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DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS

TECHNICAL ASSISTANCE SERVICES AND SPECIAL FUND PROGRAMMES

FLOOD CONTROL PROBLEMS IN TAIWAN

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SUMMARY

One-fifth of the cultivated land of Taiwan is protected by [illegible] dykes. These dykes have been well maintained and [illegible]

[illegible] have greater [illegible]

From field observations and studies of data, I concluded that this is probably not so and that the phenomenon has a simple and logical explanation. The rivers, restricted by their dykes, have risen and are flowing above the levels nature would normally provide [illegible]

[illegible]

This may appear at present economically insoluble, however, flood disasters of unprecedented size will one day force the country to face this problem and adjust its water planning accordingly.

When I found that engineers in Taiwan were unaware of this phenomenon, [illegible] 1965 [illegible]

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[illegible]

[illegible] land coastal plain along the west side, covering about one-quarter of the total area, while the rest is mountainous. On the east side of the island the mountains are bounded by the Pacific Ocean and there is no coastal plain. Mountains there are composed of firm rocks which resist erosion. In con[illegible] the [illegible] slope of the mountains is formed of easily-eroded material [illegible]

[illegible]

During the wet or monsoon season, however, precipitation is heavy and can reach 1 m. (approx. 3 feet) in 24 hours during a typhoon.

This mass of water erodes large quantities of soil from the slopes [illegible] lowland areas and coastal [illegible]

[illegible] which frequently bring death and devastation to wide areas of the highly cultivated plain. Further, it has been observed that the frequency of the highly damaging floods and their destruction has increased rather than decreased with time, even though the dykes protecting the lowland plain have been maintained in good order and have been raised in height periodically.

[illegible]

[illegible]

The soil comprising the plain is transported in the hilly country without great difficulty because the gradient of the streams generally is greater than that required to transport the sediment load. This excess [illegible] which takes place in the [illegible]

[illegible] ground at the foot of [illegible] the minimum gradient [illegible] through this part of the system has [been attained]. This slope remains constant as long as the configuration of the channel and the load of water and sediment does not change. However, should the discharge or the sediment load change, the slope will also change to adapt to the new condition.

In this discussion we assume temporarily that this does not occur and that the gravitational slope remains relatively constant, a condition [illegible] or degrading.

[illegible] tion of the lowland [illegible] and 3. The two principal types of development which have taken place are firstly, that in which natural processes were undisturbed by man and, secondly, that initiated by the installation of the flood-control dykes and which is continuing at present.

During the first period of time A to B (Fig. 2a) the lowland was formed by accretion of coastal land along the seaboard and by deposition of layers of soil provided by floods overflowing the [illegible] side, the heavier [illegible] lighter material [illegible] great quantities of [illegible] its level to [illegible] river channels. The length of the rivers, or the width of the plain, and the height of the [hinterland] were therefore always related as shown on Figure 2a.

This process would have continued, but with increasing land use for agriculture, the widespread flooding could not be tolerated and dykes were constructed to confine the rivers during the flood season.

[illegible] ecting the country [illegible] ed, however, that [illegible] entire river [illegible] deposited on the plain, [illegible] confined to the river channels. The rise of the hinterland was therefore stopped and the sediment load, previously used for building it up, was carried to the sea, thereby accelerating the accretion of coastal land. This is illustrated by many villages which at one time were fishing villages along the coast, but are now 5 to 10 km. inland. As the plain widens, the length of the rivers increases proportionally and the additional head required to overcome this increasing length is provided by raising the river system as a whole. Since this process is confined only to the narrow area between the [illegible] through which [illegible] level of the dykes

This development continues and considering the plain as a point of reference the water levels of the rivers continually rise relative to it.

as [illegible]
ent[illegible]
nat[illegible]

The [illegible] customary to speak about "Nature's delicate balance" which man cannot touch without bringing about adverse effects. The developments in Taiwan are a classical example of such a disturbance.

3.0 [illegible]

[illegible]
de[illegible]
The [illegible]
the sea with enclosing dykes. Since the elevation of the polders is at or below mean sea level the salt water will be kept out by artificial drainage.

The acquisition of new land is most important for Taiwan, hence the [illegible] land is no more questioned than the installation of [illegible]
ev[illegible]
devel[illegible]

[illegible]
de[illegible]
wa[illegible] settling in the present coastal area will have to be transported farther along the river channels to the sea, the lengths of which have suddenly been increased by the width of the polder. If we assume that the slope of the river near the mouth is of the order of 0.0002 during high discharges, the wa[illegible]
be[illegible]
th[illegible]

[illegible]
c[illegible]
si[illegible]

4.0 POSSIBILITIES FOR IMPROVEMENT

[illegible]

[illegible] the retention [illegible]

[illegible] mountains of [illegible] small retaining structures installed in the many creeks and tributaries. In Germany, this method of sediment retention is called: Wildbachverbauung. However, erosion in the Alps is small compared with that of the west slopes of the mountains of Taiwan. It is therefore very unlikely that sufficient storage capacity can be provided each year to retain the sediment load effectively.

Storage lakes also have not proven successful. Those erected for [illegible] years. The [illegible] in some areas [illegible] drainage area is [illegible] the country [illegible] Retaining material in such volume is, furthermore, like heaping up avalanches and creates serious new problems.

Retaining water to reduce the peaks of floods faces the same end, i.e. the quick reduction of storage capacities through sedimentation.

[illegible] rivers--not [illegible] the planning [illegible] levels and the [illegible] reverse [illegible] water levels.

This can be accomplished by two methods, - taking a more direct route to the sea and by straightening the rivers.

Straightening, as in the vicinity of Taipei on theTanshui River, for reducing the flood danger will have only a local effect. No improvement will occur in the areas below. and conditions may even be temporarily worsened.

[illegible] the lowland [illegible], no length [illegible]

A last resource, which has not been explored, is that of the smaller discharge ranges. The velocities available are obviously too weak to transport sediment in their individual channels, but a combination of discharges from two or more rivers into one channel would provide the transport strength to clear the lower part of a river system during certain periods of the year. Figure 5 shows the assumed velocity graphs of two rivers which flow side by side through the plain. For convenience these [illegible] critical [illegible]

[illegible] has not reached the transporting stage, the discharge from river I were diverted into river II, or vice versa, velocities sufficient to initiate transport

[illegible]

The greatest problem of this scheme is, of course, the diversion of large quantities of water from one river to another. The scheme, therefore may appear arbitrary and quite unrealistic from the practical viewpoint. [illegible]

[illegible]

The term "weather control", in this instance, means the release of the heavy load of water carried by typhoons before striking the island. Since rainfall and the water collected in streams and rivers are the agents eroding and transporting the soil, the entire process of moving soil from [illegible]

[illegible] opinion, having [illegible] knowledge in this field.

5.0 CONCLUSION

[illegible] process is [illegible]

The most outstanding feature of present developments is the elevation of the rivers above the natural levels they would have taken had they been unrestrained. This process will continue as long as the rivers lengthen. Land reclamation in coastal regions now under consideration will further [illegible] this process.

[illegible]

[illegible] Water Resources Commission, Taipei, Taiwan.

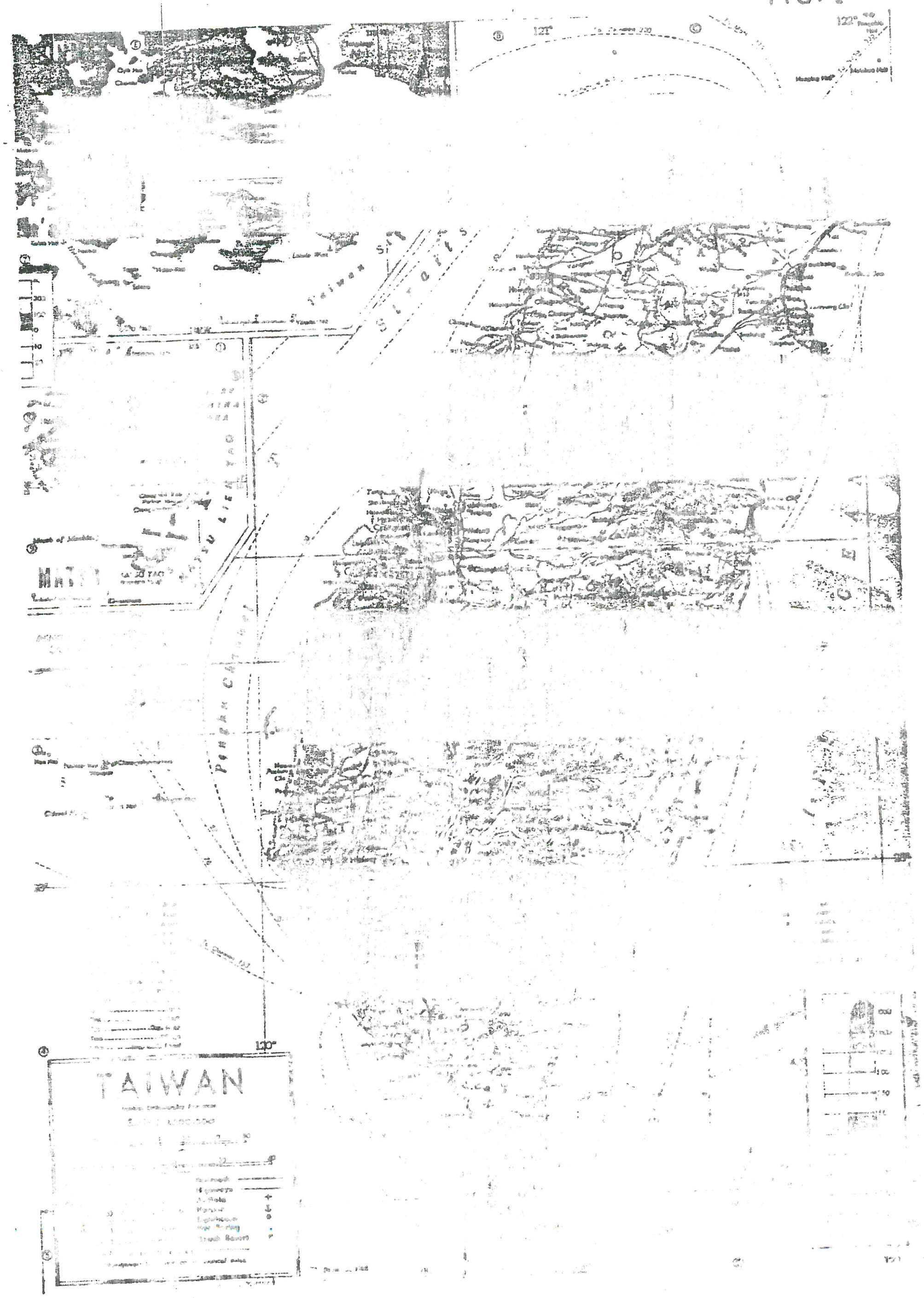
[illegible] rise of [illegible]e rivers [illegible] to [illegible]vent [illegible]ation.

The diversion scheme is, in my opinion, the only one capable of doing this effectively. The project may appear at present economically unjustified; however, flood disasters will eventually force us to revise our opinions and act only in accordance with the principles established by Nature.

[illegible]

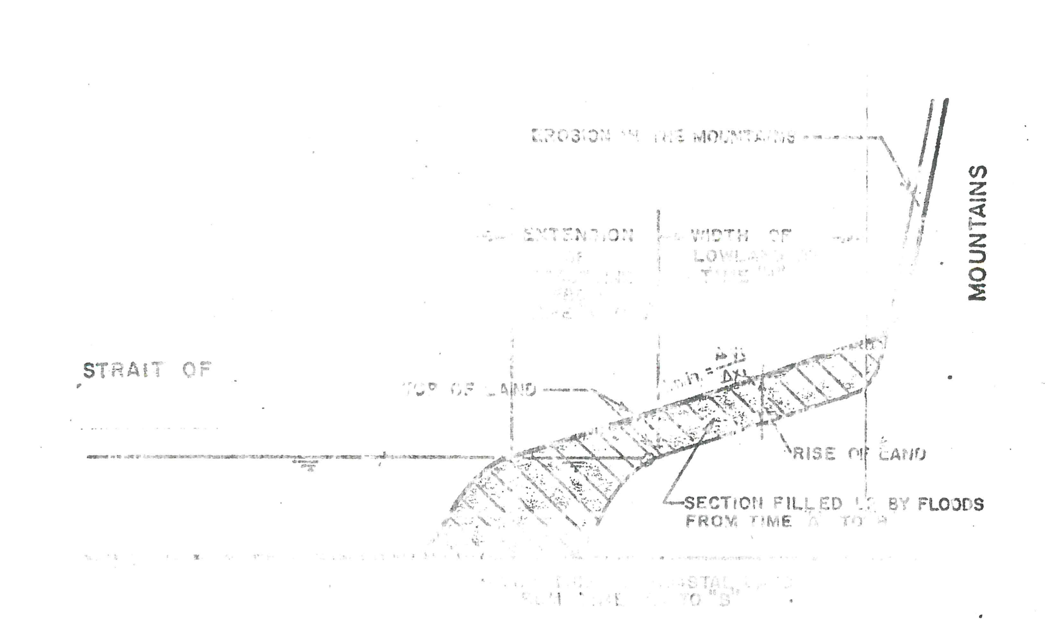
The [illegible] the ass[illegible] the staff [illegible] of the National Research Council, in particular that of Mr. J. R. Clarke, in preparing the paper.

FIG. 1



FORMATION OF LOWLAND

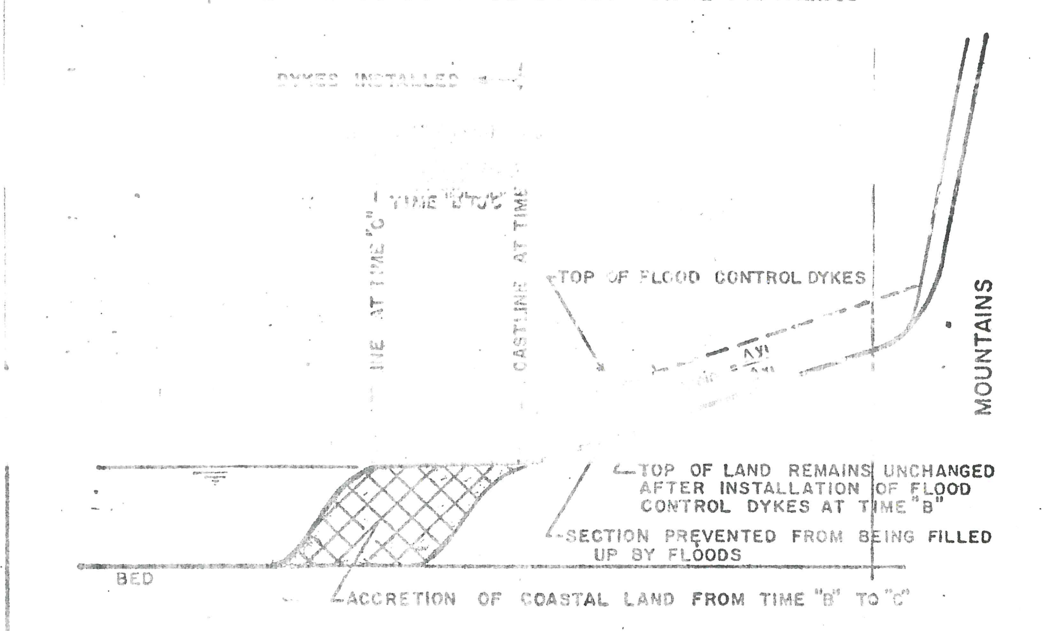
FIG. 2a



FORMATION OF LOWLAND

AFTER FLOOD CONTROL DYKES WERE INSTALLED

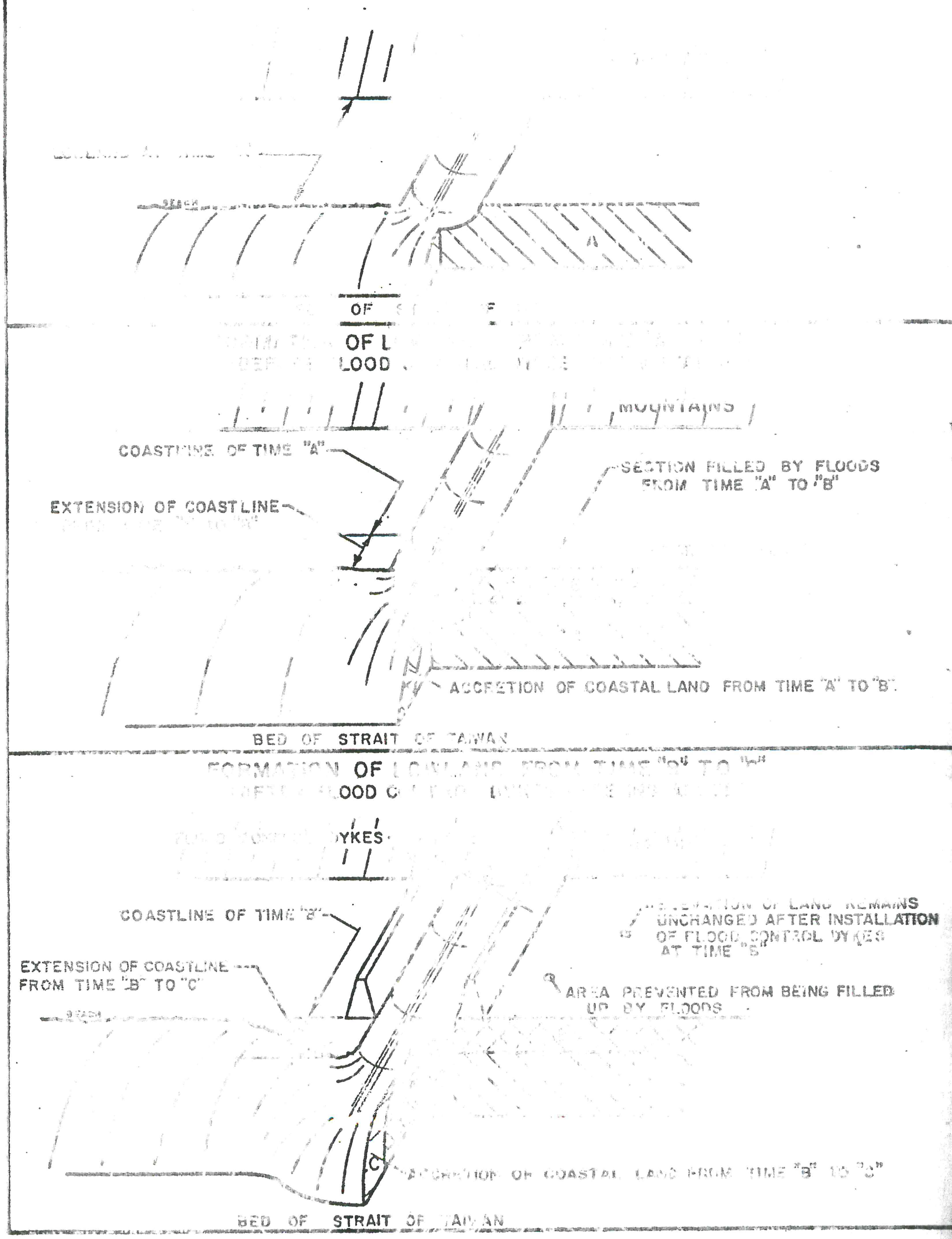
FIG. 2b



FORMATION OF LOWLAND- VARIOUS STAGES

FIG. 3

FORMATION OF LOWLAND AT TIME "A"



TIDAL LAND DEVELOPMENT (SCHEMATIC) FIG. 4

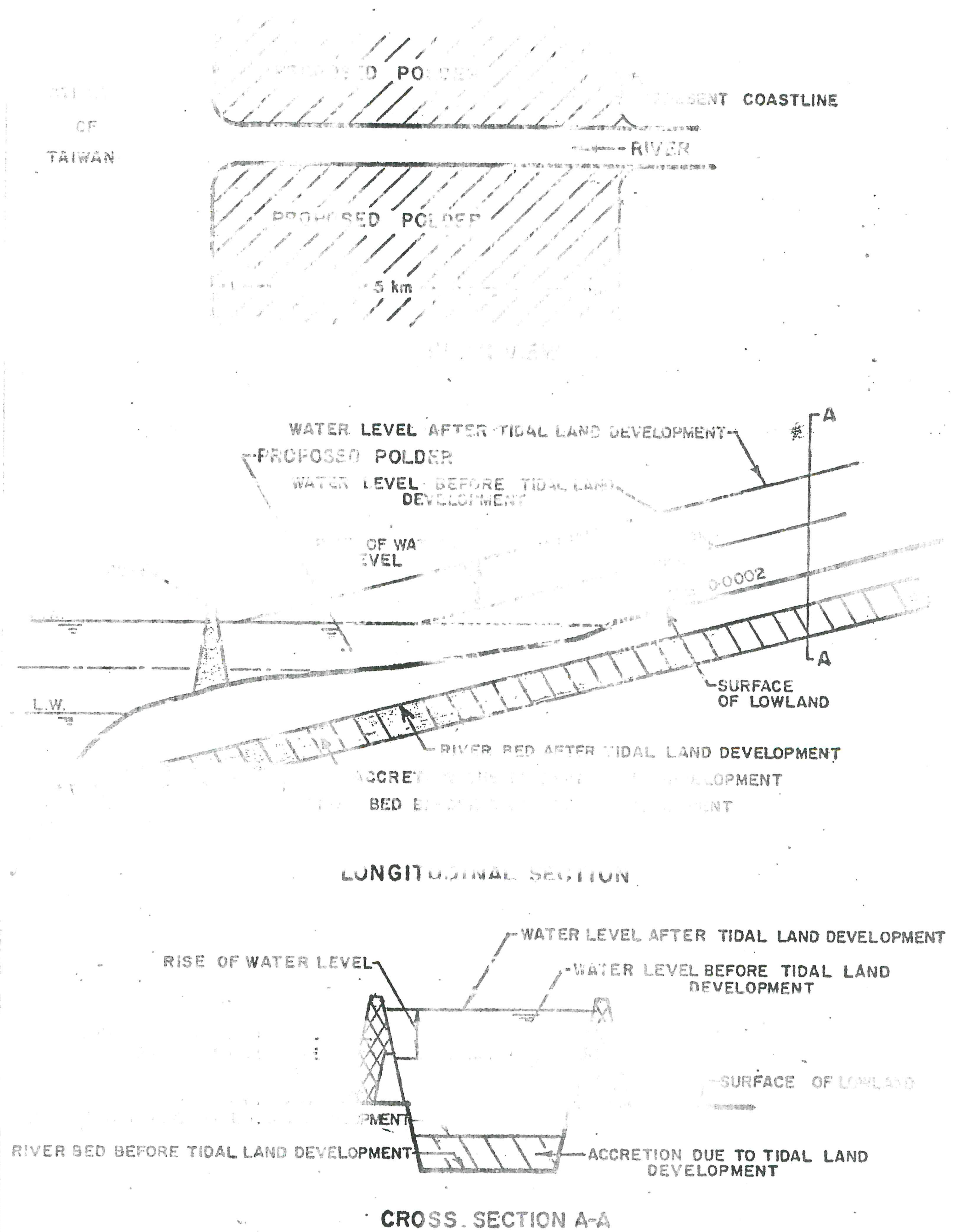


FIG. 5a

VELOCITY STRUCTURE IN A DIVERSION SCHEME
FOR CLEARING RIVER CHANNELS IN COASTAL PLAIN