Engineering options for managing Waituna Lagoon water levels and values

Background

Water levels in the Waituna Lagoon have been artificially managed since 1908.Temporary openings to the sea were historically undertaken to improve fish passage. Over recent decades openings have been used to maintain adequate drainage for agricultural land in the bottom of the catchment. Openings also benefit water quality by flushing nutrient-rich water and sediments out of the lagoon. When open, lagoon water levels fall and become influenced by the tide. This creates extensive mud flat areas, an important habitat for supporting trans-equatorial migratory wading bird species. Diverse plant communities present in the wetland are also dependent on changes in the water table.

Despite the benefits for drainage and water quality, the timing and duration of lagoon opening may impact the health of *Ruppia*, an important aquatic plant for lagoon ecosystem health. Established *Ruppia* plants have a high tolerance to saltwater but successful seed germination requires low salinity conditions in spring. *Ruppia* flowering and seed production is also negatively impacted by low water levels over the summer period, due to a loss of suitable habitat. To ensure a healthy and sustaining *Ruppia* population, the lagoon should be closed over the spring and summer period, regardless of water level.

Lagoon openings are conducted manually by excavating a channel from the lagoon to the sea. Lagoon closure occurs naturally and is dependent on the time of opening, tides and weather conditions. Openings conducted in winter typically close before summer, whereas openings conducted in spring or summer may take much longer to close. Over the years a number of opening locations have been trialled, with the most recent openings occurring at Walker's Bay. Openings are authorised under a resource consent when water levels reach 2.0m, which may occur any time of the year.

The ability to better manage lagoon openings and closings may provide a long term solution which meets the values of lagoon water quality, *Ruppia* health and catchment drainage. This idea is not new, with ideas for a diversion channel to remove excess water first explored as early as 1955. This study evaluates different options for managing lagoon openings, which can be considered alongside other technical studies as part of any decision making process.

Approach

A pre-feasibility engineering scoping study was undertaken to evaluate alternative options to open and close the lagoon while achieving the desired drainage, flushing and salinity levels. Five engineering approaches were considered:

- Mechanical opening of the spit at one or more locations with unaided closure
- Mechanical opening of the spit with some type of aided closure
- A mechanical opening combined with an internal structure
- A structure through the spit, and
- A canal to an adjacent body of water

To provide insight into the feasibility of the various options, the engineering assessment was supported by uncalibrated hydrodynamic modelling and knowledge of the existing *Ruppia* bed locations. Different opening locations (Figure 1) and the likely costs and maintenance requirements of each option were also assessed.

DHI environment SOUTHLAND Te Taiao Tonga DairyNZ

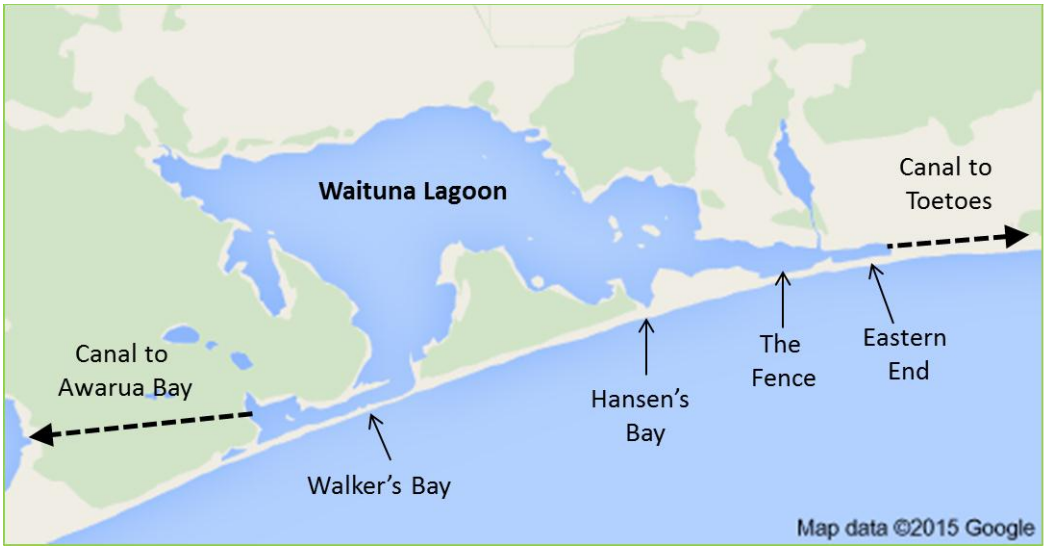


Figure 1: Location of breach sites and potential diversion canals.

Key findings

Mechanical opening with un-aided closure:

1. Walker's Bay and Hansen's Bay are considered the most suitable of the existing locations used, costing between $3000 and $4000 each time (Table 1).
2. The natural mudstone sill at Hansen's Bay helps maintain higher water levels in the lagoon but the risk of further sill erosion is unknown. Breaches at this location are likely to close more quickly than at other sites, due to non-cohesive and highly mobile gravel, and wide section of beach (90m).
3. A western opening for Walker's Bay should be considered due to the predicted lower (15 - 20%) ebb tide flows which may promote earlier closure than other locations. Initial openings may close earlier than required until the existing channel deepens and becomes wider.
4. All opening locations result in insufficient water depth to support optimal *Ruppia* growth conditions in the lagoon over summer.
5. Opening the lagoon at two locations at the same time is not considered viable due to the risk of immediate closure or one location closing before the other.

Mechanical opening with aided closure:

6. The success of undertaking a mechanical closure is uncertain.
7. The practicality of an aided closure using temporary structures such as sand-filled geotextile tubes is uncertain and on-going costs high.

Permanent control structures:

8. This option provides the most flexibility for managing lagoon water level, drainage, flushing and *Ruppia* requirements.
9. An internal dyke with gate structure at Hansen's Bay is the most viable of the structures considered, as the required dyke length at this location is shortest.
10. Potential issues with sedimentation and associated maintenance of the gate and outlet need to be considered.

Diversion canal Toetoes Harbour

11. A diversion canal (width 40 m, length 4km) to Toetoes Harbour (Figure 1) has potential when considered as an option to remove excess water alongside manual openings to achieve flushing.

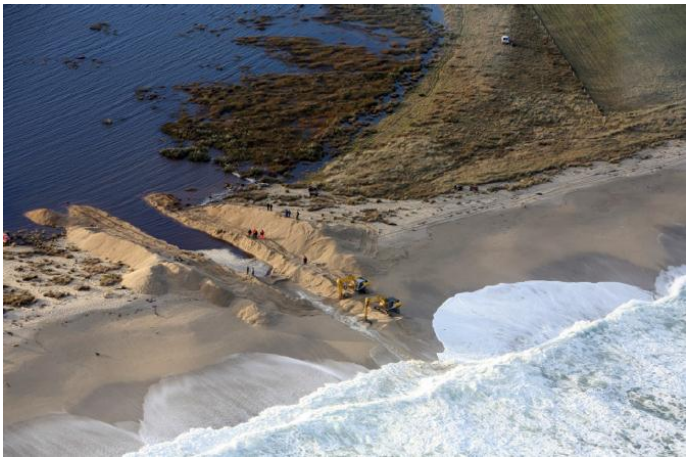
12. The initial cost estimate for this option ($2.1 million) is less than other engineering alternatives and likely land purchase schemes.
13. The impact on the receiving environment (hydrodynamics, water quality, salinity intrusion, ecological and cultural values) and fish migration needs to be assessed further.

Alternative options:

14. A flap culvert to the sea is not considered feasible due to cost, maintenance requirements and the risk of blockage due to sedimentation. A culvert is not sufficient to flush the lagoon with seawater.
15. A diversion canal to Awarua Bay (Figure 1) should not be considered further due to likely impacts on water quality in the bay and the extensive excavation works required through the Awarua Wetland.
16. Further options not considered feasible were a pump and pipe network, rolling opening schedule and two diversion canals together (Awarua Bay and Toetoes Harbour).

Table 1: Estimated capital and maintenance costs for alternative engineering solutions for Waituna Lagoon opening and closing.

Engineering Option	Cost of each event	Capital cost	Maintenance cost (per year)
Mechanical opening with un-aided closure	$1000-$4000		
Two mechanical openings with un-aided closure	$2000-$8000		
Mechanical opening with aided mechanical closure	$12,000		
Mechanical opening with aided closure using a temporary structure		$60,000	$60,000
Internal dike with gate structure		$560,000	$20,000
Culvert through split to littoral zone		$2,300,000	>$25,000
Culvert through split beyond littoral zone		$4,500,000	>$10,000
Canal diversion to Toetoes Harbour		$2,100,000	$25,000
Canal diversion to Awarua Bay		$1,600,000	$25,000



Manual opening at Hansen's Bay (Photo Environment Southland)

This work was undertaken by DHI (New Zealand) and managed by MWH for DairyNZ and Environment Southland. More detailed findings can be found in the final report available on the DairyNZ and Environment Southland websites.

DHI (2015): Waituna Lagoon- Pre-feasability Engineering Scoping for Lagoon Closings/Openings. Report prepared for Environment Southland and DairyNZ.

For further information contact david.burger@dairynz.co.nz or katrina.robertson@es.govt.nz

DHI environment SOUTHLAND Te Taiao Tonga DairyNZ