PROPOSAL FOR

WATER MANAGEMENT SCHEME TO FACILITATE ECOLOGICAL RESTORATION OF THE HAWKSBURY LAGOON

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KUNZEA CONSULTANTS
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Photos courtesy: Brian Monk
Front cover is view north east up the tip arm of the Hawksbury lagoon during period of low water level

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1 PROJECT ASSIGNMENT

The Hawksbury Lagoon has been the subject of a number of management plan initiatives and studies – the most recent being a quite comprehensive ecological assessment (Wildland Consultants, August 2009).

That report provides a vision for restoration effort, objectives for ecological enhancement and proposes a programme of re-vegetation of public land on the lagoon margins, using 11 management zones. The hydrology and the hydrodynamics of the lagoon are not addressed in any detail. The report concludes that before moving forward, it is a priority to settle on what the long-term water management regime for the lagoon will be.

There are a number of options for lagoon water management. The Wildland Consultants Report recommends that hydrological engineering advice should be sought on the design and construction of any such works.

This proposal is, therefore, a response to a request from the Hawksbury Lagoon Society to assist in the development of a Water Management Plan on improving water quality and habitat for indigenous flora and fauna, while working within quite narrow lagoon water level tolerances.

The project will include information on the anticipated ecological responses from the different water management options so the community and stakeholders can make informed choices.

This assignment is underpinned by two strong themes

- *Thorough integration of all available information into a coherent and sustainable multi-purpose plan.* There is a considerable amount of information available about the lagoon that needs to be brought together. The Wildland Consultants Report and the proposed Bird Management Plan will be particularly valuable as complementary resources for this purpose.
- *Working closely with the community to develop the concepts and promote community "ownership" and enthusiasm.* Clearly, this study will be most valuable if it results in a course of action that is acceptable to a high proportion of the community. During the study we therefore specifically allow for time for workshop meetings with the wider community to present scenarios, determine preferred options and the next step forward. That way the community will understand what sort of outcomes they can expect.

Essentially the community will be facilitated in deciding what values the lagoon would be best managed for and, in close consultation with the Department of Conservation (Statutory Managers of the lagoon) and other key stakeholder bodies, how this might best be achieved.

2 BACKGROUND

The general character of the Hawksbury Coastal Lagoon has been well summarized by Dr Barry Robertson (Water quality investigation, Otago Catchment and Regional Water Board Undated).

> *"Hawksbury Lagoon is a shallow, saline coastal lake (surface area 40ha and mean depth 0.4m) lying in the centre of the township of Waikouaiti (Population c 900). It is divided into three separate arms by a system of narrow causeways. The flow between the arms is regulated by a system of floodgates. Surface drainage to the seas is prevented by a sand barrier that is periodically removed to control [limit] the depth. Water is retained in the larger western arms of the lagoon by the flood gate system.*
>
> *"The drainage basin (area approximately 1600 ha) consists largely of rolling hills which discharge into two small streams.... There is a considerable amount of urban development around the lagoon borders. A reticulation system now collects [Waikouaiti] sewage ... and transports it to oxidation ponds [situated approximately1.5 kms to the south and outside the lagoon catchment]*
>
> *"The lagoon supports a wide range of waterfowl (McDonald, 1981) and is designated a Wildlife Management Reserve. The main purpose of the reserve is the conservation of wildlife through habitat improvement."*

Conclusions state that;

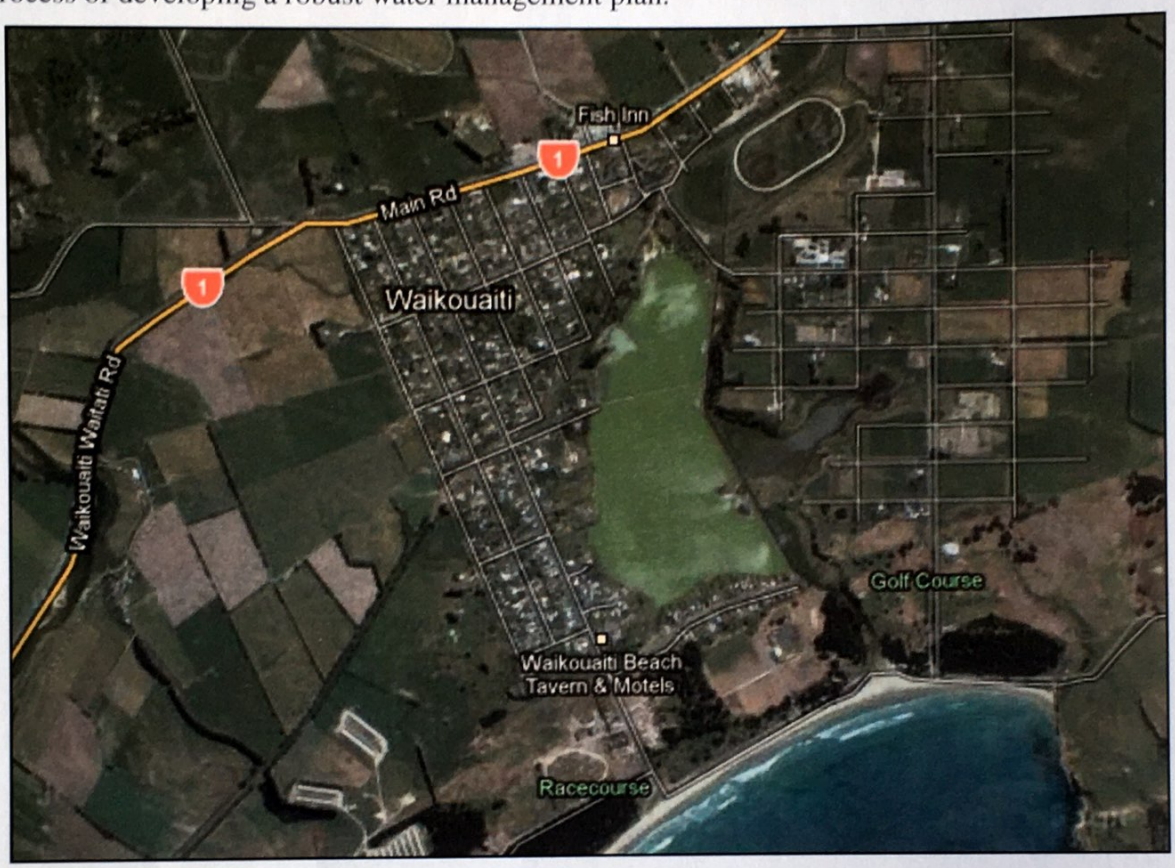
> *"the results of this preliminary water quality survey indicate that the Hawksbury Lagoon was in a eutrophic state (water transparency was low. Macroalgal growth was abundant and dominated by a few species and summer and autumn phosphorus concentrations were high) and that combination of factors were contributing to this state.*
>
> *Nitrogen was the nutrient most likely to have been limiting to algal growth and it was postulated that processes operating within the lagoon contributed to the high lagoon nutrient levels. Rapid nutrient recycling rates were attributed to the presence of large numbers of waterfowl, the shallow nature of the lagoons and the reducing conditions in the bottom-water and sediments"*
>
> *..."Because water quality is dependent on the residence time of water in each of the arms, it is desirable that the flow regime be manipulated to give the highest attainable water quality."*

While this is not a recent report, the degraded condition of the lagoon persists and to some extent is a function of the extent to which it has been modified by human activities, including

- land reclamation of approximately a quarter of the original area,
- causeways that physically compartmentalize the lagoon
- residential development to near the waters edge
- removal of most of the native vegetation in the lagoon catchment
- changes to the landuse that have increased the nutrient and leachate load

- changes in the waterfowl populations

Developing a better understanding of the quantitative significance of such factors is part of the process of developing a robust water management plan.



Hawksbury Lagoon – the lower end of which is located approximately 500m from the ocean

3 CONSULTATION

In preparing for this proposal we have spoken with the following persons and organizations

- Shirley McKewen and some other members of the Hawksbury Lagoon Society for a site visit and existing information available on the lagoon.
- Dr Marc Schallenberg, Zoology Department, Otago University on information the university holds on the environmental history of the lagoon, and on the possibility of incorporating palaeoecological research into the study.
- David Mules, Department of Conservation, on general background to conservation of the lagoon but particularly any cultural interest.
- Pete Ravenscroft, Department of Conservation, on native fish values and options for enhancing habitat
- David Knowles, Otago Regional Council, on Council interests in the lagoon, trigger waterlevels for works and on any engineering work that has been done

- Matt Hickey and Nicola McGrouther, Otago Regional Council, on any hydrological information the Council holds for the lagoon catchment

In addition to the Hawksbury Lagoon Society Inc, and local residents and property owners, stakeholder groups who may also be able to support the process include Kati Huirapa Runaka ki Puketeraki, Department of Conservation, Otago Regional Council, Dunedin City Council, Fish & Game NZ, NZ Ornithological Society, NIWA, University of Otago, and River – Estuary Care Waikouaiti/Karitane.

We will seek to liaise with and involve these organisations in the project as appropriate.

4 OBJECTIVES

The objectives set by the Hawksbury Lagoon Society for this study are:

1. Overall general improvement in the quality of the water within the lagoon
2. Assessment of the external nutrient supply; strategies to manage abundance
3. Assessment of the severity/type of pollutants entering the lagoon; strategies to reduce/exclude pollutants
4. Review of the hydrodynamics of the lagoon, provision of strategies to better manage hydrodynamics with minimal ongoing human intervention
5. Assessment of the level of salinity in different parts of the lagoon; comment on beneficial and detrimental effects
6. Determine optimal water level for improving water quality and bird habitats, as well as meeting the requirements of adjacent residents
7. Provide a range of options to reduce turbidity, deoxygenation, algal blooms, midge population explosions and sediment exposure (odour)
8. Suggest areas of the lagoon where aquatic planting could be beneficial
9. Consideration of strategies which may in the future enable native fish (inanga) to access the lagoon during spawning.
10. Anything else which in our opinion may assist in achieving objective 1

The project proposed will address all of the above objectives with a view to developing an integrated scheme that improves water quality and maximizes ecological opportunity (particularly the bird and fish habitat) within the identified constraints.

5 SCOPE

In an ecological sense, Hawksbury Lagoon appears to encompass the transition zone between estuarine lagoon and freshwater wetland habitats. Yet because of historical changes to ecological drivers such as hydrology, the system is evolving more towards a wetland. The extent to which land use practices and hydrological modifications have accelerated this transition is unclear at present. Nevertheless, any restoration effort must first decide which of the following future directions is preferred for restoration:

1. Facilitating the transition to a wetland;

2. Holding or reversing the trend to sustain an estuary;
3. Some combination of 1 and 2.

This decision will provide the broad framework for the long term water management regime and will need to take into account the new confounding factor which is rising sea level as a result of climate change.

Restoration could involve a number of technical options to alter the predominant water regime which require careful evaluation. Examples include

- altering the flow circulation pattern or rate
- artificially enhancing circulation and aeration
- supplementing inflow from ground or surface water
- modifying the existing causeway system
- deepening or infilling selected parts of the lagoon
- more effective water control or fish passage devices in different parts of the lagoon
- managing the water level and flow regime in different parts of the lagoon
- enhancing the connectivity to the sea during spring tides or for longer periods using installed conduit

Hawksbury Lagoon – view south across the central causeway

The feasibility of adopting such options will need to consider the constraints including:

- capital and maintenance cost
- social and cultural preference
- risk of flooding
- risk algal bloom
- risk of odour or insect nuisance issues with low water levels
- resources of community and capacity to sustain intervention
- existing land tenure and use adjacent to the lagoon and in the catchment

6 APPROACH

6.1 General

Our overall approach to the project may by summarized as follows

1. Investigate the water management and ecological opportunities
2. Identify and superimpose the constraints to fully achieving those opportunities
3. Develop realistic alternative scenarios that the community can consider

Because there is a considerable degree of interdependence between ecological and water management opportunity, to refine the scope of the project, this process will be iterative. ,Our view is that at this early stage, it is very important to consider all the technical options on their merits.

So this project is seen as a **process** of not only identifying technical options, but also as a collaborative journey with the community. The intention is that by its completion there will be a high level of understanding of the issues and options as well as a commitment to any final decisions about the best way to proceed.

While we expect the study will enable wide agreement on the general direction for water management (see Section 5 "Scope" above), its likely that there will be further details to work out in a subsequent stage or stages of scheme development. Recommendations will be made to assist this process.

The report resulting from this study is therefore expected to be a working document that will narrow the options and should be of considerable assistance in any dialogue with the statutory mangers (DOC) on future management of the lagoon.

6.2 Ecology

The first step in ecological restoration is to devise and agree on realistic, yet comprehensive goals involving all the stakeholders. This principle would need to be applied particularly to the Hawksbury Lagoon project because the site has a complex history, some fixed constraints, and the varied stakeholders will have differing visions.

Once goals are described, a means to achieving them and measuring progress towards them, can be developed. In this case, there is a wealth of background information to build upon and we envisage adapting and adding to the work of others in the light of the goals and the opportunities presented by any feasible hydrological modifications in order to develop a practical restoration framework.

Given the level and nature of human modifications to, and interests in the lagoon, there will need to be a level of trade-off between desirable ecological values with other values such as cultural, amenity, landscape and recreation. In this case, it would appear that improving ecological health will automatically improve other values. For example, improving the fish habitat should increase cultural, amenity and landscape values, as well as reducing problems with odour and insects (e.g. midges which recruit from the lake sediments).

Some consideration will also need to be given to the landscape context of any restoration process at Hawksbury, in particular, linkages with other ecological assets and influences of land-use practices.

6.3 Hydrology and water management

An issue that has been identified as a primary factor in determining lagoon water quality is the residence time and turnover of water (Robertson B).

This is a function of the relatively small catchment area to the surface area and volume of the lagoon. The first step in examining the scope for altering the water management of the lagoon and its likely effectiveness is to quantify the water balance for both the catchment and the lagoon.

From what we have been able to ascertain, there is little recorded hydrological data available for this catchment. This will require the use of indirect methods to arrive at water balances. With this information it will be possible to evaluate the scope there is for improving water quality with the natural runoff from the lagoon catchment. This might include improved aeration, changing the causeway arrangement or improving existing water control structures.

Should the scope for improvement with the natural runoff be limited, there is the option to look at enhancing flushing by other methods including taking better advantage of spring tides, providing supplementary water sourced from a local aquifer (groundwater), or from the Waikouaiti River. The latter might be done when flows in the river were above a certain threshold or during floods, for example, and ideally by gravity.

6.4 Water quality

A series of tests will be undertaken during the period of the investigation to provide a more representative understanding of quality flux and provide a reliable baseline from which benefits of the project can be gauged as it is implemented.

The sampling programme will need to be matched to the various sites. For example the range and frequency of determinands deployed in lagoon tributaries will differ from those used in the Lagoon. They will also take into account any tests done to date. Typical environmental indicator species include Total Phosphorus, Total Nitrogen, Nitrite-Nitrate Nitrogen,

Ammoniacal Nitrogen; Dissolved Reactive Phosphorus, Escherichia coli (E.coli), and Suspended Solids. For biological health of freshwater systems, Macroinvertebrate Community Index (MCI) and Dissolved Oxygen are useful. The specific combination of determinands will be finalized after the literature review and detailed information requirements are finalized.

A monitoring programme to continue after the conclusion of this stage will provide a reliable basis on which to refine the project.

7 PROGRAMME AND METHODS

Because of the nature of the project outlined and the need for flexibility, it is not possible to be highly prescriptive about the programme and methods. Broadly, however, the project will include the following elements

7.1 Ecology and restoration criteria

- Determine the environmental history and current ecological status focusing on understanding the dynamics of the system; particularly the interplay between water quality/flow regimes and terrestrial/aquatic habitat type/quality verse invertebrate/bird/fish diversity and abundance.
- Review ecological restoration proposed to date (including the Wildland Consultants 2009 report) and ensure integration and development of these proposals into the overall scheme.
- Confirm requirements of waterfowl and fish for inclusion in concept development and design criteria.
- Assess relative importance of existing drains connecting to the lagoon in sustaining the biodiversity
- Evaluating the benefits of constructed spawning areas for indigenous fish
- Assess feasible restoration goals and likely ecological effects with given hydrology management options.
- Facilitate progressive stakeholder discussions to devise and select restoration goals with wide enough community support to be feasible management objectives. We anticipate holding 2 public meetings in Waikouaiti to update the community on progress and seek feedback.

7.2 Hydrology and water engineering

- Assess surface water hydrology to generally characterise catchment runoff and seasonal distribution from which to derive the water balance
- Analysis of the hydrology and the runoff profile as a basis for proposing a more workable and simplified water level control systems that will handle floods, but at the same time keep the lagoon within the optimum range.
- General assessment of the groundwater hydrology and surface drainage system for potential as supplementary water source and as potential conduit for contaminant

- Consideration of any possible engineering means to enhance connectivity between the estuary and the sea at crucial times
- Scheme concept development, including engineering options and indicative costing thereof
- Preliminary field investigations for feasibility for any proposed engineering works
- Level survey to confirm technical feasibility of water management options
- Drawings with key dimensions for proposed engineering works including any protection and fish passage requirements.
- Reporting on management options considered and preference

7.3 Water quality

- Water quality analysis to confirm the distribution of salinity as well as both the general nature and concentration of contaminants.
- Identification of potential sources of contaminants (be they diffuse or point source) and their relative contribution to any impacts will guide priority action planning
- Development of a monitoring programme to continue after the completion of the assessment.
- Analyse results in time and space to determine sources and trends of constituents and for comparison with water quality from adjacent catchments

The emphasis will be on providing sufficient detail that individual projects can be identified, prioritized and implemented.

7.4 Lagoon historical environment

Palaeo-ecology is defined as the study of fossil organisms and their associated remains, including their life cycle, living interactions, natural environment, and manner of death and burial to reconstruct the historical environment. Paleoecology uses data from fossils and subfossils to reconstruct the past state(s) of aquatic ecosystems.

It can therefore provide a record of the recent trends in biological activity and physical process (eg rate of sedimentation) that have occurred within the lagoon sediments. This can be used, for example, to predict when the lagoon would become a wetland with no intervention. It can also provide clues to the effects of historical changes to catchment landuse on sediment rates and quality including changes to the biology of the estuary floor and relative saline and freshwater influences.

Otago University (Dr M Schallenberg, Limnologist) has expressed an interest in coordinating such a study with this proposal.

We are enthusiastic about the inclusion of such an investigation because of the greater understanding it would provide concerning the recent nature and rates of change that the lagoon has undergone such as the interactions between nutrient/salinity status and hydrology and aquatic

life abundance and diversity. One of the benefits of, this information would be to assist in developing management strategies for controlling nuisance algal growth.

This would provide increased confidence in the ecological response to any proposed change in the water management regime. However the cost of this project is estimated to be a minimum of $10,000 so has not been included in this preliminary stage of the project.

Recommendations regarding the value of including such an investigation in a future stage will be provided at the completion of this study. .

8 COST AND TIMELINE

Below is the cost estimate for the scope of work outlined above for a one year project.

Table 1: Cost of project

General Item	Item Cost ($NZ)	Subject Cost
Review historical ecological studies and assess current status	3,200	
Devise feasible range of restoration goals given hydrological management options	800	
Facilitate progressive stakeholder discussions to attempt to select & adopt community supported restoration goals.	2,800	
Reporting: Summarize process, present a framework for achieving goals including restoration objectives plus monitoring & adaptive management protocols.	2,850	
Ecology Subtotal		9,650
Field investigations and hydrological assessments	4,850	
Engineering plan development and reporting	3,500	
Survey and drafting	2,000	
Water quality analysis	1,500	
Hydrology Subtotal		11,850
Report printing and contingency allowance	1,350	1,350
Total (excluding GST)		**$22,850**

We expect the process of completing this scope of work (that is investigation, working with the community and preparing final recommendations) to take approximately 9 months from the time the work is commissioned.

An indicative timetable for the work programme is contained in the following table.

Table 2 Indicative timetable for work programme

Work Item	Working month								
	1	2	3	4	5	6	7	8	9
Ecology									
Determine the environmental history and assess current status									
Restoration goals from hydrological options									
Hydrology									
Field investigations and hydrology									
Engineering options development									
Surveying									
Water quality tests									
Stakeholder discussions									
Stakeholder discussions for community restoration goals									
Reporting									
Report and recommendations									

9 PROJECT TEAM EXPERTISE AND EXPERIENCE

9.1 Dugald MacTavish (BScAg, Dip Groundwater, MSc Irrig and Drainage) Irricon Consulting

Dugald has thirty five years of experience in water resources engineering both overseas (approximately ten years) and in New Zealand. Irricon Consulting was formed as a partnership in 1991. Initially, a large part of the company's activity was undertaking ground and surface water resource investigations for regional councils. Some of this work involved developing groundwater models.

Other work experience on larger projects in NZ includes Waiareka Kakanui Irrigation and Water Resources Study (1993), the North Otago Groundwater Investigation (1994, both undertaken for local government), the Gravity Irrigation Scoping Study (2002), and an Irrigation Assimilation Study (2003). In several of these studies, he acted as team leader of interdisciplinary consulting teams involving different companies.

More recently an increasing amount of work has concerned river protection, plan development, legal aspects of the RMA and resource consents, groundwater quality monitoring including landfill impact monitoring and reporting.

Dugald will act as the team leader on this project and take responsibility for deliverables.

9.2 Dr Robin Mitchell (BSc (Hon), PhD Restoration Ecology) Kunzea Consultants Ltd.

Robin has fifteen years NZ and international experience in environmental assessment, research and teaching. This experience has incorporated all elements of the project cycle including: design, fundraising, implementation, analysis and reporting. The projects have been developed in a variety of cultural and stakeholder contexts such as central & local government bodies, universities, not-for-profit groups, corporations and private landowners.

This breadth of experience is complemented by adeptness at communicating with diverse interest groups through writing, speaking and facilitating. Robin's professional focus is sustainable environmental management with an emphasis on ecological restoration; the subject of his PhD. Robin is a highly motivated and conscientious person who practices a friendly, collaborative and interdisciplinary approach to work

Recent wetland projects Robin has been involved in include assessment of wetland type, condition and significance for the Otago and Southland Regional councils, as well as the Environment Court. Robin has also advised many landowners on wetland restoration options and methods through work with Environment Southland and the NZ Landcare Trust. A current project is devising a multi-landowner riparian restoration vision and plan for the Waikawa catchment, Southland.

Robin will provide the ecological input to the Water Management Plan development