CHRISTCHURCH CITY COUNCIL

FEASIBILITY STUDY
FOR A PROPOSED FLAT WATER
RACING FACILITY AT
BOTTLE LAKE FOREST

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by

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1.0 INTRODUCTION

This document reports on the feasibility of establishing a flat water sport - rowing, canoeing, dragon boating, outrigger canoe, junior sailing - facility in Bottle Lake Forest Park. The facility would be an alternative site for the international competition standard flat water facility initially proposed close to Christchurch International Airport. The report is in the form of an extended executive summary representing a broad brush, first pass, look at the option, in advance of a preliminary design for the facility. While the report is essentially concerned with technical issues the economic aspects have not been ignored. The accent has been on identifying straightforward low cost solutions to the technical problems associated with developing a flat water sports facility within the plantation which leads on to an identification of the advantages of the site. The size of the proposed facility is 2500 m long by 500 m wide by 4 m minimum depth.

2.0 LOCATION

Bottle Lake Forest is located on the north east edge of the city bounded by the Pegasus Bay coastline to the east, farmland to the west and housing to the south and south west, Waimairi and Parklands. To the north is the Brooklands Lagoon and the Brooklands settlement. The Burwood landfill is contained within the south east corner of the forest.

The forest is owned by the Christchurch City Council (CCC) and is run as a commercial forestry operation the pinus radiata trees being grown and harvested on a plot rotation basis. The forest - apart from those areas/plots being harvested at any time - is available for leisure activities; mountain bike, running, walking and horse riding tracks have been provided by the CCC through the area.

While the forest is large in area fitting a lake of the required plan dimensions - 2.5 km x .5 km - within it, while maintaining the principal axis of the lake in alignment with the direction of the prevailing wind, effectively cuts the plantation area in two. If the longitudinal axis of the lake is set in line with the prevailing wind direction at the airport then the axis is at an angle to the coast and a better fit within the area. If the wind direction at the beach is closer to normal to the coastline - yet to be precisely established but more in line with local opinion - then the lake will be a tight fit within the plantation and it may be necessary to acquire some of the farmland west of the plantation. Either way the beach end of the facility will be close to the beach but in behind the coastal dunes.

3.0 KEY REQUISITES FOR THE SITE TO BE AN ECONOMIC OPTION

In order for the site to be an economic proposition a number of key points need to be satisfied:

- The ground must either be relatively impervious or self sealing or, alternatively, the natural ground water level must be high, this to retain the water in the lake.
- The site needs to be close to flat to minimise the volume of excavation required.

- The soil to be excavated should be easy to excavate and easy to dispose of, preferably of some commercial value so that it can be sold to recoup part of the expenditure.

- There must be a ready source of fresh water capable of filling the lake and maintaining a low flow through.

The extent to which the Bottle Lake Forest site satisfies these conditions will be considered in the following sections.

4.0 HYDROGEOLOGY OF THE SITE

The principal hydrogeological components of the site are:

- An unconfined surface layer aquifer, the Holocene Christchurch Formation, which consists of fixed and semi-fixed fine to medium grained sands with a variable silt and shell content extending to approximately 35 m depth.

- This layer is underlain by a confining layer or aquitard comprised of clay, silts and peat with a minimum thickness of 2 m.

- Underneath this layer there is a confined aquifer, the Riccarton Aquifer, the uppermost confined aquifer in the Burwood area.

The surface layer extends approximately 2.5 kms inland where it merges with the peat swamp deposits of the Springston Formation. Within the sands of the Christchurch Formation the water level is relatively high and seasonally stable, as shown by the water level recordings taken in boreholes around the landfill site. The natural ground water level is approximately 2 m above mean sea level (MSL), the seasonal variation is of the order of .4 to .7 m. Within the Bottle Lake Forest area the measured groundwater levels range between .1 and 4.9 m below the local ground level. There are two existing small ponds within the plantation used as water reservoirs for fire fighting.

The movement of the water within the Christchurch and the underlying formations is towards the coast in line with the gentle hydraulic gradient across the site. The interface between the fresh groundwater and the seawater starts under the sand dunes, on top of the aquitard or confining layer, coming up to the surface on the beach.

The confining layer creates artesian pressure within the Riccarton Aquifer. A borehole through the aquitard to the Riccarton Aquifer will discharge water under pressure at the surface and existing boreholes are used to fill water tankers within the forest. The natural artesian pressure allows the tankers to be filled without the need to use pumps. The capacity of the Riccarton Aquifer is thought to be more than sufficient to supply water for the proposed lake without resulting in deleterious seawater intrusion into the aquifer. This will need to be the subject of further study to confirm the ability of the aquifer to supply water for the lake, both for the initial fill or groundwater top up, and to maintain a flow through the lake.

5.0 IMPLICATIONS FOR THE ESTABLISHMENT OF THE LAKE

The hydrogeology of the site is favourable for the establishment of the lake. If the lake is excavated to the minimum depth requirement - 4 m - below the minimum natural groundwater level the lake can be expected to remain full without any need to seal the sides and bottom of the lake. The lake can be filled and topped up from a borehole sunk down through the aquitard to the Riccarton Aquifer.

A relatively low hydraulic gradient exists across the site towards the sea, flow within the surface layer, and the Riccarton Aquifer, is towards the sea. As a consequence any leachate from the landfill will move in a direct line towards the sea, there is no potential for contamination of the proposed lake.

To ensure a small flow through the lake a small diameter pipeline can be provided to discharge kale water to the sea.

6.0 CONSTRUCTION ISSUES

Excavation of the lake is, at first sight, complicated by the high groundwater level, or at least it would be if conventional land based trucks and excavators were used. Advantage can be taken of the high water table however to float dredging plant once the trees have been cut and removed. Excavating while floating avoids inevitable dewatering and piping problems associated with trying to excavate in the dry in an area with a high natural water table level. A cutter suction dredge, or dredges, can be used to dredge the sand and pump it to the disposal or accumulation areas. These can be of the order of hundreds of metres away if pipelines and booster pumps are used to transport the sand slurry. It would be possible to pump all the sand excavated by the dredge directly to the beach.

The use of a suction dredge and the easily dredged nature of the sand sediment allows the possibility of low excavation and disposal costs.

The easily dredgeable and erodible nature of the sediment presents problems for the maintenance of the lake banks when subject to wave attack from waves caused either by wind or vessel wakes. Geotextile containers, tubes or bags filled with excavated sand, can be used to contain the sand to form the sides of the lake. This is the cheapest form of retaining system for the lake shoreline and the bags can be shaped to have a sloping face so that waves incident on them are forced to break and completely dissipate their energy. Reflected waves or claptois are unacceptable in a flat water competition area.

7.0 COASTAL HAZARD

The seaward end of the lake will be 200 metres from the beach at its closest point and behind the back of the coastal sand dunes. The Pegasus Bay shoreline south of the Waimakariri River is stable and is prograding at the rate of .5 m per year. This is expected to continue, although at a reduced rate, concurrent with the predicted sea level rise. While the beach is stable and slowly prograding there are large storm induced variations in the beach morphology and volume. Sand is taken off the beach and moved offshore into sand bar systems in storm events. It is slowly returned back on shore in calmer swell conditions. The sand dunes provide an essential buffer against storm wave erosion of the beach and must be retained. The lake must be behind the dunes clear of the beach dynamic zone. The proposed preliminary layout allows for this.

The proximity of a large volume of water maintained at a constant level close to the back of the beach raises the possibility that the groundwater level will be elevated on the beach which will in turn lead to increased erosion in storm events. High groundwater levels on beaches make it hard for the sand to stay on the beach and accelerate erosion under storm wave attack. To guard against elevated groundwater levels on the beach sheet piling can be used at the seaward end of the lake to seal the lake off and force the groundwater stream flow lines deeper.

8.0 DISPOSAL OF THE EXCAVATED SAND

The excavation or dredging of the lake will produce a huge volume of sand, of the order of up to 7 million cubic metres. The use of hydraulic dredging techniques allows this material to be delivered by pipeline to disposal or accumulation sites well away from the lake. The sand could be pumped into the sea, into the littoral or alongshore drift system, so that it would be distributed south along the Christchurch beaches, ultimately improving the coastal defences for Christchurch. This would be a massive slug of sand equivalent to more than 40 years natural supply from the Waimakariri River to the beaches south of the river. Rather than being pumped out into the nearshore zone the sand could be used to build up the sand dune system directly where the sand volumes were low or non existent. The sand is a coastal defence resource.

It is also an economic resource being in demand for use as a construction material. Again the volume excavated equates to many years demand but it could be sold to help offset the costs of the excavation.

A part of the volume could also be dispersed within the forest to build up the ground levels and make the area more interesting and varied as a recreational area, an enhancement of the existing facility.

The best approach to disposing of the excavated sand is likely to be a combination of all three alternative options. A feature of this site however is that all three disposal methods offer some form of benefit.

9.0 CONCLUSION

This broad brush review of the key features of the Bottle Lake Forest site indicates that the construction of the proposed flat water facility is fully feasible. The key points are that the sand material can be readily excavated and disposed of, despite the large volumes involved, the hydrogeology is favourable and the coastal hazard is low. In addition construction issues associated with excavating and retaining sand in an area with a high natural groundwater level - a direct consequence of the favourable hydrogeology - can be dealt with effectively and economically. There is no risk from the adjacent land fill site.

In comparison with the site originally proposed close to the airport the Bottle Lake Forest site is closer to the city, close to other major sports facilities at Queen Elizabeth Park and is not complicated by bird strike issues. It would appear to warrant more detailed engineering investigation to develop detailed costings.