# Geomorphic Processes and Coastal Change in the Lagoon System, Lower Waiau River, Southland.

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## EXECUTIVE SUMMARY

1. This report concerns development and change in the landforms of the lower Waiau River and adjacent coastline. The investigation has been carried out in particular light of principles, controlling relationships and physical processes known to affect other South Island, coarse-grained river mouth systems.

2. Changes that have occurred in the post-control period, together with their management implications have been approached by first determining the long term geological evolution of the barrier beach, the lagoon and the adjacent coast. This has provided a clear context against which to assess human-induced changes in the river mouth system for both the period prior to control for hydro-electric power generation and for the post control period. The stance adopted has been that control for power generation has been one of a number of influences on the system. Each influence initiates a sequence of changes that have a distinct time scale ("relaxation time") as well as a variety of expressions in the landscape. Change is ongoing in the system and not readily either preventable or reversible.

3. The modern Waiau coastal system has developed in the last 6000 years. The system may have been depositional immediately after 6000 years BP when sea level reached an elevation near its present value.

4. The present barrier enclosing the mouth of the Waiau River is effectively modern in age. This reflects a continuing process of river sediment supply, reworking through the barrier and loss of sediment to other parts of the coastal system. The internal structure and composition of the barrier have been established.

5. The barrier is built of materials supplied from the Waiau River and has no significant admixture of sediments from any other source (eg: the updrift coast or the sea bed). The barrier is thus particularly sensitive to hydrological and sediment delivery changes in the Waiau River catchment.

6. Net longshore sediment transport appears to occur from east to west, though transport to the east can occur from time to time. Net transport westward is reflected in persistent westerly offsets of the Waiau River mouth and in the historical patterns of erosion and accretion along the coast.

7. The eastern (updrift) shore is predominantly erosional. It is nourished only spasmodically, if at all, by sediments from the Waiau River.

8. The western (downdrift) shore is mildly accretional. It receives sediment from both the Waiau River and the eroding eastern shore by longshore drift.

9. It is possible that tectonic uplift has influenced the system at some time in past several thousands of years. This would have induced scour in the lower river

channel and increased the sediment supply to the coast (both east and west of the mouth), as well as promoting barrier beach growth. Tectonic uplift of uncertain amount and timing may explain the steep gradients and coarse grain sizes found in the lower river (within 2.5 km of the coast).

10. Forest clearance and conversion to pasture have also influenced the river system and its relationships with the coast. Most notably this caused an increase in coarse sediment supply to the lagoon (and ultimately to the coast). Most of this supply originates from bed and bank erosion in the lower Waiau itself and reflects a change in channel adjustment style that began prior to control and which has been accelerated since control. Much of this adjustment will now be complete.

11. In historical time, particularly in the post-control period there has been growth of the barrier beach at the Waiau mouth. The downdrift., western shore has been in mild sediment budget surplus.

12. The most significant post-control hydrological changes affecting the mouth system have been the reduction in the level of minimum flows in the river and a substantial reduction in moderately high energy events associated with discharge peaks greater than the mean flow.

13. Lower minimum flows have contributed to mouth closure. Closure is most probable in the autumn equinox and winter. It is at these times when river flow is low and high energy waves on the adjacent coast have their greatest frequency of incidence.

14. Large floods still pass down the river but there has been a reduction in moderately large flows with discharges greater than the mean flow.

15. In the post-control period excursions, both eastward and westward of the mouth have reduced. Prior to control excursions involved up to 4km of coast. Since control the mouth has been less mobile and has had a dominantly westerly (downdrift) offset.

16. The Waiau River mouth system has been shown to be rather delicately responsive to changes in catchment conditions. It seems probable that coarse sediment supply to the barrier will decline over the coming decades as adjustment to hydrological changes in the catchment is completed. The outlook is for barrier growth to slow or cease and for excursions of the mouth position to again increase.

17. In terms of the "large river-small river" concept shown to be important to the behaviour of many other coarse-grained South Island river mouth systems, it has been shown that the Waiau has derived much of its character as a "small" river unable during formation of the system to maintain itself against coastal erosion. In the historical period, mainly as a result of human change in the

catchment (including but not limited to control for hydro-electric power generation) the Waiau became a "large" river, able to more than maintain its mouth against marine erosion. The outlook is for it to once again become a hydrologically "small river". The time scale of adjustment to the post-control changes is not known with certainty but is in the order of 50 years with most of the changes occurring in the first half of the post-control period, ie: most of the change has already occurred.

18. The burden of these conclusions is threefold. First, that changes introduced by control are overlaid on natural and other human changes occurring in the system. It is incorrect to ascribe all change in the mouth system to post-control hydro-related change. Secondly, the changes induced in the mouth system by control are largely but not completely self-correcting given sufficient "adjustment time". Thirdly, there is no management action that can reasonably be taken that will either prevent the process of adjustment from being completed, or that will reverse the cycle of changes initiated in 1969.

19. It is especially important to note that lagoon and barrier beach behaviour are the outcomes of interaction between coastal processes (mainly wave action) and river processes. The extremes of river flow (both high and low), their durations and their timings relative to coastal storms are the main controls of barrier breaching and mouth excursion. These aspects of behaviour are not well related to mean flow in the river and thus are not likely to be much affected by altering the mean flow.