Technical Methods

Otago Regional Council

Monitor and evaluate

What is it?

Using the newly installed monitoring buoy and other data to better understand lake processes and trends. Using data to inform future decisions about whether (and how) intervention options should be implemented, and to monitor and potentially optimise any remediation efforts.

How does it work?

A period of intensified monitoring may help to identify the most effective intervention option, or alternatively establish whether the lake is recovering naturally (as has been suggested), and therefore active intervention is not required.

Risks

Uncertainty on how long a natural recovery process will take, and it may be unrealistic to expect the supply of phosphorous from the catchment will be significantly reduced any time soon.

Success of using this method alone relies on a successful catchment management program.

Benefits

The monitor and evaluate approach would help to quantify any 'natural' improvement (or degradation) in the lake.

It may help to inform later decisions, but by itself, it will not lead to any direct changes in water quality.

No additional expenditure. Lowest risk option.

Costs

One-off cost: $100,000*

Ongoing cost p.a.: $2,000

*This investment has already been spent.

Flush lake with augmented water

What is it?

Supplementing the flow of Mill Creek with cooler and low-nutrient water from the Arrow River (via the Arrow Irrigation Company irrigation scheme).

How does it work?

Two primary benefits:

1. Increasing the volume of cleaner water into Lake Hayes from the Arrow River to flush out the nutrient-rich lake water.
2. Under optimal summer conditions, cooler water can plunge to the lowest part of the lake to help prevent the occurrence of anoxic bottom water (water that is depleted of dissolved oxygen). Oxygenated water inhibits the release of phosphorous from lakebed sediments which would otherwise occur.

Risks

The second benefit is likely to be most effective in the warmer months, however that is when flows in the Arrow River are comparatively low and irrigation water may not be available.

Arrow River water allocation not guaranteed beyond 2021 (minimum flow process).

This process will need to run over many years to be effective; we cannot expect an immediate outcome.

It may require additional work to create a modified outlet to ensure the augmented water does not adversely affect lake levels.

This process would need to be repeated if nutrients continue to enter the lake.

Benefits

ORC took the opportunity to install a 130-metre-long pipe to Mill Creek in 2018 to preserve this method while the golf course was under development at Millbrook Resort.

The environmental risk associated with this method is relatively low, as it simply increases an existing natural process.

Modelling indicated augmentation was a promising option to improve water quality.

Costs

One-off cost: $295,000*

Ongoing cost p.a.: est $25,000

*A portion of this investment has already been spent.

Use air bubbles to destratify lake

What is it?

Using a perforated pipe at the bottom of the lake, compressed air bubbles will blow through the pipe over spring/summer to create large lake currents to destratify (mix) the lake water that will prevent anoxic bottom water forming.

How does it work?

This method does not aim to remove phosphorous from the lake, but helps prevent it changing to a dissolved state, which is conducive to algal blooms.

May take 5-10 years of operation before no longer required.

Should prevent further algal blooms once operating.

Risks

The air compressor will need to run 24 hours a day over summer and operates at approx. 77dBA (almost shouting level), thus requiring a sound-proof shed to operate.

If turned on at the wrong time of year, aeration could promote algal blooms.

The system may not promote mixing across the whole lake (and therefore be less effective).

Mixing the water may bring suspended particles from the lower part of the lake to the surface, thereby reducing water clarity in the short-term.

There could be other unintended ecological consequences caused by preventing lake stratification.

Benefits

This method has been successfully used in several other New Zealand lakes, including Lake Waikopiro (Hawke's Bay) and several Auckland City Council drinking water reservoirs.

Over time, this process will make the water column clearer.

The surface lake temperature is likely to only drop 1°C, which may not be noticeable to lake users.

Costs

One-off cost: $670,000*

Ongoing cost p.a.: $76,500

*Consent applications and lease agreement costs subject to change.

Chemical application

What is it?

Alum will bind with phosphorus at the lake bottom, so algae cannot use the phosphorus to grow and create blooms.

How does it work?

Three application methods; each with pros and cons associated.

1. Boat application–slow and may affect zooplankton before reaching the lakebed.
2. Trickle in via Mill Creek–this requires a substantial dosing plant at the site.
3. Direct injection method –using 100 or so tanker trucks with a pipe at three locations around the lake to feed the alum into the lake.

Risks

Adding chemicals to a lake may not be deemed acceptable.

Addition of alum could discolour the lake (depending on application method).

Retreatment will be required if the source of the nutrients is not addressed; i.e. a successful catchment management will also be required to ensure longevity.

Benefits

Likely to have an immediate positive effect on lake water quality.

When alum is applied by boat or direct injection, there is no long-lasting visual impact.

The dosing rate can be altered as the DRP level changes over time, which would reduce ongoing costs, and deliver the maximum benefit of the treatment.

Costs

Set up cost: $230,000

Cost per application: $722,000*

*Alum cost is not fixed and it's difficult to determine how long dosing takes or the concentration of the dose.

Withdraw nutrient-rich water

What is it?

Using a submerged pipe, draw out nutrient-rich water from the anoxic bottom waters within the lake and discharge it into Hayes Creek (Lake Hayes outlet).

How does it work?

Uses hydraulic head to preferentially withdraw water from the deep part of the lake.

This method is the only system that actively removes phosphorous from the lake.

Risks

Anoxic water drawn from the bottom of the lake may be discoloured or odorous (until it re-oxygenates in Hayes Creek).

Results will not be immediate; they may be years or decades away. Algal blooms could still occur while this method is operating.

Visual impacts with an outlet weir being required and pipe being placed along the bed of the lake.

While the phosphorus is removed from the lake, it will continue to build up if attention to the quality of water entering the lake is not addressed.

Benefits

Low ongoing costs.

Probability of success depends on how rapidly it can withdraw phosphorous from the lake (undefined).

Pairs well with the augmentation option.

Costs

One-off cost: $660,000

Ongoing cost p.a.: $20,000