Freshwater Lake - Future Options Consultation

Technical Report by CCS Water Proofing the West Team considering Option 2A

This CCS Water Proofing the West report provides potential technical solutions consistent with the general principles within Option 2A:

- **Option 2A – Off-line treatment** - a system where water is circulated out of the lake into a bioretention system and treated using filter media, plants and other biological processes external to the lake water body and re-circulated back into the lake.

Disclaimer:
Given the preliminary nature of the assessment undertaken to date, the options presented are subject to further feasibility, site investigations and detailed design.

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REPORT – Freshwater Lake Option 2A Analysis

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Introduction

Strategic Context

The purpose of this report is to provide an additional offline bioretention filtration option for **Freshwater Lake on Delfin Island (FwL)**, taking into account community expectations to improve the Freshwater Lake ecosystem, capital cost implications, and ongoing operational and maintenance requirements (including environmental factors).

Council wishes to understand the **viability of options for the Freshwater Lake asset**, including a full lifecycle plan to support this valuable community asset.

Strategic Objective

The premise of this initiative is there will be opportunity to improve value for the community through:

- Most cost-effective delivery.
- Continued **reduction of impact on the environment**, eg water reuse and species protection.
- Increased **'liveability' in the Council area** through making open spaces 'green spaces' and 'blue spaces' which create and enable community access.
- Ensuring minimal disruption of the community enjoyment of the 'blue space' lake through operational and maintenance activities.

Community Expectations

CCS's Your Say engagement identified that reducing the Lake's size was unacceptable. Stage One community feedback identified the following four themes:

1. Plan for the future
2. Improve water quality
3. Enhance biodiversity
4. Activate the place

These themes are explored in the options to remediate FwL.

Background

FwL was constructed in the 1970s as part of the Delfin Island development. CCS engaged the University of South Australia (UniSA) to review FwL's performance in 2001. In 2001, UniSA reported that 12% of the 340 ML/annum of groundwater extracted was allocated to irrigation with the remainder flowing through Freshwater Lake (FwL) and discharged to West Lakes (via seepage or overflow) or evaporate. In 2003, CCS expressed a desire to meet ISO 14001 Environmental Management System accreditation standards (UniSA, 2003). AGT completed a hydrogeological study that determined that the 340 ML/a extraction rate from T1 aquifer well 6528-511 was sustainable. Seepage rates were reduced from 2003 by relining the lakes.

Groundwater flows were reduced in response to the Millennium Drought (2008-09). Groundwater flows were 21.2 ML/a in 2019 to offset FwL evaporation and seepage[1]. In September 2020, this became the native groundwater entitlement licensed under the new Adelaide Plains Water Allocation Plan (DEW/GA, 2021). A WGA report (WGA, Jun 2022) presented evaporation and seepage of 18 ML/annum and 28.5 ML/annum respectively.

Water quality issues facing FwL in 2001-2003 (UniSA, 2003) include

- Total coliforms between 900-2,700 cfu/100 mL above ANZECC Guidelines for secondary contact
- Low dissolved oxygen levels of 6 mg/L
- Total nitrogen and phosphorous concentrations exceeding guideline values for fresh water ecosystems and recreational use
- Groundwater (and FwL) salinity was 1300-1600 mg/L as total dissolved solids, but FwL salinity spikes to 3000 mg/L at the end of summer (UniSA, 2003, p. Figure 4).

Current Water Balance

Several efforts have been made to estimate the current water balance. The annual water balance in and out of the lakes is estimated in Table 1.

Table 1: Current annual water balance

In	Range	Average	Out	Range	Average
Rainfall in wet months	2-15ML	7ML[2]	Evaporation	15-25ML	18ML[2]
Groundwater	20-40ML	33ML[3]	Seepage[4]	15-70ML	22ML[5]
			Overflow	0-5ML	0ML
Total		40ML			40ML

An additional 6 ML/a is required for green space around the lake and 34 ML/a for green space around Corcoran Reserve (CCS data).

[1] CCS licence application CM 20/145415; DEW Ref: 363148-128389

[2] (WGA, Jun 2022) Table 7/UniSA

[3] CCS estimate from 2021 November-March groundwater usage data; beyond the licensed volume of 21.2 ML/a

[4] Seepage was reduced in 2003-2006 (Figure 2 - Figure 3)

[5] A large range has been reported. 22 ML/a is the balancing figure from 2021 groundwater inflow data, assuming <2 ML/a overflow in the period.

Options Identified

Options identified in a WGA Report (WGA, Jun 2022) include:

- Option 1: De-sludge the lake and retain the lakes current operational model.
- Option 2A: De-sludge the lake, line the lake and install a system for water moved from the lake into a bioretention system and treated using filter media, plants and other biological processes and then returned to the lake.
- Option 2B: De-sludge the lake, line the lake and install a system where water is treated in the lake using plants and other biological processes in a wetland system within the lake area.

This report details an additional solution for 'Option 2A' where existing bioremediation wetlands are utilised instead of the Ocean Protect Filterra treatment (WGA, Jun 2022). This solution is described below.

Option 2A – Integrate Freshwater Lake with Waterproofing the West

Option 2A (Integrate Freshwater Lake with Waterproofing the West) honours Freshwater Lake's original design principles while remediating issues facing the lake and upgrading its environmental performance to meet contemporary standards. This option meets contemporary standards by integrating FwL with the Waterproofing the West (**WPW**), a non-potable residential and irrigation water project constructed in 2014. This project that responded to the Millennium Drought with Local and Federal funding, uses managed aquifer recharge (**MAR**) technology to capture and store water in the aquifer during winter for use in summer. Recovered fit-for-purpose water is used for irrigation of green spaces and third/lilac pipe supplies to residences to relieve pressure on the River Murray.

Option 2A - Integrate Freshwater Lake with Waterproofing the West sends water overflowing from FwL to a WPW bioremediation plant at West Lakes Golf Course/Cooke Reserve. Demand for water from WPW is increasing each year and the overflowing groundwater will enable the scheme to irrigate more green spaces.

This solution requires no intrusive de-sludging or construction works within or around FwL itself as the Cooke Reserve / West Lakes Golf Course (**WLGC**) biofiltration system is already established. The FwL water quality will rapidly improve with additional groundwater inflows. The rate of sediment trapping and bioremediation in the wetlands will be monitored once flushing of the lake begins.

Stormwater wetlands naturally accumulate organic sediment but still produce clean water (Ormsby, Jun 2022, p. 22). If sludge removal from the bottom of the lake becomes necessary once water quality improves, agitation of sludge and flushing to the wetlands rather than dredging is the preferred option. Presently, carp agitate the sludge and are periodically removed. The frequency of carp removal can be modified to manage sludge mobilisation. If areas of concentrated sludge require removal, targeted jet-vacuuming is available.

In contrast to using Ocean Protect Filterra / floating wetland / reed bed wetland system, Option 2A - Integrating Freshwater Lake with Waterproofing the West requires no ongoing maintenance activities in or around the lake. This optimises uninterrupted community enjoyment of the lake.

The flow of water though Corcoran Reserve enables revitalisation of the blue space within Corcoran Reserve in line with the original 1970's design concept.

Technical Detail

Option 2A – Integrate Freshwater Lake with Waterproofing the West: Legacy low quality water to be flushed to existing bioremediation wetlands to enable water quality in FwL to meet or exceed expectations without disruption faster than any other option.

The general water process flow is as follows:

1. Water is drawn from the aquifer at Corcoran bore and piped into 'Lake 1' and 'Lake 3' at the points in yellow highlighted in Figure 5.[6]
2. Water flows through the lakes and exits through the overflow channel.
3. Overflow water enters and flows through the existing Corcoran Reserve settling ponds (Figure 1).
4. Water is then pumped from the Corcoran Reserve settling ponds to the bioremediation wetlands in WLGC and Cooke Reserve where it is treated and pumped into the aquifer for re-use.

[6] Lake numbers are defined in Figure 4. Note that lake numbering differs between reports (WGA, Jun 2022) (Ormsby, Jun 2022). CCS numbering is consistent with WGA.

Figure 1: Movement of water (Source: GoogleEarth, 2022)

Infrastructure modifications include:

- Installation of a pump station at the last basin on Corcoran reserve to transfer the water to WLGC and Cooke Reserve MAR bioremediation wetlands.
    - Original 1970s groundwater inflow was 340 ML/a (UniSA, 2003). WGA reported the original design requiring 88-174 ML/a. The lower rate requires a pump station capable of averaging 6 L/s[7].
    - It may be viable to operate the electric submersible pump during daylight hours at 12 L/s if built in conjunction with solar panels.
- Construction of a 125mm diameter x 1,600m long pipe from Corcoran Reserve to the WLGC & Cooke Reserve MAR bioremediation wetlands. This would traverse the footbridge connecting Corcoran Reserve to Lochside Drive, then run east along Lochside Drive and north along Frederick Road as per the purple line in Figure 1 terminating in the Cooke reserve valve chamber.
    - There is potential that WLGC may also allow the pipe to cross their golf course or become an open channel for WLGC amenity.

Re-establishing a greater supply of water from the original well (6528-511) is the most cost effective and abundant water available. A more costly option is to formally link supply to the Waterproofing the West MAR scheme, however, this would lower FwL's salinity.

Option 2A captures and treats all water aside from evaporation and seepage. The lining of Freshwater Lake as outlined by WGA would reduce the seepage losses.

Presently, water from the lake naturally infiltrates into the water table around the lake edges which flows beneath the southern half of Delfin Island to West Lakes. This process has been constant since the 1970s and the local environment (soil stability and deep-rooted vegetation) is in equilibrium with this natural flow of water. Option 2A proposes to leave this process unchanged, retaining amenity and removing any unforeseen risk associated with changes in soil moisture content and major capital works associated with lining the lake. It also retains the capability to mechanically remove sediment if required without damaging a liner.

Flushing volume

The original proposed groundwater inflow rate was ~180 ML/a and following the Millennium Drought, inflow rates were reduced; approximating ~33 ML/a in 2019 (Table 1). These lower circulation rates have reduced water quality. Boron, nutrients, pathogen and suspended solid levels are key water quality indicators. Ammonia is also used as an indicator of FwL health (LWC, 2018).

The speed with which water quality can be improved will be a function of the WPW wetland's capacity. Once a water quality monitoring program is developed, an adaptive management approach will be used to optimise the flushing rate. The rate of flushing will also be modified seasonally until satisfactory water quality levels are obtained.

[7] The yield of well 6528-511 was 14 L/s when drilled in 1974.

Once satisfactory water quality levels are obtained, the proposed annual water balance is shown in Table 2.

Table 2: Proposed annual water balance

In	Range	Average	Out	Range	Average
Rainfall in wet months	2-15ML	7ML[8]	Evaporation	15-25ML	18ML[7]
Groundwater	30-180ML	140ML[9]	Seepage	15-70ML	22ML[10]
			Overflow	30-340ML	107ML
Total		147ML			147ML

Regulatory options to access FwL flushing water

There are two regulatory options to access water under the new legislation (WAP):

1. Restore the native groundwater licence entitlement. The WAP reports Unallocated Entitlement Shares of 2,599 ML in the native groundwater T1 Regional Consumptive Pool which will be available from 2022 (DEW/GA, 2021, p. 54). Overflow water from FwL would report to the Waterproofing the West scheme for reuse. This is the preferred option to generate the require FwL flushing water flow.
2. Include extraction well 6528-511 under the MAR Consumptive Pool and manage the well within Waterproofing the West. This would require minor updates to the MAR Risk Management and Monitoring Plan and additional injection capacity.

A water quality monitoring framework will be developed with DEW/EPA to govern the rate at which FwL water can be flushed into Waterproofing the West.

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[8] (WGA, Jun 2022) / UniSA– Table 7

[9] From original 180 ML/a design minus 40 ML/a seepage reduction achieved in 2005 lining from Table 7 of (WGA, Jun 2022)

[10] A large range has been reported. 22 ML/a is the balancing figure from 2021 groundwater inflow data, assuming <2 ML/a overflow in the period.

Option 2A – Integrate Freshwater Lake with Waterproofing the West - Capital Budget

In-line with other reports, the following tables provide an Opinion of Probable Cost (OPC).

Table 3: Capital cost

Item	Amount (ex. GST)
1,600 m of 125 mm pipework w/valves[11]	$432,000*
2 x 20 L/sec pumps[12]	$60,000
Cabinets, telemetry and electricals (VSDs)	$100,000
Remediation of well 6528-511 (WGA recommendation)	$150,000
Corcoran Reserve settling ponds reinstatement	$68,000
Sub Total	**$810,000**
Contingency (30%)	$243,000
Total	**$1,053,000**

* The pipework cost assumes directional boring of pipework following the road network, however if WLGC agree to allow CCS access to trench and directionally bore pipework around the perimeter of the WLGC then this cost may be reduced significantly.

Operating costs are referenced to costs in other reports rather than first principles (WGA, Jun 2022).

Table 4: Operating cost

Item	Amount (ex. GST)
Landscape – aquatic	$12,000
Water supply – FwL top-up	$20,000
Electricity, including new pumps*	$16,000
FwL + Corcoran Reserve settling ponds maintenance	$13,000
Subtotal - Waterbody management	**$61,000**
Landscaping - terrestrial ponds	$56,000
Water supply – irrigation	$2,000
Electricity	$11,000
Subtotal – Terrestrial (open space) management	**$69,000**
Subtotal	**$130,000**
Contingency (30%)	$39,000
Total	**$169,000**

[11] SADB pers. comm. 17/6/2022 Michael De Vizio Business Development – Director - 125mm diameter pipe budget $250 to $270/m including valve work. The cost for the 1,600m assumes

[12] 2 x 20L/sec pumps are recommended for redundancy and to allow maintenance work to be completed without interrupting the system.

*Electricity costs for pumping can be eliminated through investment in solar infrastructure.

Further improvements could include:

- Increasing the water treatment capacity of the WLGC/Cooke Reserve wetlands and constructing an additional injection well to store additional water if 6528-511 is to be formally included in the managed aquifer recharge scheme ($500,000).
    - Renewing the wetlands to enhance their water treatment function.
    - Honouring design assumptions of Waterproofing the West (matching extraction and injection volumes).
    - Increasing CCS's capacity to provide alternative water for irrigation and residential use.
- Modifying weirs and adding pipework to create a single FwL entry and exit. Two pumps and recirculating pipework are recommended before any works to remove sediment are contemplated (Ormsby, Jun 2022) (WGA, Jun 2022).
- Blending groundwater with low salinity WPW water ($50,000 + opex).
- Solar panels and a mounting structure in Corcoran Reserve to supply power to pumps to reduce operating cost and carbon footprint ($60,000).
- Conducting an impact study and geosynthetic clay lining the lake ($1,050,000). However, if the lake remains with its existing liner and the natural seepage flow is retained, reducing the 15-70 ML/a seepage may not be the best solution. If 22 ML/a of seepage equates to a groundwater supply cost of $22,000/a, it is not economic to spend $1,050,000 to save $22,000 per annum considering the impact of future leakage. Originally, seepage was designed to promote a higher and fresher water table to aid plant growth surrounding FwL.
- Reimagining FwL as a MAR scheme: drilling shallow extraction wells around the lake to monitor and recycle seepage ($250,000).
- Removal of the three aerators and reactive anti-algal treatment (saving $3,000/a).

Conclusion

Option 2A – Integration with Waterproofing the West responds to the Community Themes in the following ways:

1. **Plan for the future**: Integrates FwL with the expanding WPW scheme and releases surplus funds for other community projects.
2. **Improve water quality**: Integrating with WPW allows complete flexibility in flushing volumes independent on the seasonal irrigation demand of Corcoran Reserve to achieve desired outcomes.
3. **Enhance biodiversity**: Stabilises water quality to sustain species habitat.
4. **Activate the place**: Stable water quality enables planned horticultural landscaping of a valued blue and green space without reducing the view or interrupting the continued enjoyment of FwL through construction works.

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WGA. (Jun 2022). *Freshwater Lake options assessment.* Adelaide: City of Charles Sturt.

Appendix

Figure 2: 2002

Figure 3: 2006/07

Figure 4: Lake dimensions 11 Nov 2017

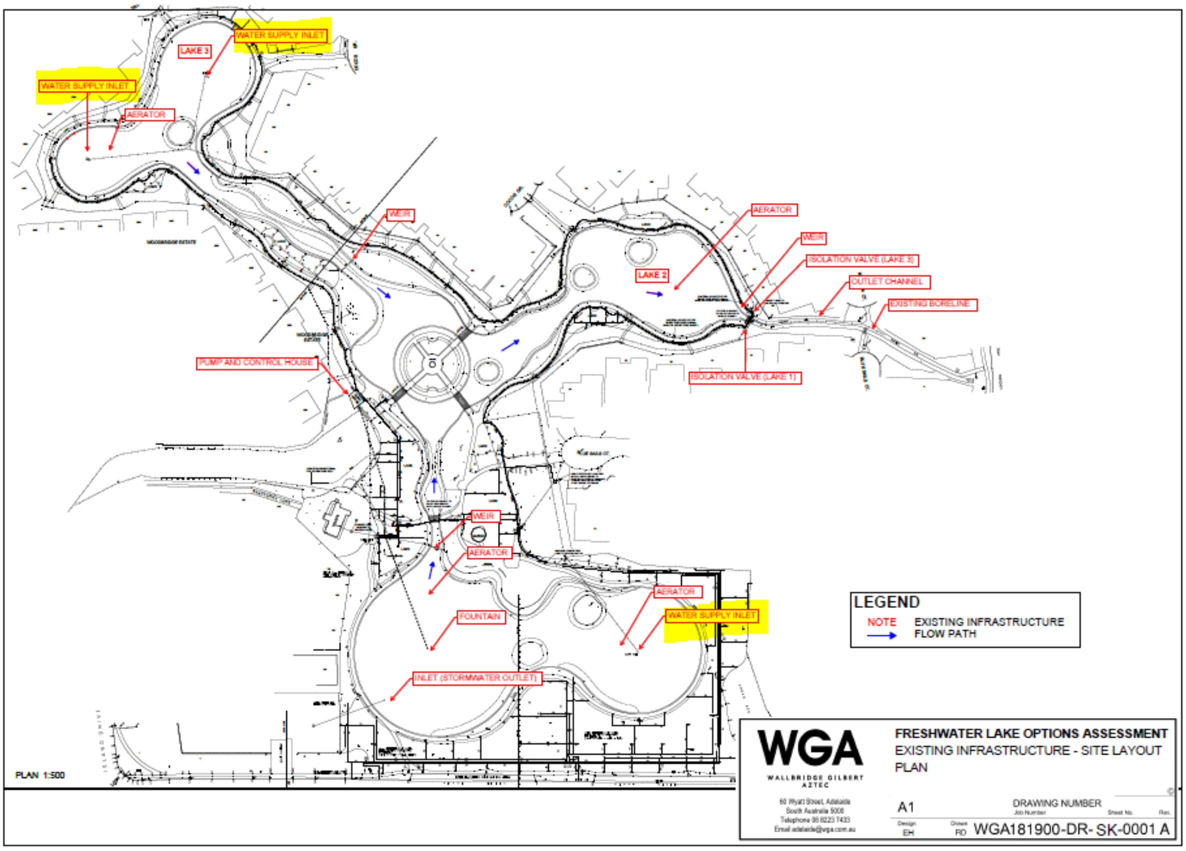

Figure 5: Conceptual Layout (WGA, Jun 2022)