Attachment to
Report 01.425

WAIRARAPA DIVISION
WELLINGTON REGIONAL COUNCIL

MOTUWAIREKA LAGOON

RIVERSDALE

HYDRAULIC STUDY

of

LAGOON

by

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March
2001

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MOTUWAIREKA LAGOON – RIVERSDALE

HYDRAULIC STUDY of LAGOON

INTRODUCTION

The Motuwaireka Stream has a small well-defined estuary and backwater lagoon reach where it enters the sea beside Riversdale Beach settlement. Studies have been carried out on the water quality of the Motuwaireka Stream and its estuary/lagoon, and there is concern at the deteriorating quality of the lagoonal reach. A number of measures have been proposed to improve water quality.

This report covers an investigation of two possibilities: the removal of accumulated material in the tributary backwater lagoon and its consequential deepening; and periodic deepening of the estuary outlet to the sea, through a direct opening across the estuary sand spit from the lagoon reach.

The nature of the estuary/lagoon at the stream mouth has been assessed, and some hydraulic modelling has been carried out of the estuary/lagoon reaches based on survey data obtained as part of the study. Information on the stream and its estuary has been obtained through a site visit, discussions with Regional Council staff and local people in Riversdale, some reports and data on water quality, and a series of vertical aerial photographs from 1944 to 2000.

On the basis of the investigations, comment is provided on the likely effects of lagoon deepening and/or periodic direct openings to the sea, and the likely on going responses.

NATURE OF ESTUARY

The estuary and its upstream lagoonal reaches form behind a coastal sand spit. There is a net northward drift of beach material along the shore, and this gives rise to a spit at the stream mouth. The position of the stream mouth varies in response to a complex dynamic of coastal and stream processes. Flood events open up the estuary channel, and can give rise to break through across the spit, which shorten the estuary channel. Coastal action tends to build up the spit and shift the mouth northward towards a rocky point and area of reefs, which prevent further northward migration.

The estuary can be completely blocked off from the sea, but there is generally a channel through to the sea, albeit a restricted one during sustained periods of low stream flow. Water levels in the estuary and lagoon reaches are controlled by the conditions at the mouth, where the stream crosses the beach to the sea, and flat water extends up the lagoonal reaches to about the Orui Bridge and Camp Anderson on the tributary. The sand spit at the coast is relatively wide, and generally lowers in the northward direction, so that flood flows can spill over the spit to the sea.

The aerial photography since 1943 shows a consistent pattern, with no substantial overall change, but with the natural variations that occur in such a dynamic environment of a stream/sea interface. The position of the stream mouth varies from the northern extremity (as in the 1975 & 1994 photography) to a direct outlet from the lagoon (as in 199 1). The

stream mouth can though be anywhere along the length of the spit, as shown on the photography (Appendix 1).

This photography indicates that the lagoon reach, upstream of the spit, has not substantially changed, at least in plan form. However, it does appear as though the retarding of erosion along the outer bank of bends has given rise to a narrowing of the channel at the bends, (Aerial photography of the shoreline profiles since 1902 is shown in the appendix). Works and planting has been carried out along the lagoon side where it bends away from the coastal dunes, to mitigate erosion into the sand dunes. While this has stabilised the outer bank of the bend, the natural migration trend would have given rise to continuing accretion on the inner side, resulting in an overall narrowing. The same narrowing would appear to have taken place at the next bend upstream, where the tributary backwater enters the main lagoon. There has been planting along the outer bank at this bend, presumably for erosion protection, as shown on the series of aerial photographs.

The survey shows that the main flow channel along the estuary reach behind the spit is very shallow, with minimum bed levels (at around 0.5 to 1 .O m RL) not much below high tide levels. The lagoon reaches upstream are significantly deeper, with the main lagoon being deepest at the first bend, beside the coastal dunes, at about -1 .O m RL, but remaining relatively deep up to the Orui Bridge.

The partial isolation of the lagoon from the sea is indicated by changes in the water quality parameters, with lower salinity and higher bacteriological counts, compared to other coastal sites. There is also a pronounced seasonal variation in these parameters within the lagoon, with both salinity and bacteriological counts rising over summer and autumn, due to a relative and progressive lack of flushing. Water temperatures in the lagoon, as expected, are also more variable than along the coast, and rise over spring and summer before dropping off in autumn.

The backwater on the tributary has been recently deepened just upstream from the road culvert. However the culvert invert is quite high, at around 0.65 m RL, and the lagoon bed immediately upstream is around this level. The level control of the culvert would have increased the rate of deposition along the backwater, and reduced the flushing effect of flood flows. This culvert, then, significantly alters the dynamics of the backwater, giving rise to a shallower lagoon.

HYDRAULIC MODELLING

A hydraulic model of the lower lagoon/estuary reaches of the Motuwaireka Stream was set up using the HEC-RAS computer programme. The model extended from the Orui Bridge downstream to the sea, and included the tributary backwater to upstream of Camp Anderson. A confluence junction was incorporated into the model, so that the model had both a tributary and main channel arm above the confluence.

There was no hydraulic data available to calibrate the model, and estimates were used for channel and berm resistance, based on previous modelling experience. As the aim of the modelling was to provide qualitative information only, and look at the general implications of alterations, this lack of calibration was not that important.

Flood flow information was also not available, so flood flows were estimated using flood estimation procedures, based on catchment characteristics (area, height etc) and rainfall intensities, and also regionally determined flood generation factors. From this analysis, dominant flood flows (of around a 2 year return period) were determined for the main stream and the backwater tributary. For the purposes of the hydraulic modelling, these dominant flood flows were taken as 5 m^3/s for the tributary, and 50 m^3/s for the main stream, and these flows were applied to each modelling run.

The model was first run for the existing channel conditions, as surveyed, and as extended out to the sea. The effect of a deepening of the backwater was then assessed, by running the model with the channel upstream of the road culvert deepened by about 1 metre.

The channel through the spit at the stream mouth will scour out during flood events, and an enlargement and lowering of the channel from the sea upstream was modelled, using the existing channel with its mouth at the northern end by the area of reefs. A diversion cut directly to the sea, from where the coastal dunes end, was then modelled, with scouring enlargement also taken into account.

Attached as an appendix are output tables and plots from this hydraulic modelling. The set of cross section plots is for the existing, unaltered, channel conditions. The tables and long section profile plots are for the different conditions modelled, including the assumed beach scouring.

This modelling shows that a deepening of the backwater lagoon would have only a minor effect' on flow conditions during flood events. The flow conditions are controlled by the road culvert, and flood levels upstream would be virtually unaltered, with some consequential lowering of flow velocities because of the greater flow area with deepening.

The modelling shows that critical flow conditions would be generated at the stream mouth during floods, as would be expected. Flood levels in the estuary are controlled by these critical flow conditions at the mouth, and floodwaters would spill over the sand spit. Enlargement and lowering of the channel at the mouth affects only a very localised area, with the critical flow control just shifting up the channel, with conditions further upstream remaining largely unaltered.

A diversion cut directly to the sea would not really alter flow conditions in the lagoon, unless the scouring of the spit substantially lowers the channel through to the deeper water of the lagoon bend beside the coastal dunes. This would only happen in especially large flood events, and in general flow velocities along the lagoon would rise only marginally from a direct opening to the sea.

COMMENT

A deepening of the tributary backwater lagoon would alter the conditions of the lagoon by giving rise to deeper water. The accumulated deposits, sludge and rubbish would also be largely removed. This would then reverse an historical trend, generated over the longer term by catchment clearing and more recently by the installation of the road culvert.

The hydraulic conditions along the backwater lagoon during flood events would not, however, be significantly altered. Deposition would continue as in the past, with flushing restricted by the culvert. There is no significant tidal pulsing at the backwater lagoon, as

the downstream estuary channel is relatively high and restricted in size. Thus the greater depth will not be useful in terms of a greater volume of water exchange over the tidal cycle.

A direct opening to the sea, from the lagoonal reach, has been present in the recent past, as evidenced by the 1991 aerial photography. There is a natural movement of the stream mouth along the length of the spit, and the position of the mouth depends on the pattern of flood events and sea wave storms and their juxtaposition in time. Any direct opening would very quickly develop a natural channel with a high bed level across the spit and restricted channel size, and would be subject to a progressive movement northward.

If a direct opening was artificially developed during spring, when there was a fresh or small flood in the stream, then a deep channel would not be maintained across the spit. Even if the artificial cut was taken down to a low level, this would have only a very temporary flushing effect on the lagoon, as a natural accretion would soon restrict any tidal exchange.

A periodic re-establishment of the stream mouth as a direct opening from the lagoon would certainly change the estuary/lagoon dynamic. The mouth would only move slowly northward, and the periodic openings would mean that the mouth was mostly at the southern end. There would be some greater tidal effects on the lagoon, as flood flows would establish a direct connection to the sea at intervals. Perhaps more significant would be the greater exposure of the lagoon to sea waves during storm events. Sea waves would wash into and out of the lagoon, and this would alter the water quality of the lagoon, while enhancing the connectedness of the lagoon reach to the sea.

The generation of tidal exchanges in the main lagoon area would have significance for the backwater lagoon, and make the deepening of this lagoon more effective in terms of water quality.

The study of the aerial photography and the hydraulic modelling, along with the field inspections and discussions, has then provided enough information about the Motuwaireka estuary/lagoon to indicate the general nature of this dynamic system, and some of the likely effects of proposed modifications.

From this information, it is suggested that the deepening of the backwater lagoon would give rise to some beneficial improvements in water quality. This would be due to the removal of accumulated sludge and rubbish, and because there would be deeper water in the lagoon at the normal water levels that are maintained by the estuary/lagoon system. The disturbance of the lagoon bed would though have some temporary effects on-water quality from the released of reduced materials.

There would, however, be no significant change in hydraulic conditions along the lagoon, either at low flows, because there are no significant tidal flow exchanges, and at flood flows, because of the flow control exercised by the road culvert restriction. Over time the lagoon would shallow up again, with preferential re-deposition in the deepened areas. This accumulation would, though, be relatively slow, and the deepening of the backwater by an excavator is not an expensive exercise.

The rate of sediment accumulation in the backwater lagoon could be significantly reduced by the development of a sediment trap area at the upstream end of the lagoon. Material carried down the tributary stream will naturally deposit first and most rapidly in an area of

suddenly reduced flow velocities at the top end of the lagoon. A trap area could be defined by a cut to fill operation involving a low level bund across the lagoon and a well defined flat graded area upstream of it. Access to this area could be maintained for periodic sediment removal by machinery.

Concerning direct openings to the sea from the lagoon reach, it is suggested that these openings would have some direct impacts on the water conditions of the lagoon, mostly through sea wave intrusion. Sea wash during storms would bring sea water directly into the deepest part of the lagoon, at the bend beside the coastal dunes. This sea water would sink under the fresh water of the stream, and tend to accumulate in the bottom of the lagoon.

The opening would very quickly develop a natural form, of a high bed level and small channel size, and any significant tidal exchange within the lagoon would be very temporary. Flood flows would, though, be able to enlarge the opening more easily, and there would be some increase in flow velocities along the lagoon during flood events. This would have some effect in reducing sediment deposition in the lagoon, although the degree of effect, while probably small, is difficult to estimate.

A change in the salinity conditions of the lagoon would affect the lagoon ecology, and the die off of vegetation with the change in conditions would give rise to scums and accumulations of decaying materials. The periodic openings to the sea may generate more saline conditions in the lagoon on a semi-permanent basis, giving rise to a sustainable change in the ecology of the lagoon based on the more saline estuary conditions. However, if the openings are relatively temporary and ineffective, a higher degree of ecological instability may be generated in the lagoon, with consequential greater oscillations in vegetative and aquatic life.

The direct opening would be moved northward by coastal action, and would probably have to be re-established each year, if an opening in this position were to be maintain. The development of a direct opening may also be unsuccessful, with the flow reverting to the pre-existing channel towards the northern end of the beach. The cost of establishing a direct opening may then be more than the excavation of a single artificial cut. If these opening are to be undertaken, then the cut should follow a curve, that fits the natural form of mouth openings, and not be cut straight through the beach.

The nature of the main lagoon has been affected over time by the retarding of natural bend migration through bank protection measures. There is, though, insufficient information to quantify this effect. The road culvert has more clearly affected the nature of the backwater lagoon, increasing the rate of sediment deposition. The timing of this effect and its overall significance is though, once again, difficult to estimate.

March 2001

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APPENDIX

HYDRAULIC MODELLING

Output tables and plots from the HEC-RAS modelling.

- Existing – as surveyed – channel
  Table; Profile plot; & Cross Section plots
- Deepening of the Backwater Lagoon upstream of the road culvert
- Beach Scour added at the mouth
- Diversion of direct opening to the sea from the Lagoon
- Diversion opening with Beach Scour

AERIAL PHOTOGRAPHS

- 1943, 1965, 1975 and 1994

CHANGES IN SHORLINE PROFILES

- 1902 - 1994