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Taihoro Nukurangi

Water quality monitoring protocol for the Waiau Arm

NIWA Client Report: CHC2010-112
September 2010

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Prepared for

Meridian Energy Ltd

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1. Introduction

1.1. Background

In May 2003, following a relatively dry summer and autumn, a major water quality / algal bloom issue was observed in the lower section of the Waiau Arm (Ms Jan Riddell, witness for the Waiau Working Party, 7 September 2009). A number of stakeholders raised concerns over this 'bloom' and the health of the Waiau Arm. In response to these concerns, Meridian commissioned a water quality study of the Waiau Arm (Spigel et al 2006). This study showed that water quality and clarity in the Waiau Arm are determined by a number of factors, including flow, residence time, phytoplankton biomass and run-off during rainfall. The relationship between flow, residence time and phytoplankton biomass and ultimately water quality was not straightforward. Spigel et al. (2006) found that there was a strong seasonal temperature and light effect, with low algal biomass maintained during winter even with long residence times, but moderate levels of chlorophyll *a* (a measure of algal biomass) could develop in summer months even at short residence times.

In addition to this study, Meridian instigated a water quality monitoring programme in the Waiau Arm in December 2006 which continues to present day. The purpose of this monitoring programme was to ensure timely detection of any potential water quality issues to allow for efficient management of the Waiau Arm.

1.2. Manapouri Tailrace Amended Discharge (MTAD)

In 2010, Meridian was granted a resource consent to increase the maximum allowable discharge from the tailrace of the existing Manapouri Power Station. This would result in changes in the discharge of water down the Waiau Arm, in particular an increase in the number of days minimum flows will be discharged down the Arm. This could lead to an increased risk of phytoplankton biomass developing to a point where it begins to negatively impact the water quality and clarity in the Waiau Arm during summer months (Sutherland and Graynoth 2009).

In the hearing evidence of Sutherland (2009) monitoring of water quality and clarity was recommended during summer months to detect early changes as a result of phytoplankton growth. Mitigation of declining water quality, by means of a managed 'flush' of affected water out of the Waiau Arm, was also recommended. In the hearing decision by the consents committee the consent conditions state:

Waiau Arm Water Quality

Prior to exercising this consent, the consent holder shall prepare and implement a protocol for monitoring changes in water quality and for subsequent flow management in the Waiau Arm, in accordance with the details set out in Appendix A of this consent. The purpose of the protocol will be to establish a monitoring programme and a management plan specifying the actions to occur should declining water quality and/or a phytoplankton bloom be detected. The aim of the protocol will be to ensure that the flushing of the affected water in the Waiau Arm, with water derived from Lake Manapouri, occurs in an effective manner in response to the actual measured effect and until the affected water is removed. The protocol shall be forwarded to Environment Southland for its approval prior to the exercise of this consent.

The consent holder shall undertake water quality and clarity monitoring in accordance with the protocol set out in Biggs et al (2006) and as currently undertaken in Waiau Arm. The consent holder will submit the protocol to Environment Southland prior to the exercise of the consent. The consent holder will keep Environment Southland and stakeholders informed on the implementation and ongoing development of the protocol.

Fortnightly water quality samples shall be collected by appropriately trained personnel from 1 January to 31 March.

This report outlines the protocols for undertaking water quality and clarity monitoring in the Waiau Arm in accordance to Biggs et al. (2006). Biggs et al. (2006) chose the water quality parameters dissolved oxygen, pH, temperature and the clarity parameter Secchi depth for monitoring following consultation with the Waiau Working Party, Guardians of the lakes, Department of Conservation and Meridian. The main rationale for these parameters over others, such as nutrients and chlorophyll *a*, was that these instantaneous results allows for a quick response to declining conditions.

2. Field procedures

2.1. Sampling sites

The water quality sampling sites shall be the same sites that have been monitored by Meridian since December 2006. There are three monitoring sites spaced down the length of the Waiau Arm and one control site, offshore from Frasers Beach, Lake Manapouri (Figure 1).

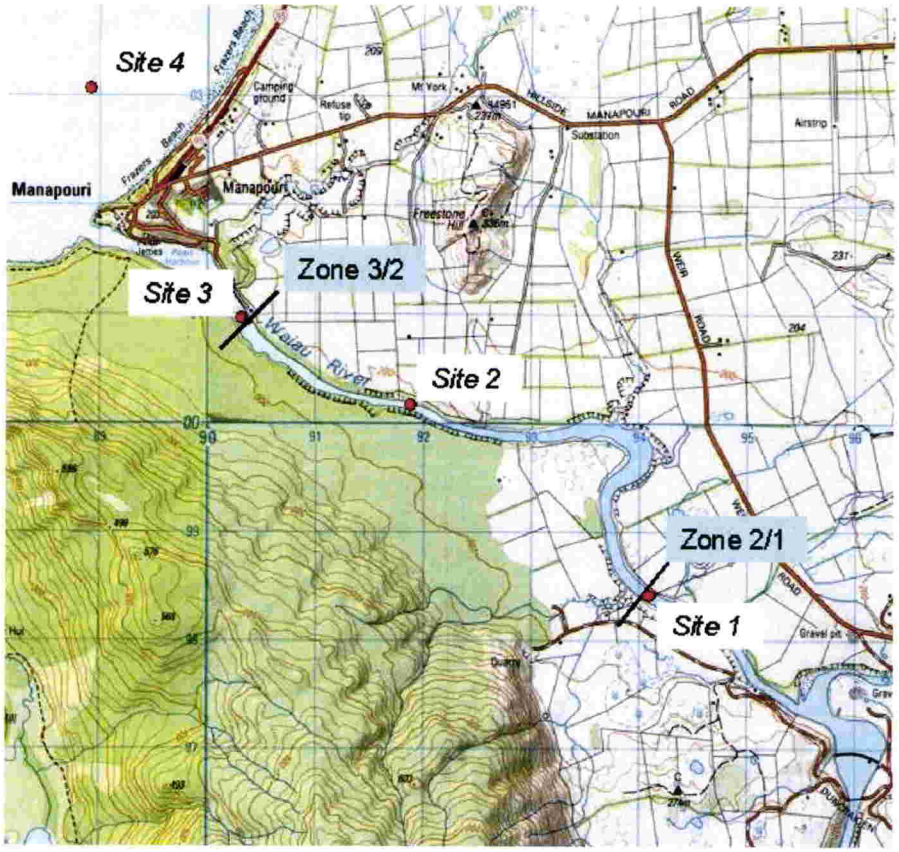


Figure 1: **Locations of water quality sampling sites within the Waiau Arm (Sites 1-3) and Lake control site (Site 4). Sites are based on water quality monitoring sites that have been sampled by Meridian since 2006.**

2.2. Timing of sampling

Water quality parameters that are influenced by factors such as biological activity (e.g. dissolved oxygen) or sunlight (e.g. temperature) vary over the course of the day. In order to compare parameters between sampling occasions in a meaningful way, it is important to ensure that sampling occurs at the same time of day each occasion. Measurements should be made between 9.00 and 10:00 am NZST since, for most variables, morning water quality values are typically similar to the diurnal median value (Oswald, 1991).

2.3. Secchi Disk Depth

Secchi disk depth should be measured in accordance with methodology in Davies-Colley (1994) and Burns et al. (2000) and described below. Secchi disk should be viewed on the sunny side of the boat to avoid distortion of the view by the shadow of the boat. The Secchi disk, attached to a graduated line, is simply lowered into the

water until the image disappears. This depth is noted and the disk is then raised slowly until the image just reappears. The average of the disappearance and reappearance depths is the Secchi depth (m).

2.4. Temperature and dissolved oxygen profiles

At each site profiles of temperature and dissolved oxygen should be recorded down a water column profile. The first measurement shall be recorded just below water surface, then at 0.5 m and 1 m below water surface, then in 1 m increments until just above the bottom of the Arm (or in the case of the Lake Control Site 4 to a maximum depth of 15 m). The dissolved oxygen probe shall be calibrated with 100% air saturated water immediately prior to each sampling day.

2.5. pH

pH should be recorded along the same water column depth profile as temperature and dissolved oxygen. The pH probe shall be calibrated against standard pH buffers immediately prior to each sampling day.

2.6. Data handling

To ensure timely detection of any potential water quality problems, it is important that monitoring results are received by the designated water quality consultant within 24 hours. Results should then be analysed and advised to Meridian's representative within the following 24 hours. This will allow for the flow management plan to be initiated by Meridian in a timely manner, if deemed necessary. The flow management plan, which includes early consultation with representatives from the stakeholders, is detailed in Figure 2.

3. Flow management action plan

To ensure a timely response to any potential water quality problem, it is recommended that the following criteria are used as trigger points for discussion on the necessity of implementing remedial action. These criteria are:

1. Dissolved oxygen: average water column dissolved oxygen falls below 85% at any site;

2. pH: average water column pH exceeds 9 at any site;

Meridian Energy Limited

2010-11 Eel migrant trap and transfer programme for the Manapouri hydro-electric scheme

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September 2010

Summary

Meridian Energy limited is undertaking ongoing research programme examining the exit of migrant eels from Lake Manapouri. Results to date indicate approximately 60 % of migrants are finding the natural exit and migrating to the sea. Modelling of the current data available to date has suggested that the exercise of the consents for the Manapouri Tailrace Amended Discharge (MTAD) may result in additional migrant eels attempting to exit through the Manapouri Power Station. As a result a consent condition is included in the MTAD consents requiring additional Trap and Transfer efforts in the period between the exercise of the MTAD consent and implementation of longer term mitigation solutions to be identified as a result of the ongoing mitigation research programme.

This report documents the programme to be initiated for the 2010-11 migration period to achieve the additional 1200 net-nights required by the MTAD consent (206157) condition. It provides the base concept for future years, although changes resulting from annual results and improved knowledge will be incorporated annually.

In the 2010-11 migrant season additional net nights will be provided by commencing the trapping programme in November. This was undertaken as a trial in the 2009-10 migrant period and proved successful, resulting in increased numbers of migrants caught despite reductions in netting ability later in the season due to flooding.

Requirement

Condition 9 of consent 206157 requires that:

Prior to the exercise of this consent, the consent holder shall prepare an eel trap and transfer programme to be submitted to Environment Southland for approval. The objective will be to mitigate the additional effect of MTAD on the percentage of longfin eels migrating downstream through the MLC outlet by increasing the number of net-nights over the existing eel trap and transfer programme by 1,200 net-nights (ie 20 nets set for an additional 60 nights). The trap and transfer programme shall continue until such time the consent holder is advised in writing by Environment Southland that the programme can be discontinued.

History

Following the 1996 Manapouri reconsenting, the Te Waiau Mahika Kai Trust was funded under the Trust Deed to undertake actions to improve migrant exits. They commenced a programme from 1998 trapping eels and transferring any eel over 4 kg to below the MLC structure. The 4kg minimum was

used at that time due to the restriction of commercial eelers harvesting eels over 4 kg, thus ensuring they were not harvested from the lower Waiau after release.

By 2003 the Trust ceased eel activities and Meridian has resumed responsibility for this work. The trap and transfer has been undertaken in conjunction with research activities primarily examining movement of migrants in the lakes and factors surrounding exit from the lake. Migrant eels have been captured and suitable migrants tagged to enable tracking. Non-tagged migrants have been relocated to below MLC. A number of contractors have attempted eel capture but all netting from 2005 to 2008 has been undertaken by Evan Brunton. There is evidence from improved catch per unit effort that there has been an improvement over time in site selection and net management resulting in improved catches. A significant factor appears to be the cessation of the use of bait in the nets. Not only has this reduced the feeder eel capture but there appears to be an increase in migrant capture.

Netting.

Netting is undertaken with fyke nets. These nets have a section of net (wing net) with weights on the bottom and floats on the top so that it is held vertically in the water column. At one end of this wing is the trap section which consists of a cylindrical sock which has a funnel opening attached to the wing. The cylindrical section is held open with a number of metal hoops. The end without the funnel entrance is tied closed and attached to a weight.

The net is set by attaching the end of the wing to a pole at the shore and stretching the net out at right angles to the shore until the weight at the end of the trap section is dropped onto the bed holding the entire net in place. This requires sufficient shallow lake bed to enable the net to sit on the bottom and be able to be retrieved. Rough ground and debris both damage the net and hold it off the bottom allowing eels to pass under it.

When correctly set eels encounter the wing and follow it into deeper water in an attempt to get round it. As they swim parallel to the wing they enter the funnel section. Passing through the funnel puts them into the trap where they remain until the net is cleared (fig 1).

Fyke nets with a mesh size of 15 mm were set along the shore-line of lakes Te Anau and Manapouri from February until May of each year. Up to 20 nets were set at any one time. In 2005, most nets were baited, whilst in 2006 – 2009 the majority of nets were not baited, and in 2010 no baited nets were used. Migrant eels were identified using body colouration and eye size (Jellyman & Todd 1982) and were visually separated from the feeder (sexually immature adult) eels.

The total weight of feeder eels in the catch is estimated. All feeder eels are released at the point of capture.

Migrant eels were individually weighed and sexed according to length and weight (males $\leq$0.75 m length and $\leq$ kg weight; females > 0.75 m length and >1 kg weight. All non-tagged migrants captured

were released downstream of MLC, however suitably sized females are tagged and released in various locations for tracking.

Location

Nets have been set in both Te Anau and Manapouri. Netting for migrants in Lake Te Anau has generally been poor. Catch per unit effort (2008) for eel was highest in Lake Te Anau at 13.5 kg/day/net. However, only 0.5 kg/day/net were migrants. In contrast, Lake Manapouri CPU is 6.1 kg/net/day of which 2.5 kg/net/day were migrants. The contractor does not believe that Lake Te Anau provides effective netting sites for migrants.

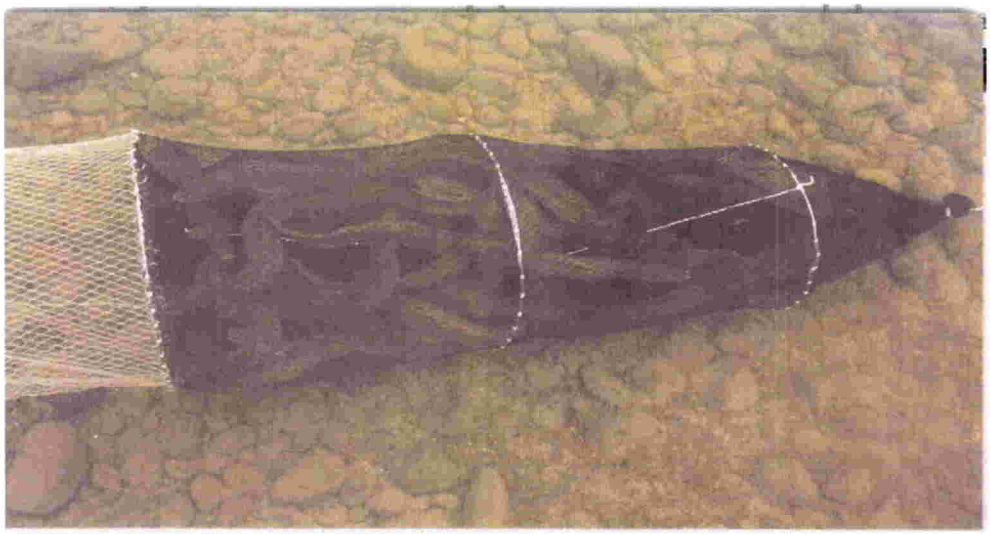


Figure 1 Fyke net with eels in Lake Manapouri

The best sites are along the Lake Manapouri shoreline in the vicinity of the discharge point of the upper Waiau into Shallow Bay. There are limited areas available elsewhere in the lake due to the steep drop-off from the shore.

Tracking data suggests that the eels are approaching West Arm in deep water and passing between the Cardinal Markers. This does support the 2003 work of Theo Bakker, who had negligible catches in large nets set between the southern Cardinal Marker and shore. We do not have nets capable of being used in the deep water and setting in these locations will be a significant navigation hazard to the boat traffic to West Arm

Netting period.

The Te Waiau Mahika Kai Trust undertook netting in March and April. When Meridian and NIWA initiated work on tracking migrants netting commenced mid February and continued until April. Nets are not in the water continuously over this period, as they are removed for storm events, and low capturing nets removed or relocated. Net setting is continuously adjusted to account for

High lake levels reduce netting effectiveness. It is believed that eels are able to circumvent the nets by swimming round the inland end or over the top. Meridian is having new nets made which have a higher wing net which will increase effectiveness in high lake levels.

year	Days netting	Net nights	Migrants caught
2008	112	1429	1561
2007	101	777	682
2006	103	1430	323
2005	101	1425	170
Average	**104**	**1265**	**684**

Table 1. Effort and capture data for migrant netting in Lakes Te Anau and Manapouri combined.

In 2009-10 netting was commenced in early December in anticipation of the MTAD. A significant number of migrants were captured prior to the previous mid-February start to netting. The netting had to be curtailed due to high lake levels from April until the end of the season. It appears reasonable that the additional net-nights be provided by netting earlier in the season that has traditionally occurred in the past.

Netting Management

It is evident that migrant eels do not show consistent activity from year to year. While this should not be a surprise, as the trapping targets a new cohort each season, it does mean that we cannot be prescriptive in developing the trapping programme. The location of the netting is left to the contractor. He sets nets in the previously effective locations, as well as trialling new sites. Ineffective nets are relocated throughout the season.

Migrant movement appears to cease once the surface temperature of Lake Manapouri falls below 13°C. Trapping is continued until either the lake temperature falls or migrant capture ceases.

Netting to date

As shown in Table 1 above, the number of net-nights has been relatively consistent over the period 2005 to 2008. However the number of migrants capture has shown continuous increases. This has occurred as the most effective sites and methods are identified. The average number of net-nights over the period is 1265. This means that we should target a minimum of 2465 net nights to comply with the consent conditions.

2010-11 Migrant trapping.

Condition 9 of consent 206157 requires Meridian to provide an additional 1200 net nights of trapping. This will be met via contractual arrangements with the contractor requiring a minimum of 2465 net nights per season.

A map showing the netting locations used in 2008 is appended. Netting will generally be in similar locations. However, some nets may be set in North and South Arms in the vicinity of the relevant river mouths on a trial basis providing didymo management protocols can be achieved.

Catch records will be examined at the conclusion of the season to determine the effectiveness of the netting. The following seasons programme is dependant on the outcomes of the previous year. Our advice to date and experience in the 09-10 season suggests that commencing trapping earlier does trap more eels. On that basis we will initiate trapping over the full period migrants are available in the lake. The additional net nights will be obtained from netting in the mid-November to Mid February period. Trapping will continue until either captures cease or the water temperature falls below 13°C (below 13°C migrant activity appears to cease).

Any amendments to this general programme in future years will be discussed with Environment Southland prior to implementation. A revision of this report, incorporating amendments, will be submitted to Environment Southland prior to the migration period.

Reporting

Raw cumulative results will be provided to ES at the conclusion of the season. However the netting results are also used by NIWA in developing modelling. The NIWA reports on the outcomes of monitoring, modelling and research will be provided in the annual monitoring report as currently occurs.

3. Secchi disk clarity: if Secchi clarity declines by more than 33% of the average of the previous 3 sampling occasions, then a water sample should be taken to quantify the water composition to determine possible causes (analyses to include ammonia, dissolved reactive phosphorus, suspended solids (total and volatile), spectral absorbance, chlorophyll *a*).

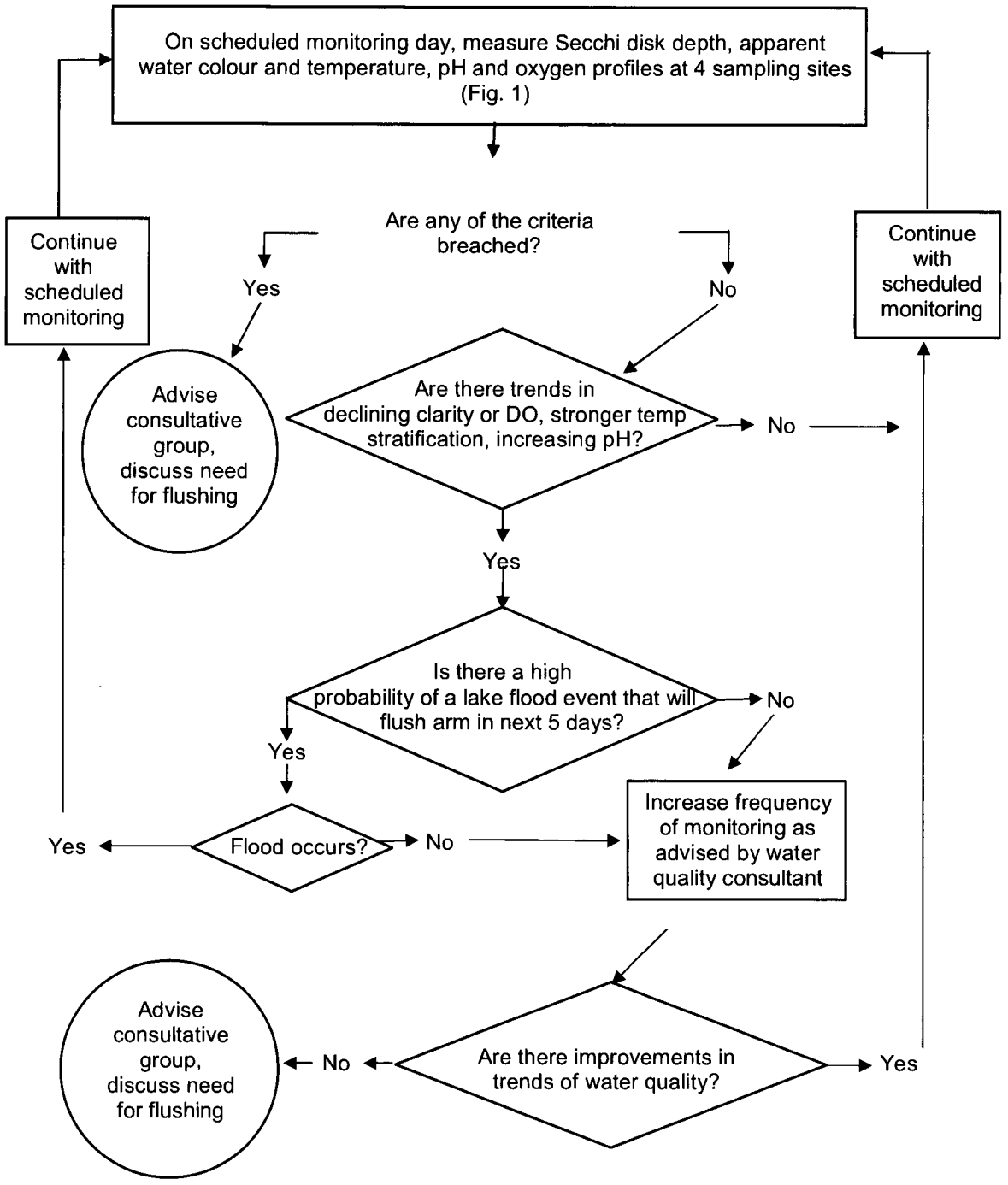


Figure 2: Flow diagram representing the flow management plan on the need for flushing of the Waiau Arm, based on the water quality monitoring results.

The first two parameters can have absolute values assigned as the trigger point as they are a direct measure of chemical quality that affect biota. On the other hand, Secchi is an apparent optical property that is a reflection of a number of interacting physical and biological processes.

The conservative trigger values set for each criteria have been used to allow for any potential problems to be identified well in advance. This ensures that if remedial action is required, the management action guideline for the Waiau Arm (Figure 2) can be implemented in a timely manner before any decline in water quality becomes an ecological problem.

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