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Ministry of Works,
P.O. Box 500,
HAMILTON.

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The District Commissioner of Works,
HAMILTON.

MAKETU ESTUARY

REPORT ON TE TUMU OUTLET AND DRAINAGE

This investigation of the hydraulic features of the Kaituna River outlet at Te Tumu and Maketu Estuary has been divided into three sections for convenience, commencing with -

(a) The Coastal works including the new outlet,

(b) the estuaries and channels within the zone of tidal influence,

(c) and the proposed secondary drainage system into the estuary, including the existing flood gate installation at Fords' cuts.

The principles underlying coastal action are exceedingly complex, and the Te Tumu - Maketu problem falls within the category of a sandy estuary with the attendant problems of littoral drift, wave action and resultant bar formation at the outlets.

Dealing first with Section (a) ; Coastal Works:

The new outlet channel intersects the great sand beds of the Bay of Plenty coast line, which is formed of gently shelving beaches in the vicinity of Maketu. The new Te Tumu box-mole with connecting embankment, is acting more as a groyne and presently ends in the beach at approximately low water mark. It cannot be classified as a breakwater, as to function in the accepted manner of harbour entrance moles, it would be necessary to carry it out to depths unaffected by ordinary wave action (considered to be 2½ to 3 fathoms at low water), a very costly structure on such a gradual shelving foreshore.

Regime does not appear to have become firmly established as yet, and the channel and associated sand-banks around the mouth may be subject to many minor changes for some time to come. There is also bound to be a further progression of the foreshore, due to the existing mole influence, and high-water mark will ultimately advance to a point that will establish a stable regimen once more.

The control of these changes is largely a matter of what works are economic in attempting to lower the estuary ebb-tide levels in order to provide for greater gravity discharge as far as possible, and probably assisted by mechanical discharge at a later date.

A visual examination of the bar material in front of the outlet showed this to be clean sea sand similar to that formed along the main beaches to the west as far as Tauranga and beyond up to Waihi. There is no evidence of any silt deposits from the Kaituna River discharge, such being probably swept out to sea in suspension.

The supplies of sand to the bar are generally believed to be moved along the beach by coastal eddies set up by the flood tide combined with wave action, in this case, moving from west to east. As these two natural forces are not readily controlled except at a very high cost, usually in the provision of two sheltering breakwaters to confine the channel to depths free from wave action and eddies affecting the sands on the ocean floor, improvements, if any, should be looked for in the estuarine channels. It is known from experience in the improvement of estuaries by concentrating the ebb current on the inner bar, that without this control of the main outgoing stream, a rapid dissipation of current energy and velocity is found, especially where several divided shoal channels obstruct the flow. Without channel fixation and deepening of the bar by training walls partial or complete removal of the sand deposits by dredging is the only other known method of improvement, and then mostly for navigational reasons and not generally to improve the hydraulic properties of the channel, though this does help to maintain the increased depths for some time after. Dredging however, is only a palliative and cannot be offered in the present instance as a mode of bar improvement.

The result of such research into the bar problem at the Te Tumu mouth of the Kaituna River may be summed up as follows: neither a short training wall on the west side, a limited extension of the existing mole, nor removal of the bar by dredging or dragline, would effect a long term improvement that would be economically justifiable in the present instance. Such works would have a very limited effect under the conditions prevailing. Only large scale training works are effective in the path of a pronounced littoral drift. In the present instance, it is considered most advisable to allow the new conditions to settle down so that the channel will maintain itself without any great variation in depth and width. It has often been observed that when apparent stable conditions are being evolved, further interference may completely upset the order of things.

Section (b):

An analysis of the hydraulic factors of the lower Te Tumu channel, with the limited data available, indicates that it is acting hydraulically, that is, the water is flowing under the influence of surface slope. It was observed recently that at three-quarters ebb, a mid-surface velocity of just over 4 f.p.s. was present and the slope as taken from the gauges was about one foot per mile. This gives a value of "C" in the Chezy formula of about 130 indicating a channel in good condition hydraulically. The loss of head in the new channel from purely bed friction does not therefore appear to be capable of any great improvement.

An examination of the tidal levels reveals that the greatest loss occurs at the bar itself, due to a variety of causes, chief of which are wave action, exposure to winds, and the effect of the bar obstruction causing a loss of energy which in turn causes a back-water or deepening upstream. This is a necessary condition for increasing the specific energy to an amount sufficient to provide the additional "head" which appears to vary from about 1'0 to 2'0 depending on sea and wind conditions, whether calm or stormy. These losses appear the same at both outlets. There remains the difference in loss of head over the length of the old channel via Maketu estuary and the new channel, an amount of about 8", which is almost the figure observed by gauge recordings, in favour of the new outlet.

It has been suggested that the Maketu Lagoon be closed at the old outlet so that all water would flow through the new outlet. The general effect of this would be to increase the average velocity by some 25% but this would not reach a scouring velocity over the bar sufficient throughout the ebb-tide period to give the extra depth required to lower the back-water levels appreciably. Experimental data derived from several sources shows that sand is scoured when $V > 1.6 (d)^{0.33}$ which for "d" = 6'0 approx. gives "V" (bottom velocity) = 3.1 f.p.s. which in turn requires a mean velocity of about 4.1 f.p.s.. On a cross-sectional area of 1,000 sq.feet, this gives over 4,000 cusecs throughout the ebb-tide or about double that of the old and new outlets combined. This is the well-known problem of providing tidal compartments of sufficient capacity to provide a flushing current on every ebb tide. Generally it would require a tidal basin about three to four times the size of the existing Maketu basin.

There appears to be one point requiring attention in reference to bar improvement during heavy floods. There does not appear to be any probings of the actual bar ridge, in order to determine if any hard layers of clay or compacted sand exist. Though these are not likely, it would be as well to test for same, and also observations should be made for the information of an outer bar ridge, especially in fine weather.

It must also be noted that the Maketu outlet gauge does not measure the actual off-shore sea-level, but some amount of the back-water curve above. As this affects the two outlets more or less equally, the curves shown may be accepted as sufficiently representative for this report.

Section (c) : Secondary drainage proposals.

It has been claimed that the old Maketu estuary provides a lower low-water level for gravity discharge than the new outlet. Levels taken on 5.10.59 and again on 22.10.59 of Fiskens and Pittars' drains show that this is not the case. In fact there is some evidence that a back flow exists from Fiskens drain to the new rock causeway through the rock fill and is taking place at low-water. The advantages claimed for concentrating the drainage water at these two outlets cannot therefore be sustained on these grounds, or on greatly assisting the ebb tide discharge to an eroding velocity at Maketu.

In this regard, there is a very critical factor present that should be given careful consideration. This refers to the possibility of the old Maketu outlet becoming partially or completely blocked during a heavy storm when conditions are favourable for a considerable west to east sand movement with low tide ranges. In such a case the estuary would become or remain full of water and effectively cut off all gravity drainage. It is considered that such an emergency should have plans prepared to meet it.

This further raises the question of the height of the relief overflow weir on the new rock causeway at Ford's cuts. A level of 98.0 has been recommended but this appears somewhat low as the top of spring tides reaches an average level of 99.50. It is considered that a level of 100.0 should meet the position more satisfactorily, as all normal flows would then be kept to the new channel. At a level of 100.50 to 101.0 during floods, approximately 4,000 cusecs will be discharged and excess water will then be going over the overflow weir into Maketu estuary. However, sufficient of the main flow will be flowing through the Te Tumu outlet to set up scouring conditions on the bar. A lowering of the bar will be reflected for a time in an increased discharge without any appreciable rise in the upstream levels. Sufficient water should be flowing through the Maketu estuary to "ventilate" the existing pondage and provide extra velocity through the mouth and assist scour in a small measure. Too much reliance cannot be placed on such overflow water greatly affecting the bar at Maketu mouth. For a 4,000 cusec flood coinciding with high water, a period of 2½ hours either side will cover the overflow condition, the remaining period allowing a full 4,000 cusec discharge over the Te Tumu bar. In the event of a major flood, it is considered that a level of 100.0 will allow an increasing amount to be diverted via Maketu with a lowering of upstream levels by a small amount probably less than 1'0, but still a useful amount.

Re Internal Drainage : (Fiskens, Pittars and Cruickshanks Drains)

It is suggested that these outlets should be made independent of Fords new outlet but it is apparent that the possible closing of Maketu outlet either partially or wholly, and the higher differential levels at low-water do not support this proposal. If the creation of internal pondage to cope with flood flows is favoured along with internal drain improvements to the existing outlets, it may be more economical in the final scheme to consider individual pumping units and retain Ford's installation for flood disposal. This would eliminate the present disadvantages of gravity disposal into the Maketu estuary.

So far as the flood gates are concerned and the difficulty of working all three during low flows, it is suggested that a low type weir plate be fitted to two of the pipes internally to operate for a design flow of say 6 cusecs and over. As it is essential to maintain a quick discharge at low water, the retention of three culverts seems very desirable so as to take advantage of

the 8" to 12" differential between Te Tumu and Maketu estuaries. Further information on the behaviour of the internal drains with hydraulic gradients measured in the field seems desirable if the above is not favoured in the light of local knowledge.

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Encl. Two Plans showing Tidal Level Comparisons and Site layout. HDO 8966 8967.