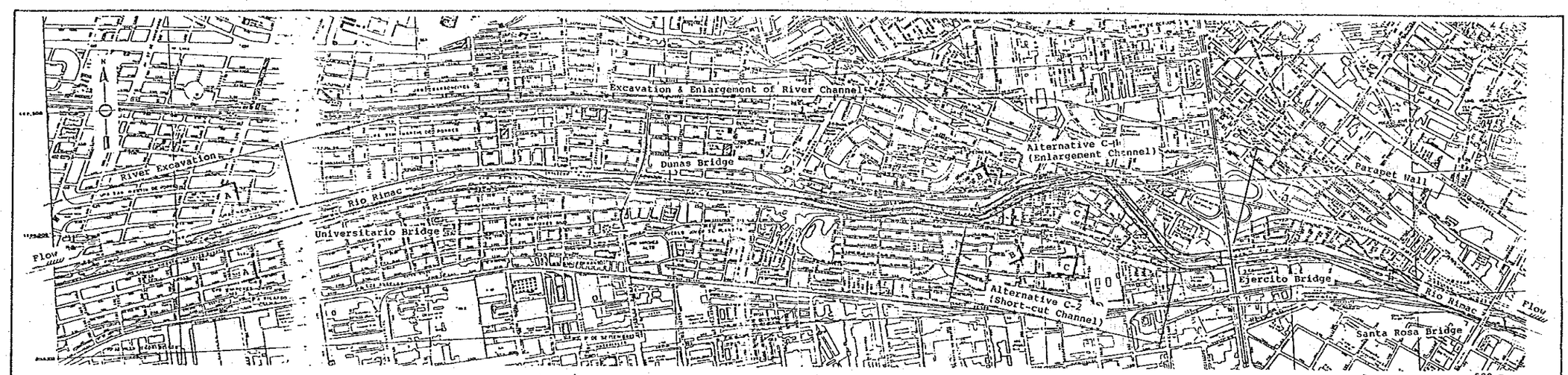
: Levee

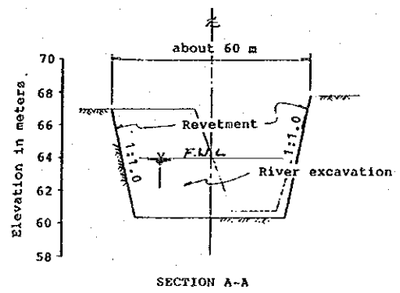
: Parapet Wall

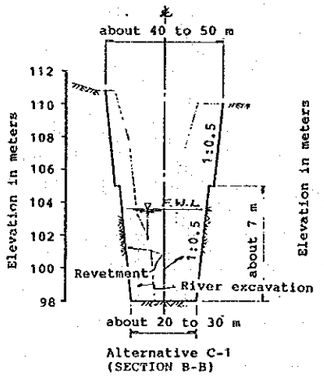
: Short-cut Channel

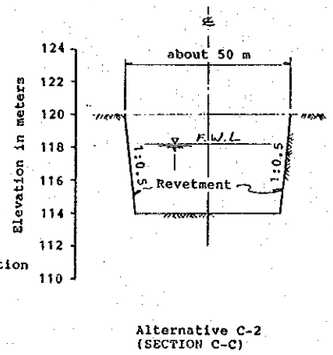
: Enlargement or Excavation of River Channel

Fig. XI-5-5 Detail of Alternative Plans in the Wide Portion in the Middle Reaches of Main Stream









LEGEND

: Levee

: Parapet Wall

: Short-cut Channel

: Enlargement or Excavation of River Channel

Fig. XI-5-6 Detail of Alternative Plans in the Narrow Gorge in the Downstream Reaches

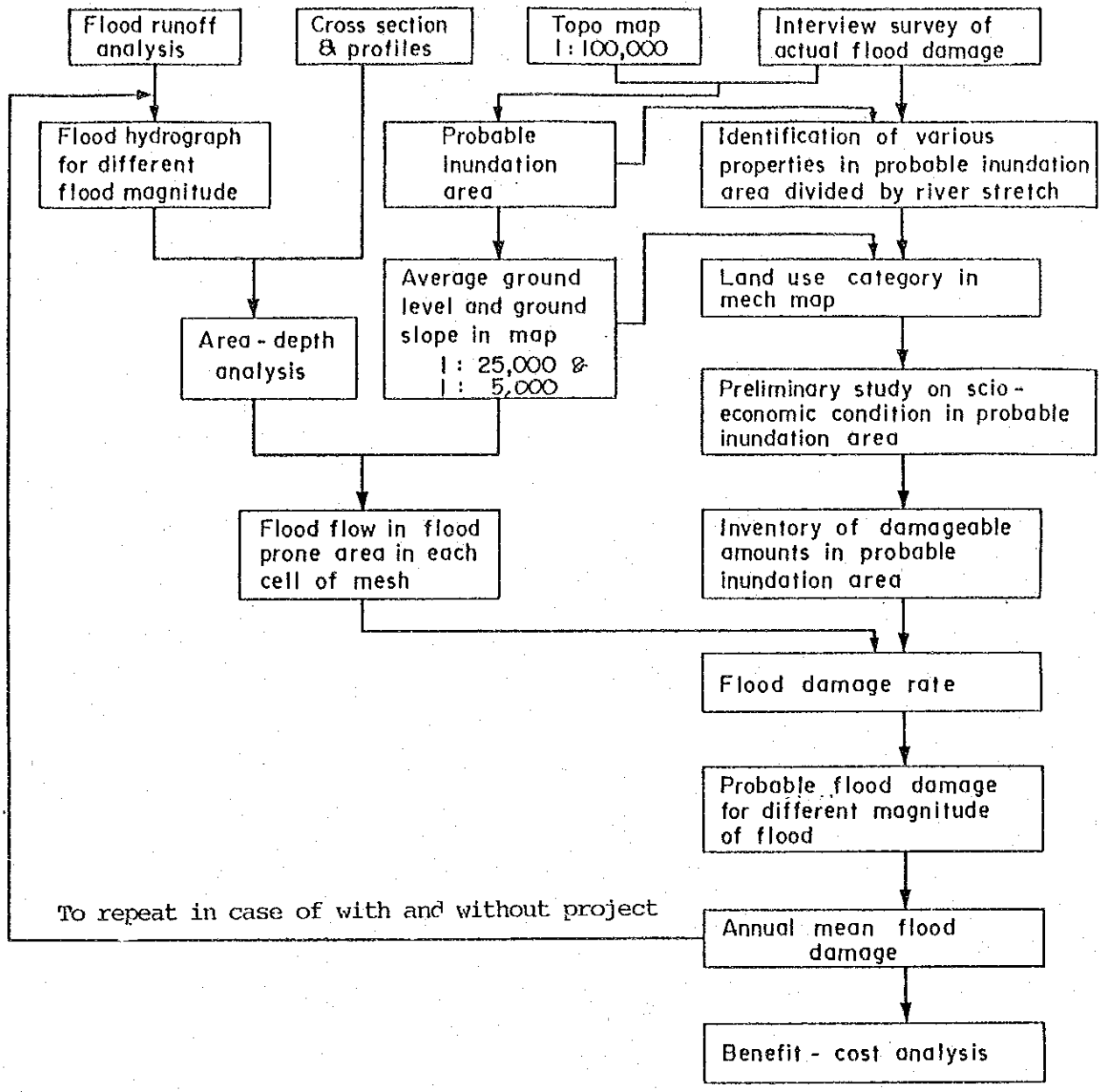


Fig.XI-6-1 Flow Chart of Flood Damage Study

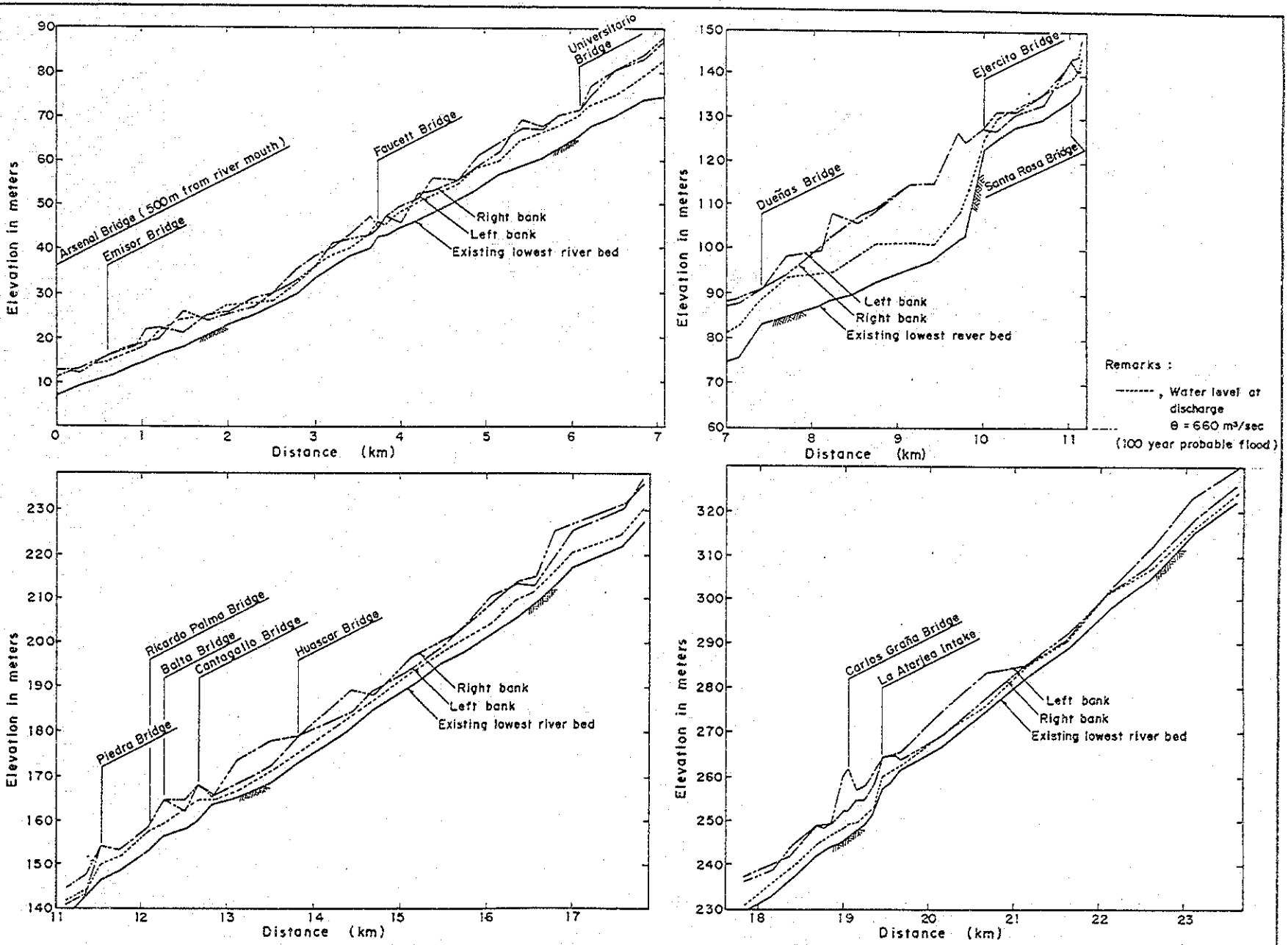
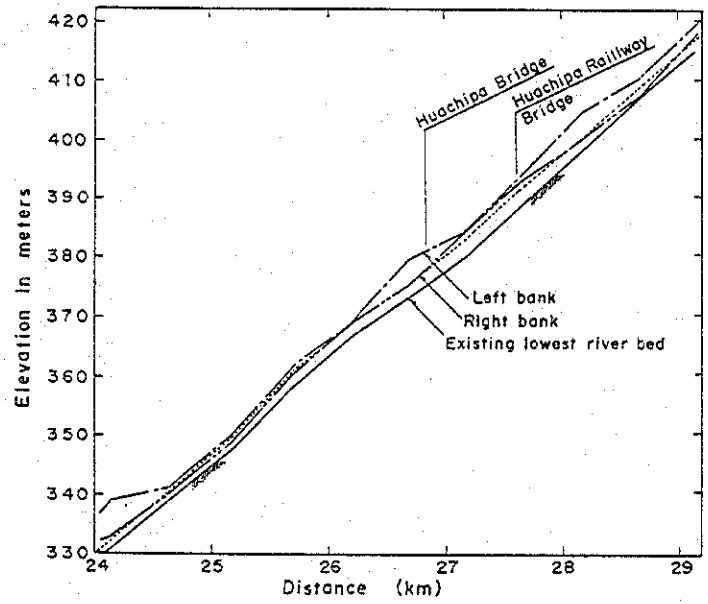
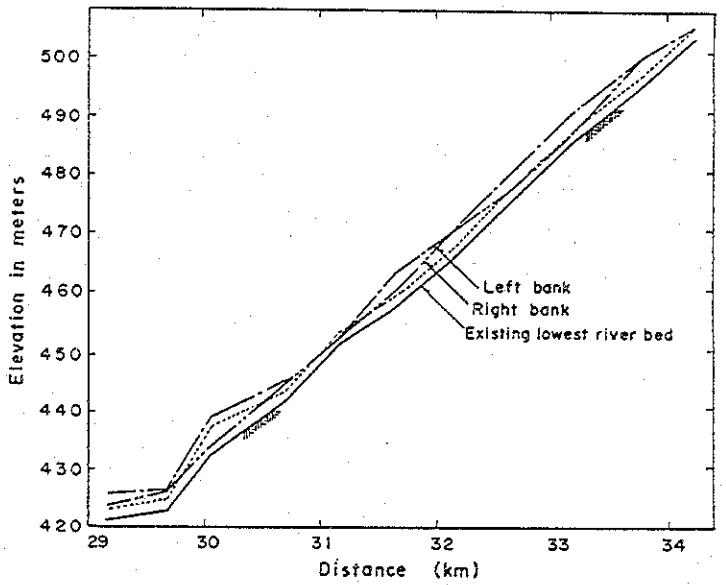
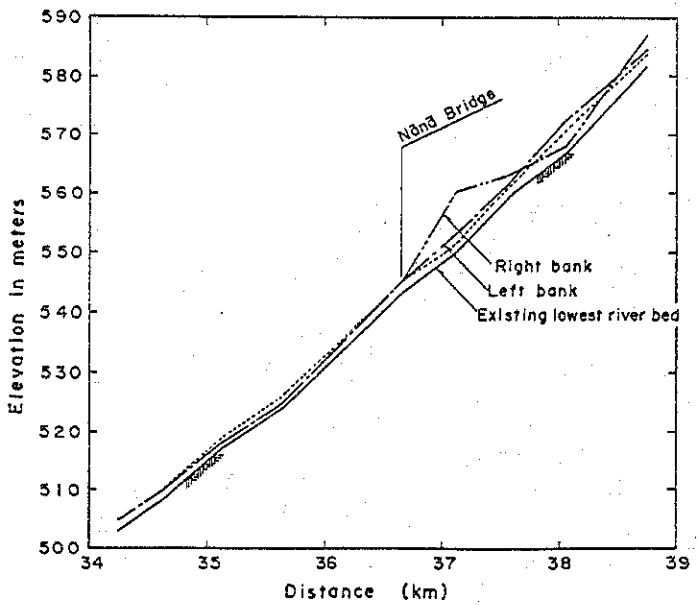
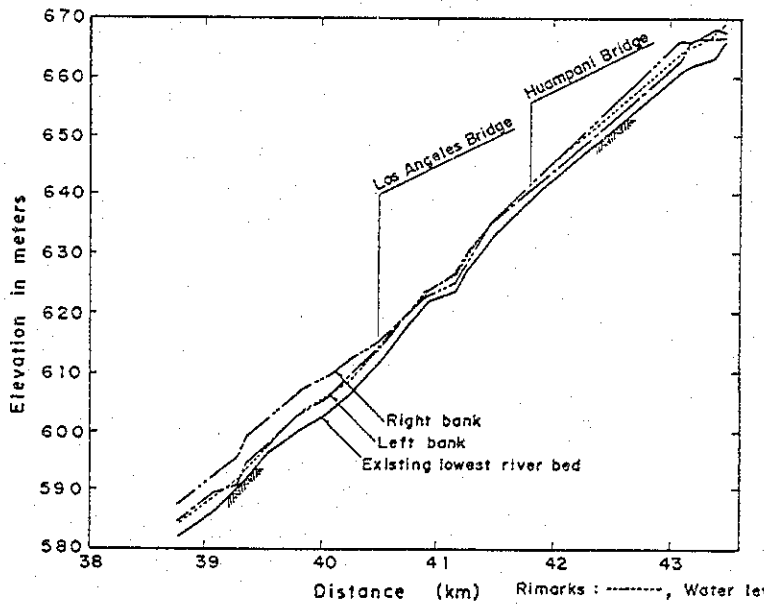


Fig.XI-6-2 Longitudinal Profile of Water Level and River Channel (1/3)









Rimarks : ---------, Water level at discharge Q = 660 m³/sec (100 year probable flood)

Fig.XI-6-2 Longitudinal Profile of Water Level and River Channel (2/3)

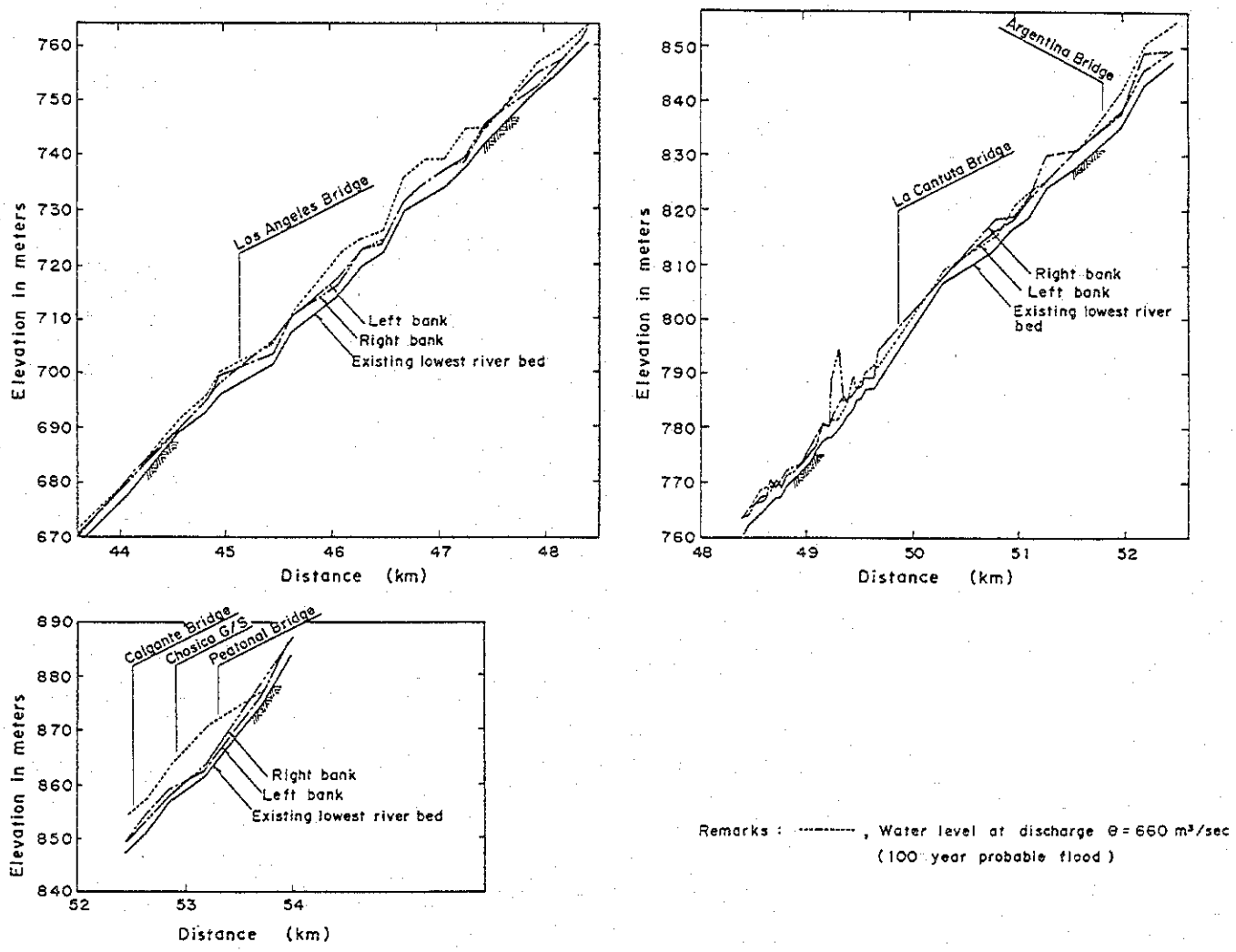


Fig.XI-6-2 Longitudinal Profile of Water Level and River Channel (3/3)

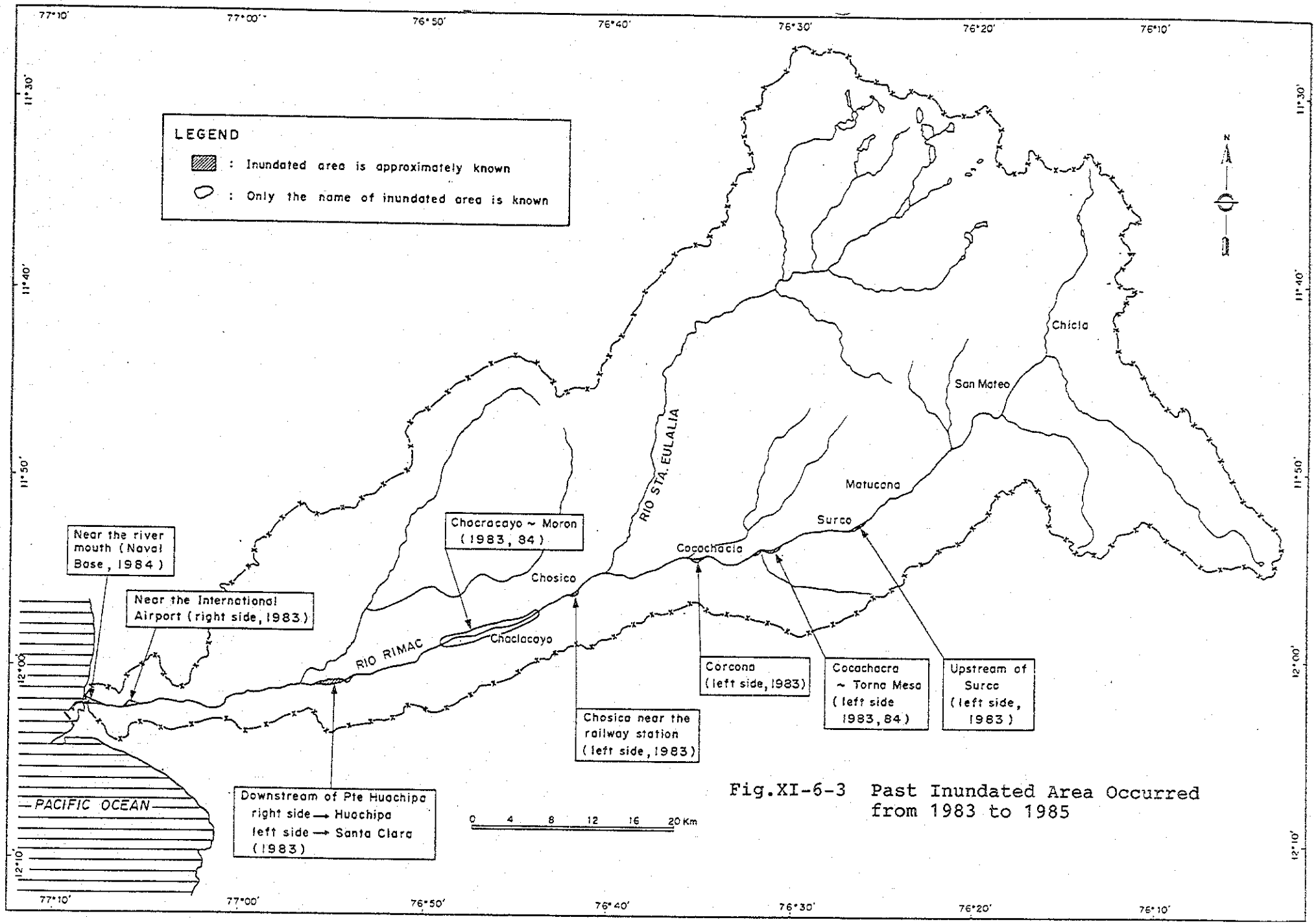


Fig.XI-6-3 Past Inundated Area Occurred from 1983 to 1985

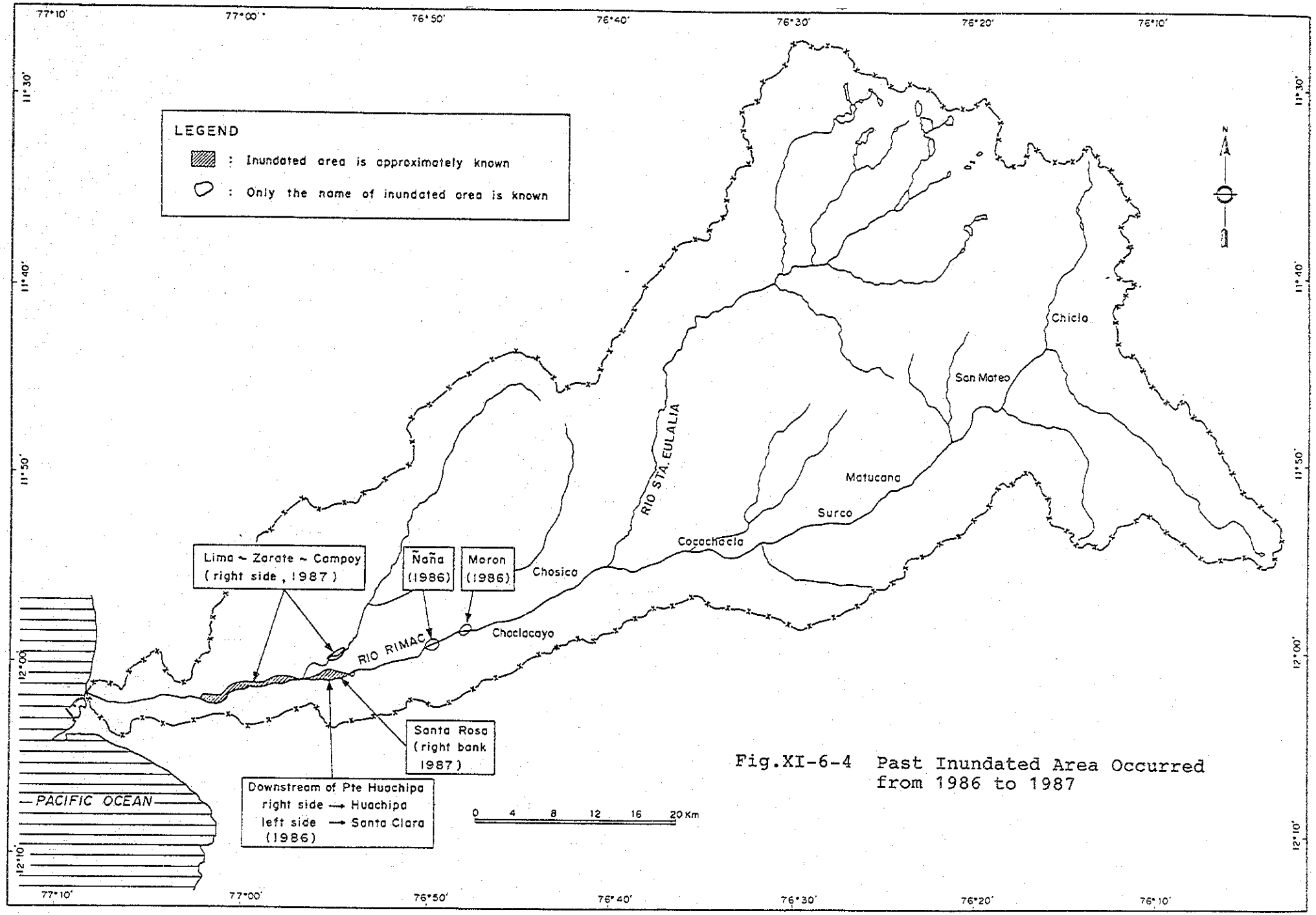


Fig.XI-6-4 Past Inundated Area Occurred from 1986 to 1987

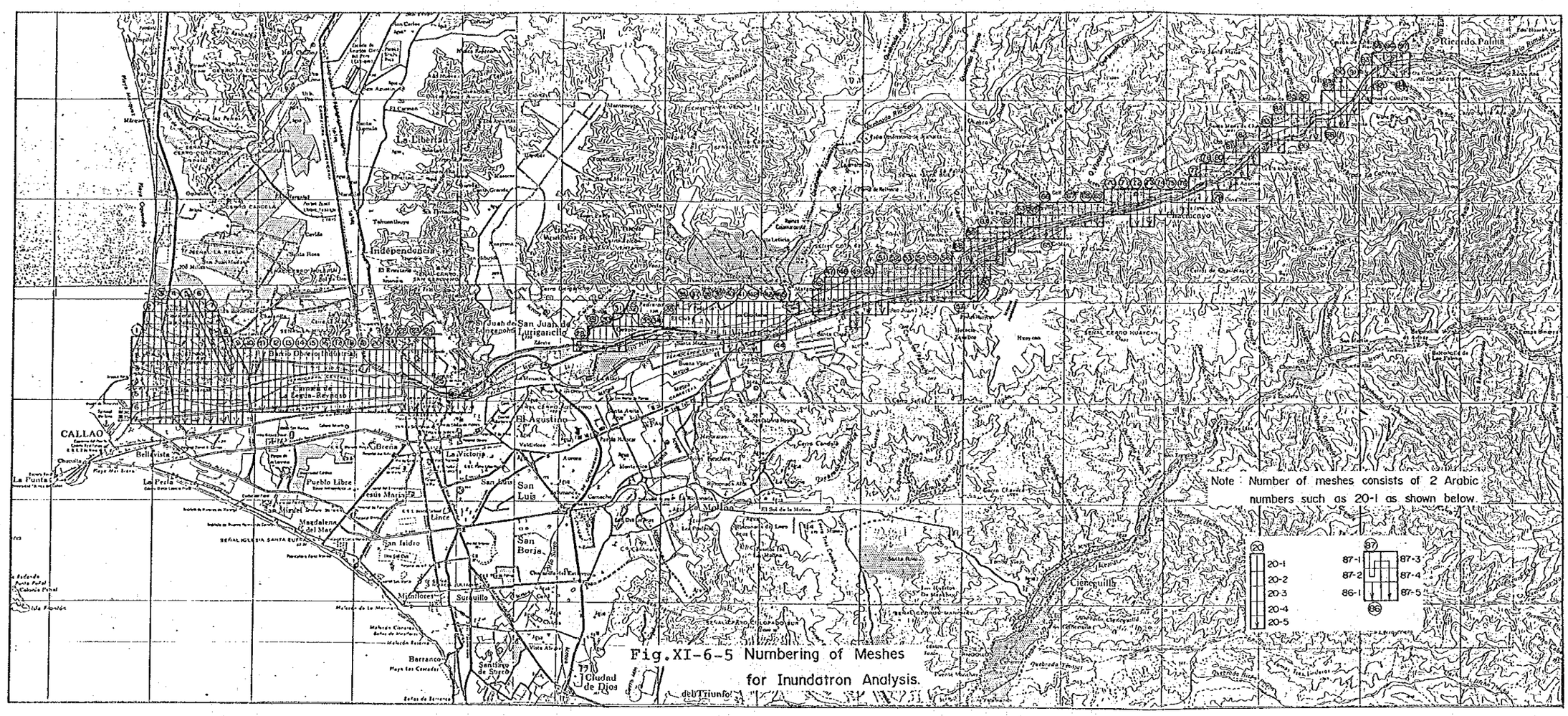


Fig.XI-6-5 Numbering of Meshes for Inundatron Analysis.

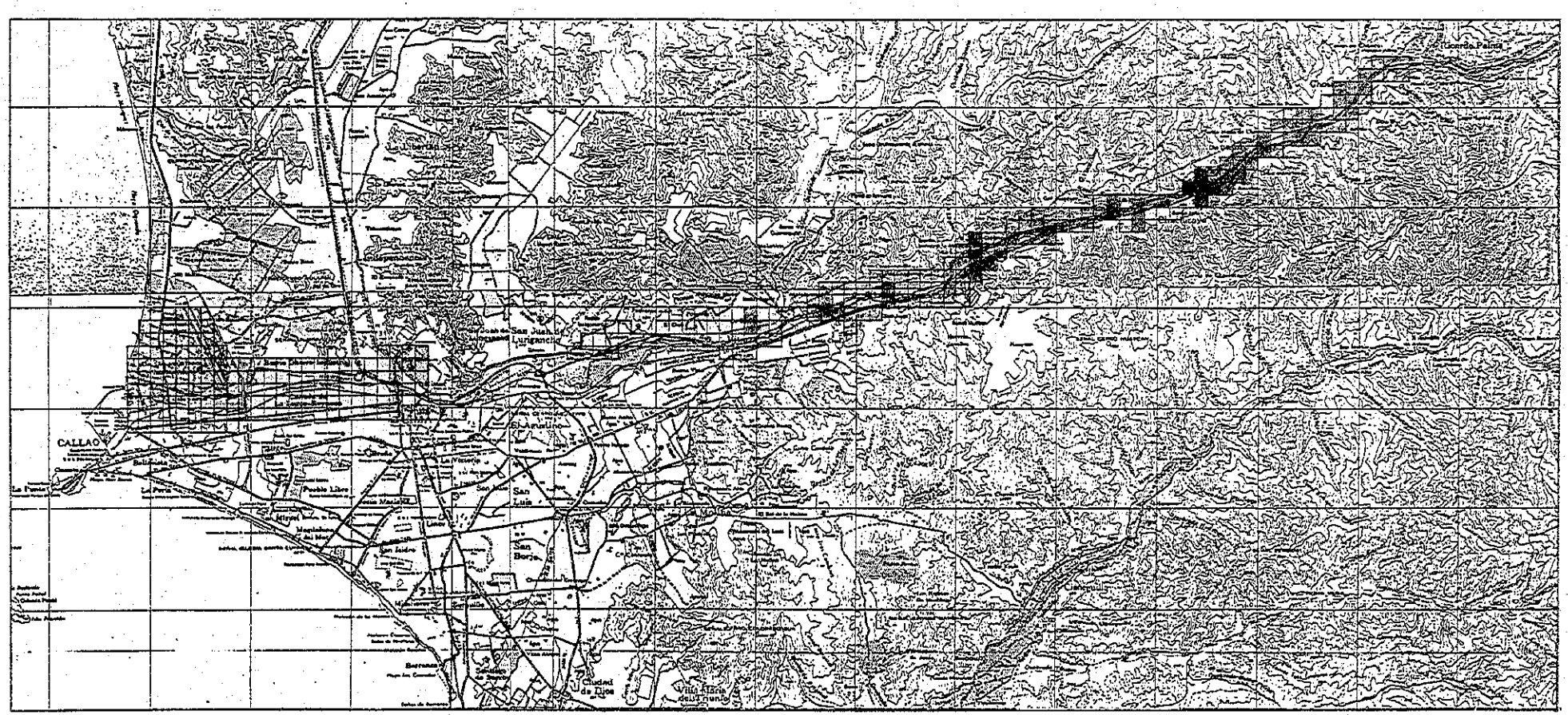


Fig. X I -6-6 Inundation Area due to Probable Flood (10 year flood)

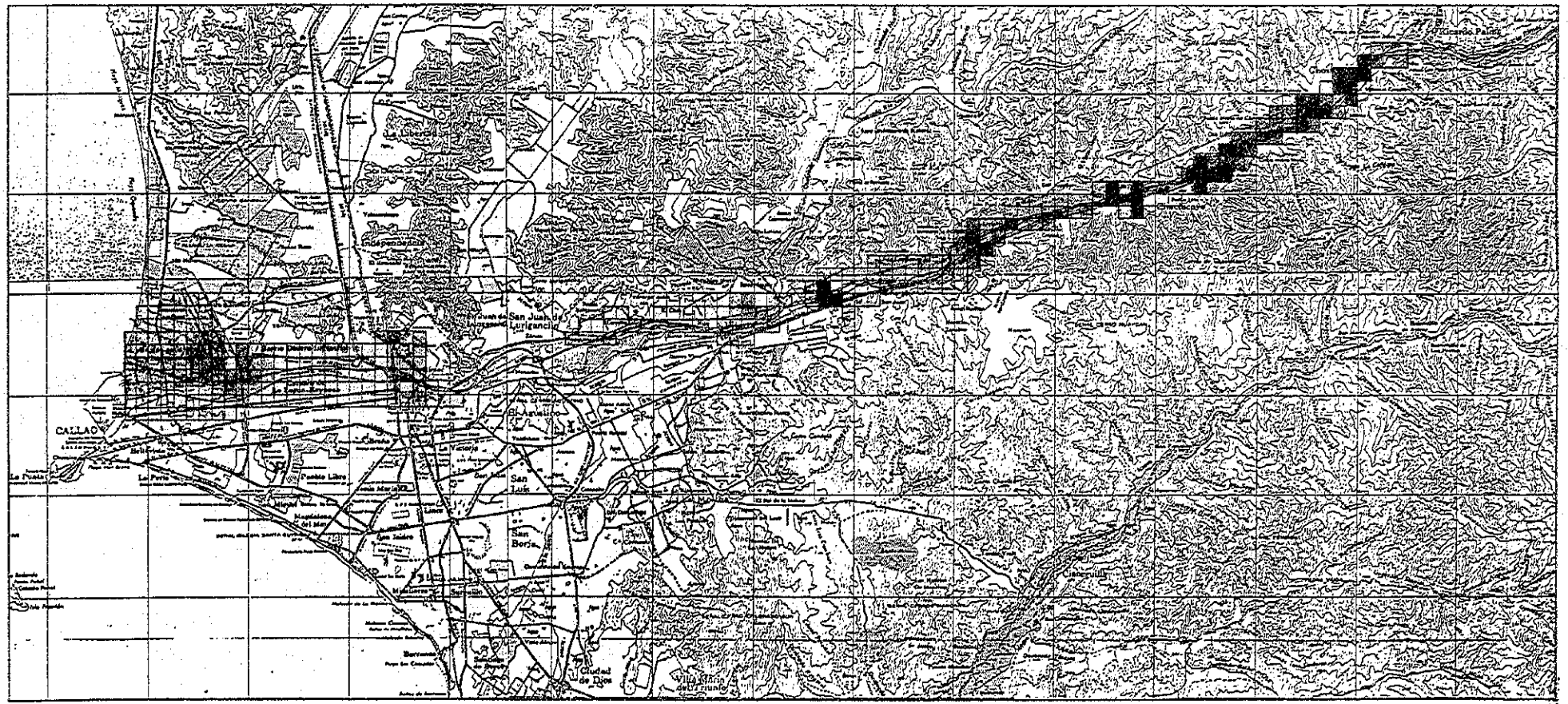


Fig. X I -6-7 Inundation Area due to Probable Flood (50 year flood)

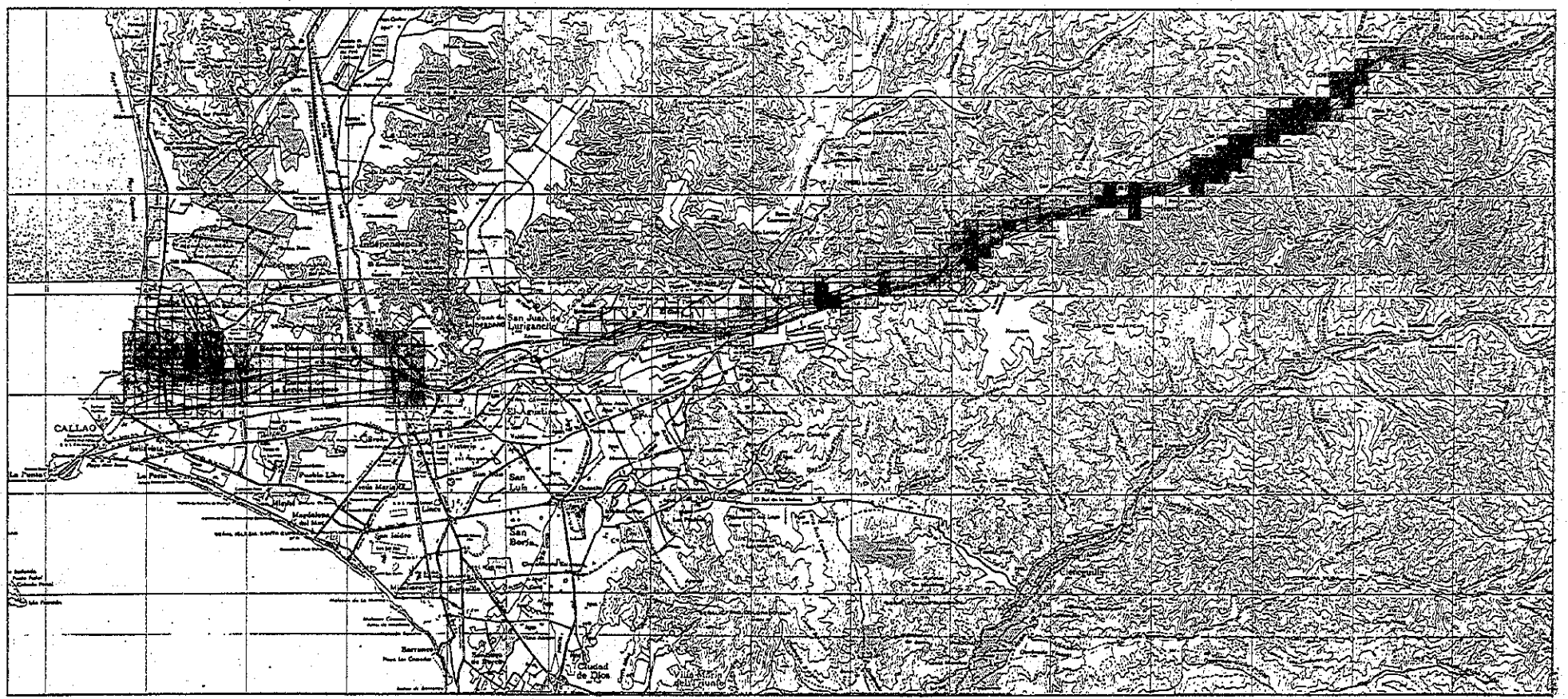
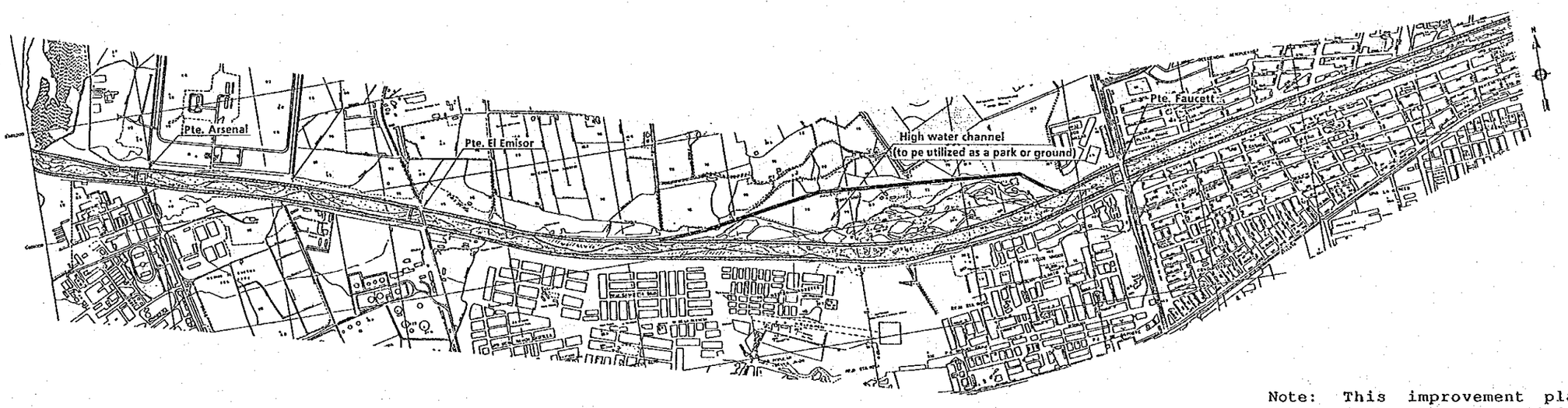


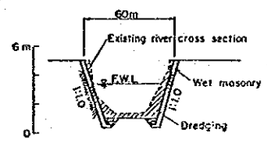
Fig. X I -6-8 Inundation Area due to Probable Flood (100 year flood)



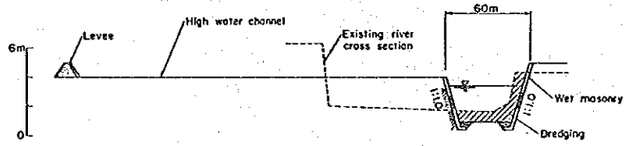
LEGEND

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



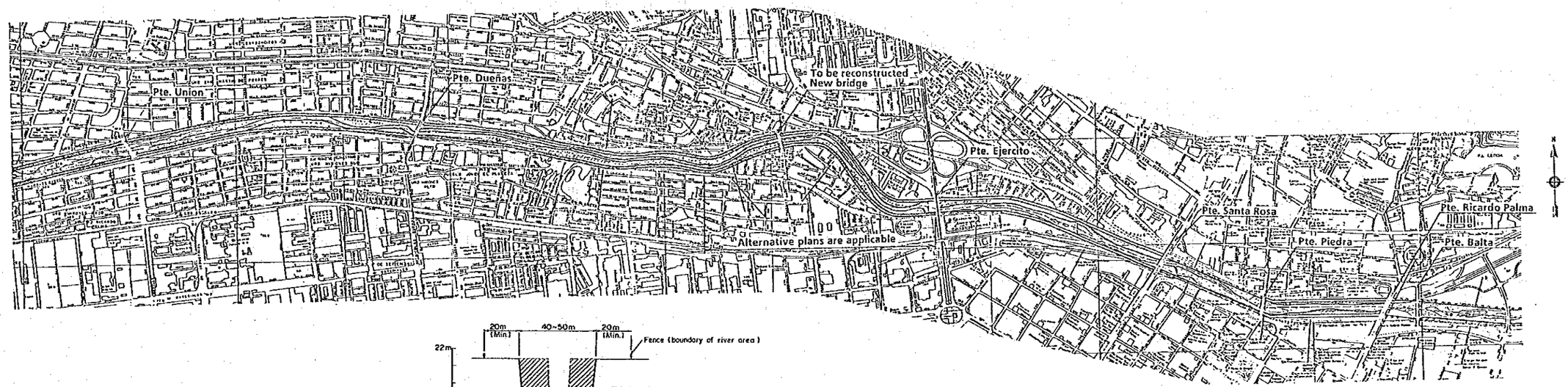
Typical Section
(River mouth - Pte. La Union)

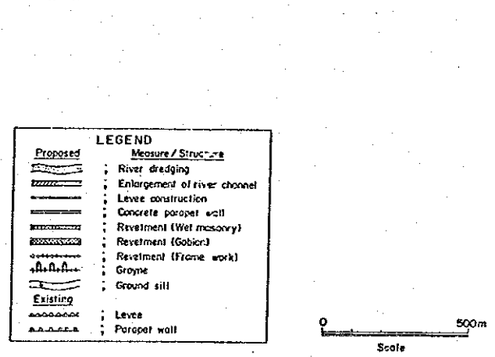


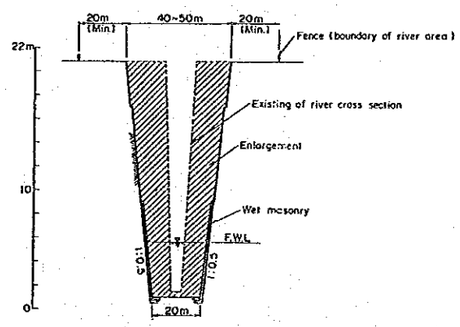
Typical Section at River Stretch having High Water Channel
(down stream of Pte. Faucett, l=1.8km)

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



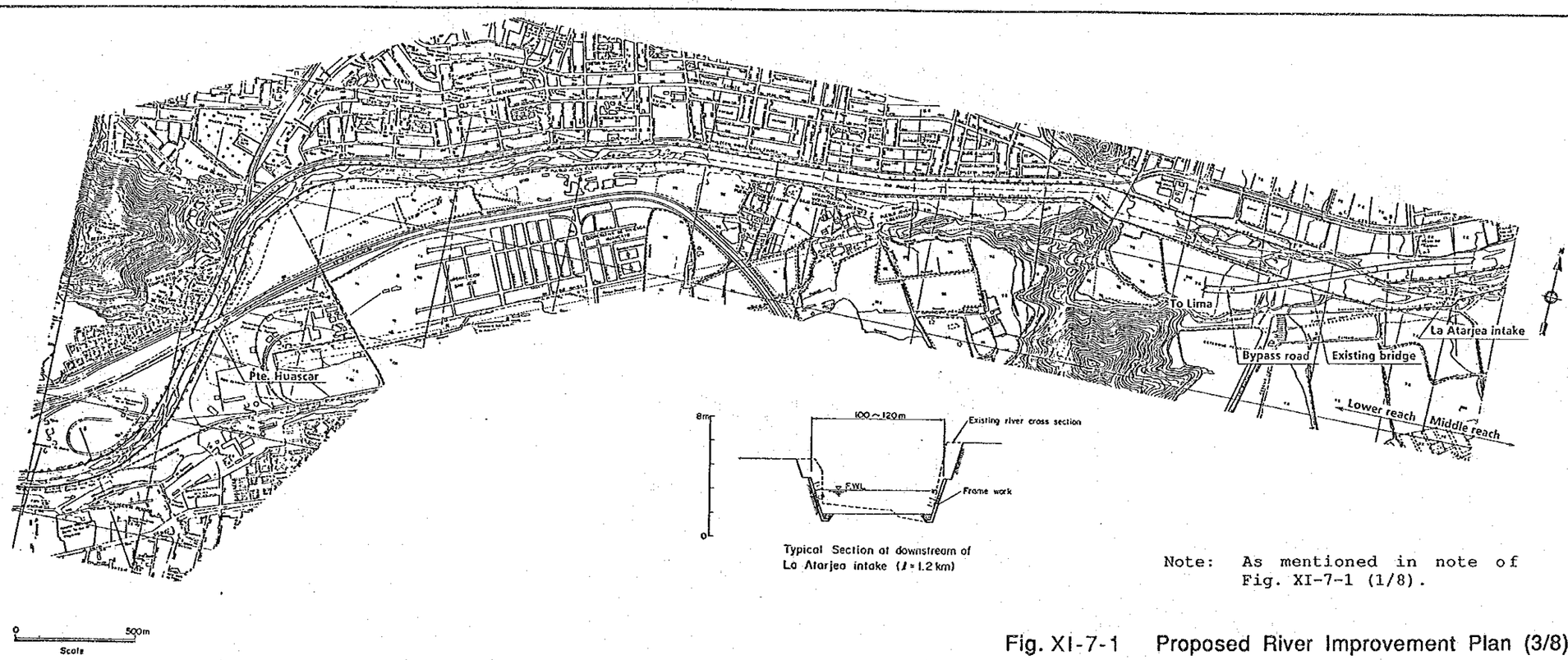




Typical Section of Narrow Portion
(Pte. Dueñas – Pte. Ejercito)

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

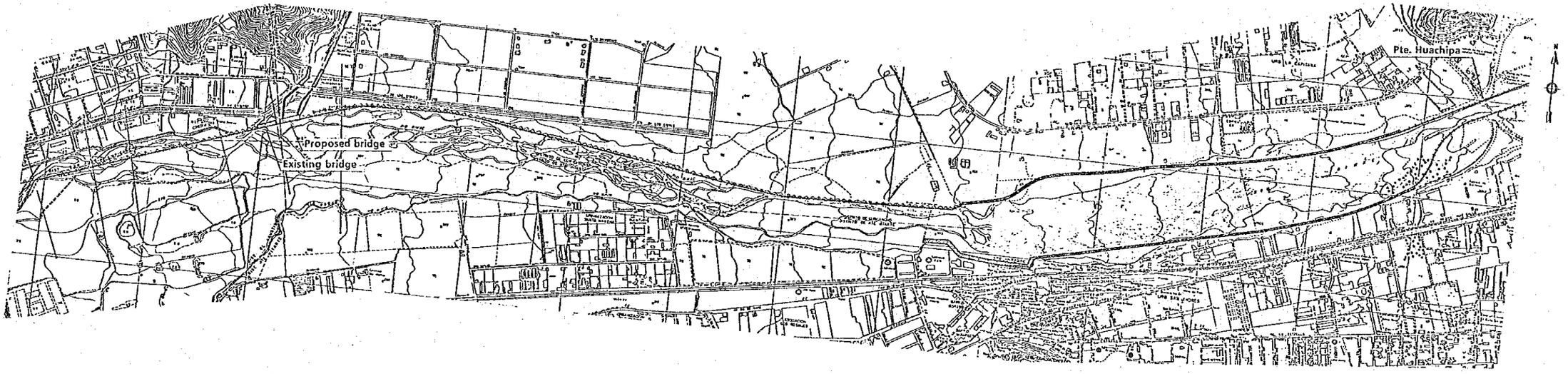
Fig. XI-7-1 Proposed River Improvement Plan (2/8)



Typical Section at downstream of La Atarjea intake (l = 1.2 km)

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

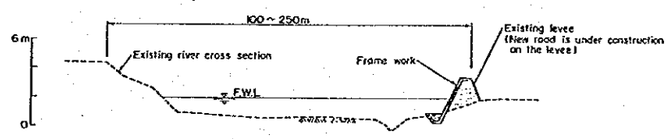
Fig. XI-7-1 Proposed River Improvement Plan (3/8)



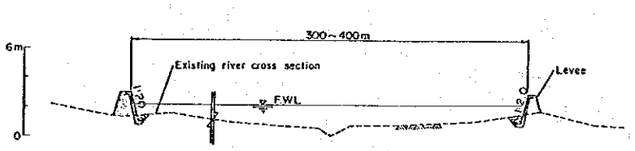
LEGEND

	Measure / Structure
Proposed	
	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



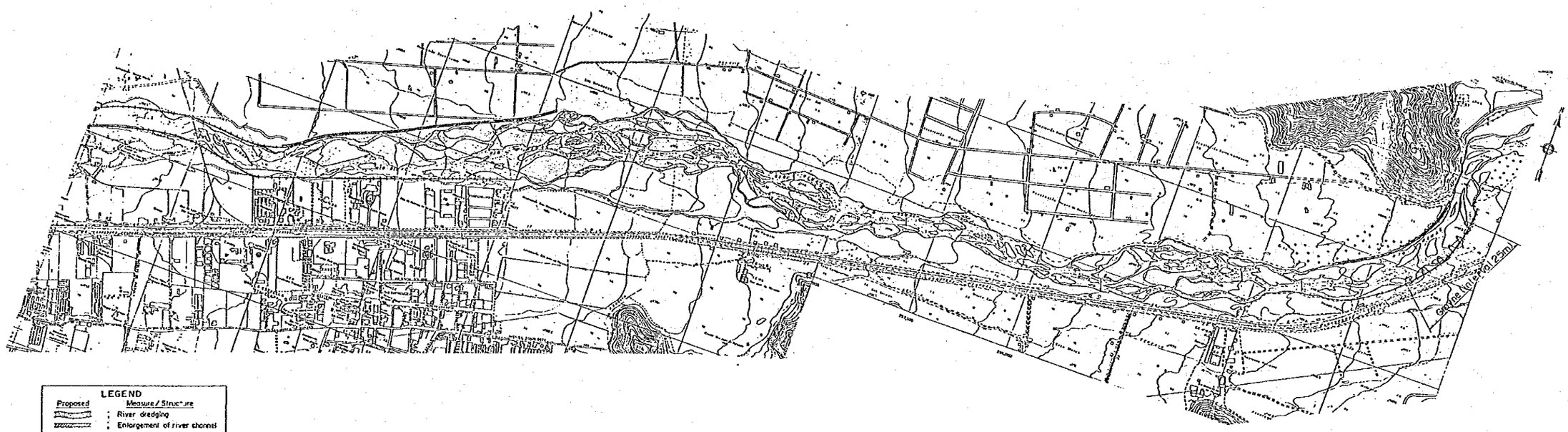
Typical Section at upstream of La Atorjea intake (ℓ=4.0m)



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

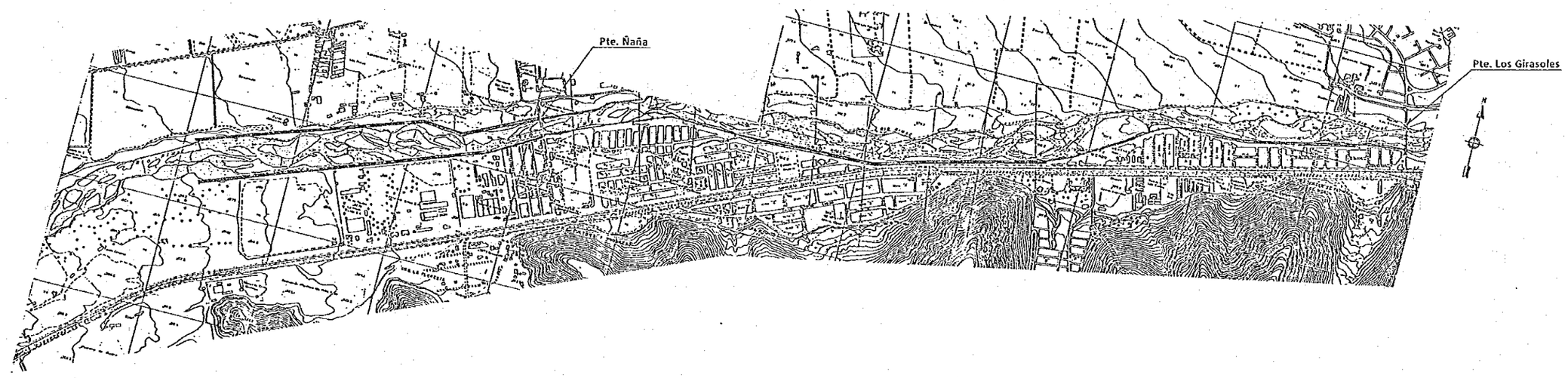
Note: As mentioned in note of Fig. XI-7-1 (1/8).

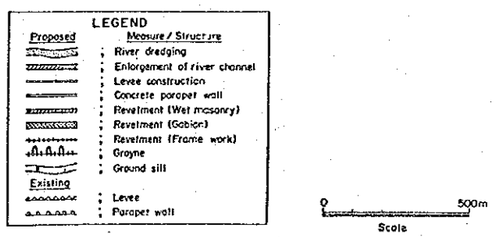
Fig. XI-7-1 Proposed River Improvement Plan (4/8)



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

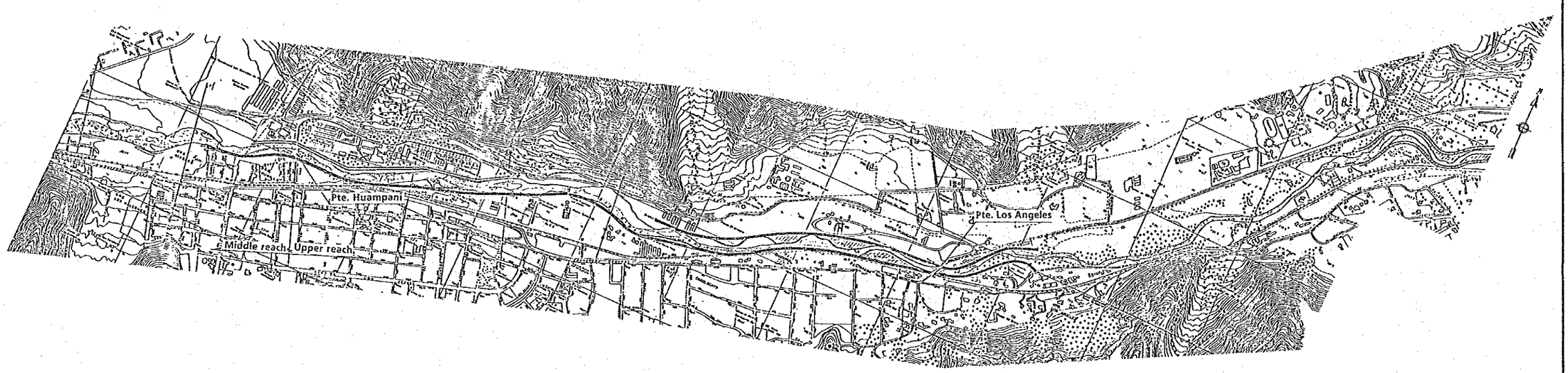
Fig. XI-7-1 Proposed River Improvement Plan (5/8)

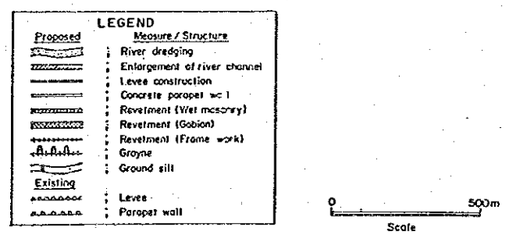




Note: As mentioned in note of Fig. XI-7-1 (1/8).

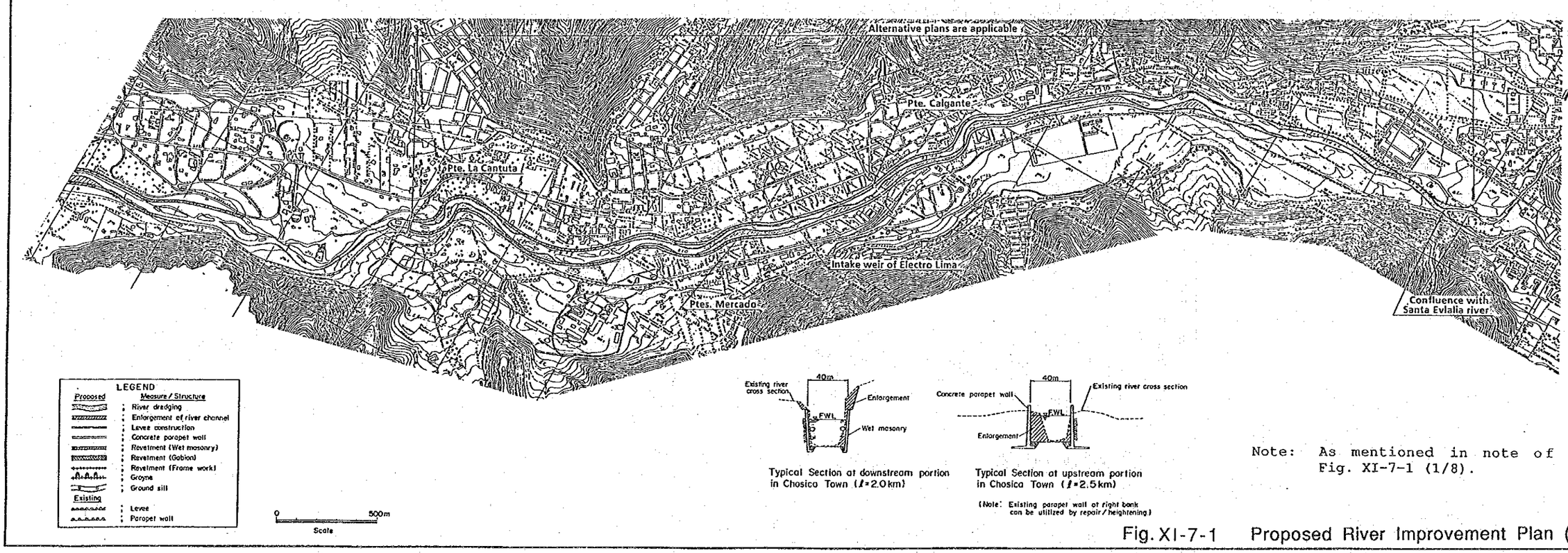
Fig. XI-7-1 Proposed River Improvement Plan (6/8)





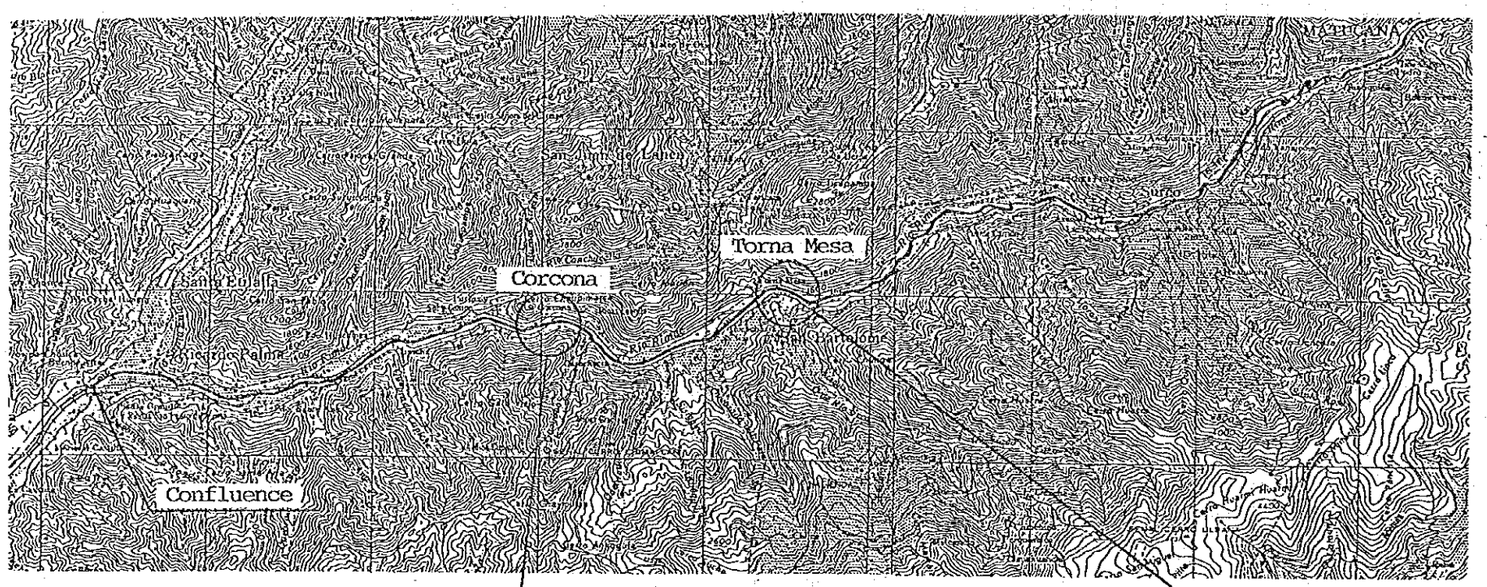
Note: As mentioned in note of Fig. XI-7-1 (1/8).

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



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

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



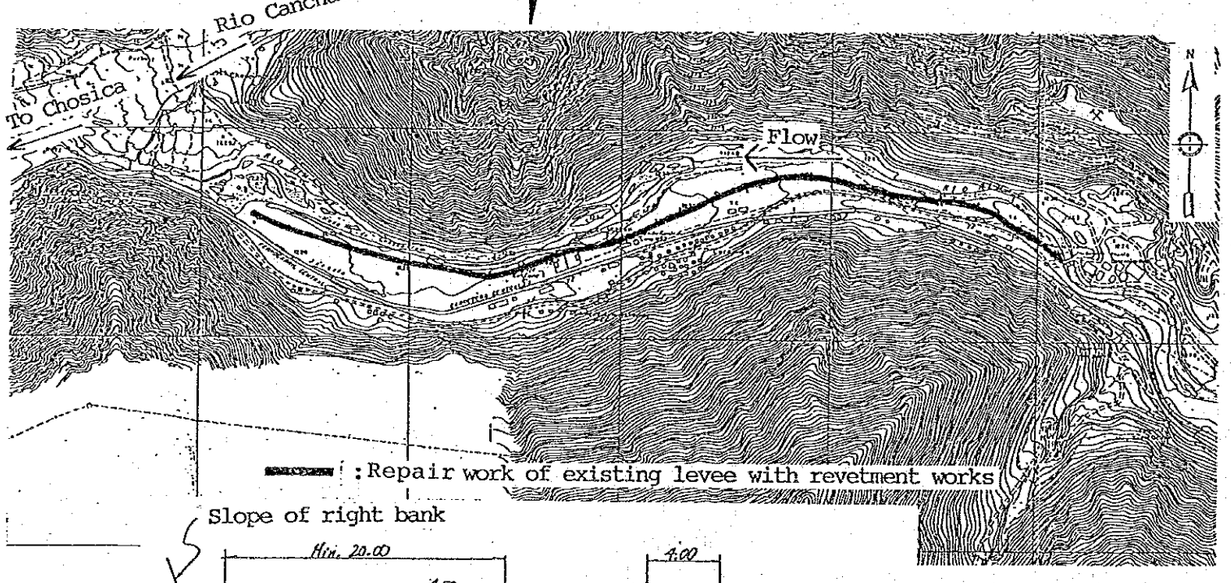
General Map

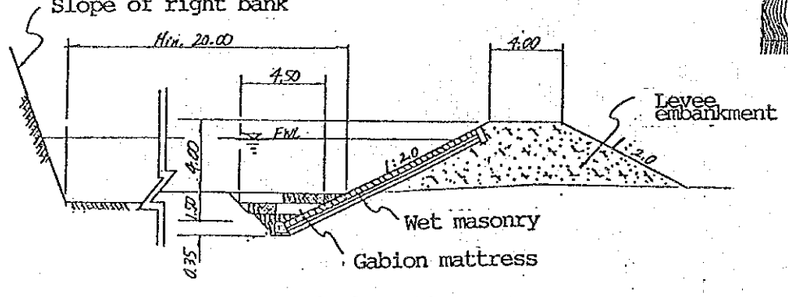
0 8km

scale

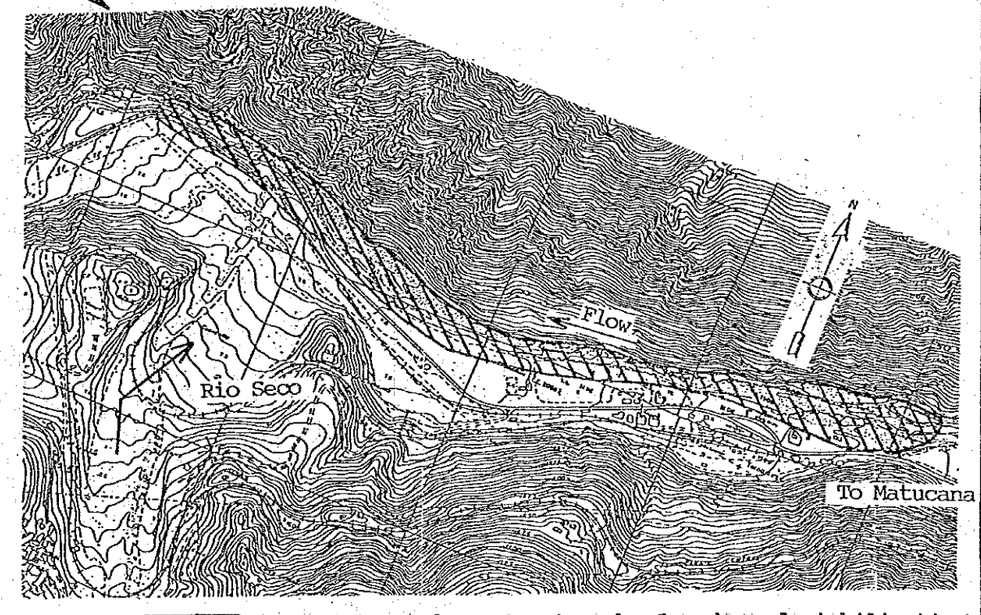
Approximate Work Quantity

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





Typical Section



: Dredging and revetment works for channel stabiligation

0 500m

scale

Fig.XI-8-1 Proposed Structural Plan of Group (B)
(from contluence to Matucana)

APPENDIX XII

NON-STRUCTURAL PLAN FOR DISASTER PREVENTION

APPENDIX XII NON-STRUCTURAL PLAN FOR DISASTER PREVENTION

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APPENDIX XII

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 damage sustainable 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 indicates 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 five 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 rive 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

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 the to the 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 increasing 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, disposed 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 in force it.

- 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 a desirable environmental condition 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 them, 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 ANNEX A.

An example of organization considered desirable for the overall river management is given in Fig XII-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 warning and evacuation system

Prior to the occurrence of destructive debris flow, the following remarkable symptoms are detected in all of debris flow disaster areas:

- Abnormal climate:

  Heavy precipitations usually commence in the adjacent Amazon river basin from around November. However, in 1986/87, there was no precipitation even in February, 1987, causing a drastic heavy rainfall in March, 1987. Such an abnormal climate is detected prior to the disaster.

- Thick cloud:

  Prior to the heavy rainfall, solid masses of cloud wholly covers the area.

- Occurrence of an abnormal noise:

  Following the heavy rainfall, an unusual noise arises in the upstream reaches of quebrada and then, continues for around 30 minutes. The noise is alike some vibration noise. It is considered that the noise arises by the collapse of unstable rock blocks on the slope due to the heavy rainfall and that the energy of debris flow is accumulated during this period.

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 periodically executed 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.

(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 ANNEX B for reference. Fig. XII-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. XII-2-3 for reference.

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