Cotter Reservoir Destratification System Process Operating Plan

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Document management

Document summary

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Document development

	Name	Position	Date
Prepared by	Marco Bottari	Water Quality Officer	23.11.2016
Reviewed by	Jonathan Thirkell	Water Distribution Engineer	20.12.2016
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Approved by	Cameron Patrick	Manager Asset Planning	21.12.2016

Version control

Version	Author	Date	Description
1.00	Marco Bottari	23.11.16	Original
1.01	John Hyam	17.01.19	Update references to Fish Management Plan V4
1.02	Sarah McLaren	23.01.19	Update responsible roles after business realignment

Contents

1. Introduction

Scope

Note: The process operation plan template has been used to capture the operating information for the Cotter reservoir destratification system. This document is better suited to a treatment process; therefore, there are several sections of this document that are not applicable. In future the information within this document may be placed into another document type/template.

The document is applicable from 1 January 2017.

All Icon Water workers responsible for decisions with respect to the management, planning, and delivery of safe drinking water related to the Cotter reservoir destratification system must apply this Process Operating Plan in all work they undertake.

Purpose

The purpose of this Process Operating Plan (POP) is to provide the framework within which process decisions are made, documented, communicated and executed for the Cotter reservoir destratification system. This will enable all the Cotter reservoir destratification system stakeholders to work together to ensure it can reliably meet its performance objectives and the enlarged Cotter Dam project conditions of approval and environmental management plans in a safe and cost-effective manner. It will inform:

- short term decisions in response to unforeseen circumstances (for Operations)
- annual budgeting (for Operations)
- works scheduling (for the benefit of Operations Services, Maintenance Services and Project Delivery)

The POP addresses the following framework and system-level activities:

- How this POP is documented, communicated and utilised.
- Description of the facility/asset system, its systems and capabilities, and operating framework
- Factors considered in the development of this POP
- Licence conditions, and internal performance indicators
- Monitoring and control
- Reports and record keeping
- Maintenance practices and procedures
- Environmental awareness

This Process Operating Plan is classified as an Enabler document within the Integrated Management System (IMS) as it enables or supports conformance with IMS requirements.

It should be read in conjunction with the reference documents listed.

References

References
Enlarged Cotter Dam – Management of Macquarie Perch During Filling Phase (2012)
Enlarged Cotter Dam – Fish Management Plan Version 4 (2019)

References
ResMix 5000 Close Coupled System – Operation and Maintenance Manual (2014) - Cotter Reservoir
Cotter Destratification System Performance Report (2016)

Abbreviations

Abbreviation	Term
ADWG	Australian Drinking Water Guidelines
ALS	Australian Laboratory Services
CCP	Critical Control Point
DO	Dissolved oxygen
E&S	Environment and Sustainability
IMS	Integrated Management System
SAMP	Strategic Asset Management Plan
SCADA	Supervisory Control and Data Acquisition
SLA	Service Level Agreement
WDE	Water Distribution Engineer
WDW	Water Data Warehouse
WQO	Water Quality Officer

Definitions

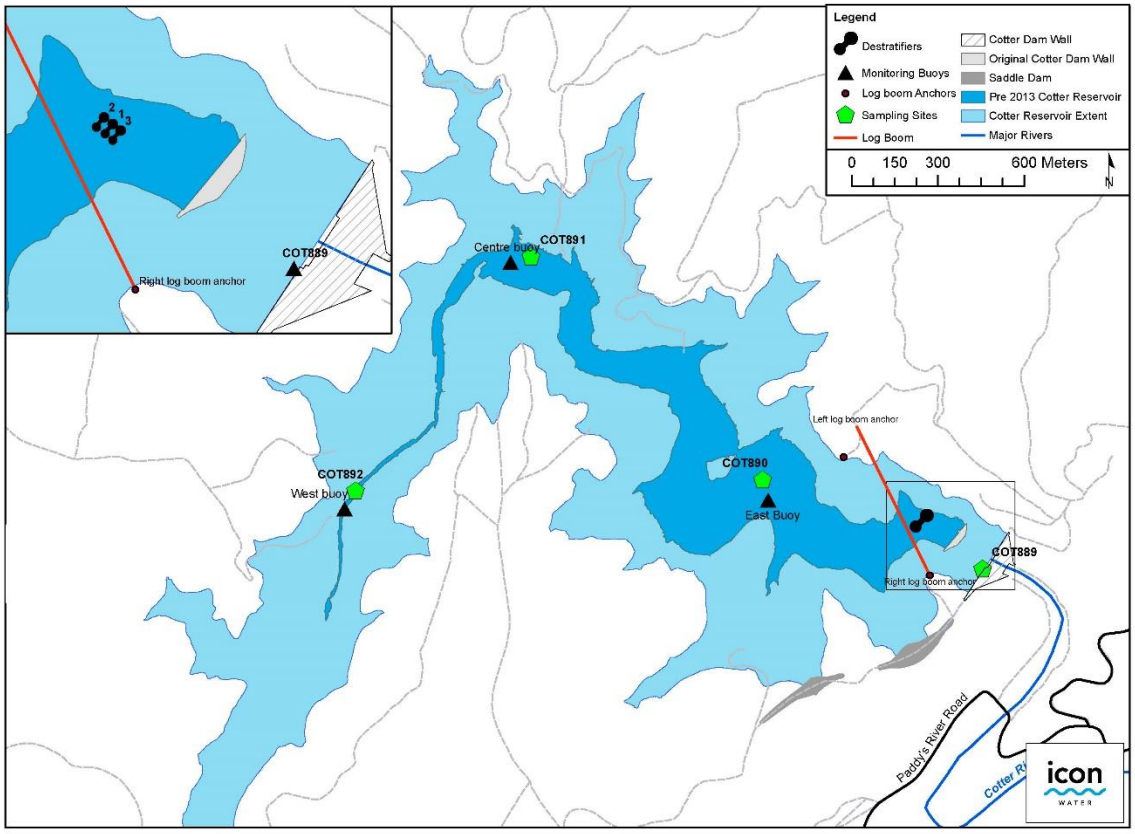
Term	Definition
Asset System/ Operational Process	Surface mounted destratification system (down draft pumps) intended to lessen the degree of stratification within the Cotter reservoir and; therefore, reduce the associated effects on the Macquarie Perch population and water quality.
Asset Owner Representative	The individual responsible for overseeing the management of the asset (i.e. developing maintenance schedules, operating plans, SAMPs etc.) to ensure it achieves its defined performance objectives. Provide input into objective setting and long-term strategic planning, evaluate performance and consider improvements to the asset. The first point of contact for decisions relating to the asset.
Performance Objective	A measureable / quantifiable result the process is aiming to achieve.
Capabilities	The inherent abilities of a physical asset

Term	Definition
Configuration Management	The management of the functional and physical attributes (data) of a system/asset and its part sub-systems and assemblies (definition taken from Asset Management Council Framework for Asset Management).
Epilimnion	The warmer upper layer of a water body that is mixed, aerobic and receives oxygen and heat through interaction with the atmosphere.
Hypolimnion	The cooler lower layer of a water body that does not interact with the atmosphere and can become anoxic.
Inputs	Resources and constraints required to delivery output
Outputs	The stated requirement for services or products required by the enterprise.
Operations and Maintenance	Combination of processes and tasks necessary to implement the required support, through which the requisite outputs should be delivered. The use of assets to provide a defined service and through their maintenance and support ensure a continuing capability to meet those requirements in terms of service, safety and reliability.
Physical Asset	A combination of interacting elements organised to achieve one or more stated functions
Process Controller	Officer responsible for monitoring, controlling and reporting of a process
Process Owner	Officer responsible for ensuring process meets its licence and setting the direction for the process
Stakeholder	As per ISO 55000 a stakeholder or ‘interested party’ refers to an individual or organisation that can affect or be affected by an organisational decision or activity. These can be internal and external.
Thermocline	The layer of water within a stratified reservoir with the greatest rate of temperature decline between the epilimnion and the hypolimnion.
Turnover	Large static water bodies stratify in summer with the warmer, lighter water residing in the upper layers. In winter, the surface water cools relative to the lower layers and; therefore, becomes denser than the lower layers causing the layers of water to invert and/or mix. This is known as turnover.

2. Asset Information

Location of Asset

The Cotter reservoir destratification system consists of three pairs of mixers bound together to form a single pontoon. This pontoon is located between the log boom and the upstream face of the Cotter dam wall at the front (eastern end) of the reservoir.



Purpose of Asset (Function)

The system attempts to reduce the severity and duration of stratification within the reservoir and in doing so beneficially impact the dissolved oxygen concentration of the water, reduce stress on the endangered Macquarie Perch, reduce dissolved metal concentrations, reduce algae numbers, accelerate biological processes, reduce the impacts and severity of turnover and create a greater volume of acceptable water for treatment.

Capability of Asset (Performance Objectives)

The performance objectives of the destratification systems are; to maintain the dissolved oxygen concentration within the reservoir at a depth of 3m, as measured at the water quality buoys and tower site analysers, above 6 mg/L, and; reduce the severity of stratification to maximise the volume of acceptable water available for treatment.

Performance Criteria	Units	Trigger value	Percentile limit	Performance period	State/Mode	Source of Criteria
Maintain dissolved oxygen concentration at a depth of 3m	*mg/L*	*<6 at three or more locations for seven consecutive days*	*n/a*	*Weekly*	*n/a*	Enlarged Cotter Dam Fish Management Plan

Process Description

The system influences selective abstraction at the start of the drinking water supply process. The destratification system operates to manage water quality in the Cotter reservoir and protect the endangered population of Macquarie Perch. This is achieved by using the impellers to draw warm buoyant water from the surface and push it down through the draft tube. The buoyant water then rises up the outside of the tube. As it rises it mixes with the cooler less buoyant water and begins to cool. Eventually the water reaches equilibrium with the surrounding water temperature (neutral buoyancy) at which point it ceases rising and begins to travel horizontally, creating a flow pattern resembling an inverted mushroom. This mixes the hypolimnion with water from the epilimnion, gradually lessening stratification and increasing the depth of the epilimnion.

During warmer months stratification is most pronounced and the risk to the Macquarie Perch and water quality is greatest. It is most important to operate the destratification system during these periods, not only to control short-term effects, but because failure to manage the stratification during summer has the potential to significantly impact the water quality in winter and the following summer.

Licence Conditions

The ACT Conditions of Approval for the enlarged Cotter Dam project requires we adhere to the Enlarged Cotter Dam – Management of Macquarie Perch During Filling Phase (2012).

Stakeholder Roles and Responsibilities

The following table lists specific stakeholders in this Process Operating Plan, and their role associated with the plan:

Stakeholder responsibilities for Process Operating Plan	Responsible Role	Accountable
Develop, review, and modify Process Operating Plan, and **consult and inform** stakeholders of the Process Operating Plan. **Verify and assess** the effects the Cotter reservoir destratification system has on the water quality within the reservoir.	Water Quality Officer	Team Leader Process Compliance Operations (Infrastructure Services Group)

Stakeholder responsibilities for Process Operating Plan	Responsible Role	Accountable
Operate (monitor and control) the Cotter reservoir destratification system and sub-systems within their defined capability, to ensure that the defined performance objectives are achieved.	Duty Water Distribution Engineer	Team Leader Network Operations (Infrastructure Services Group)
	Water Industry Operator (after hours custodian)	Plant Operations (Infrastructure Services Group)
Maintain the Cotter reservoir destratification system within the defined maximum unit process outage timeframes, to maximise system and sub-system unit availability and capability, to ensure that the defined performance objectives are achieved. **Plan future Maintenance and Capital Works** to ensure the reliability and availability of equipment meets defined targets, to ensure that the defined performance objectives are met.	Long Term Maintenance Planner (Infrastructure Services Group)	Team Leader Maintenance Engineering and Delivery Planning (Infrastructure Services Group)
Plan and deliver Projects and Major Maintenance to ensure that outage times are less than the maximum defined unit process outage timeframes, so as to maximise system and sub-system unit availability and plant process capacity in order to meet process limits defined in this POP to meet volume and quality requirements for drinking water.	Project Management Office	Pipeline Manager (Infrastructure Services Group)
Monitor compliance with the conditions of approval relating to Macquarie Perch; specifically DO levels and trigger values defined by the Enlarged Cotter Dam – Management of Macquarie Perch During Filling Phase (2012). Liaise with Regulators and researchers.	Senior Environmental Scientist	Team Leader Catchment Protection and Land Management Team (Business Services Group)

The main roles and responsibilities include operations, maintenance and governance of the Cotter destratification system. The table below summarises the division and roles associated with the activities at this facility.

Stakeholder Position	Title	Branch / Group	Name
Process Owner	Process Engineer	Operations Services (Infrastructure Services Group)	n/a
Process Controller	Duty Water Distribution Engineer	Operations Services (Infrastructure Services Group)	n/a
Process Controller (after hours custodian)	Water Industry Operator	Operations Services (Infrastructure Services Group)	n/a
Engineering (Investigations) /technical support	Senior Maintenace Engineer Water Quality Officer Senior Environmental Scientist	Maintenance Services (Infrastructure Services Group) Operations Services (Infrastructure Services Group) Environment & Sustainability (Business Services)	n/a
Operations & Site Controller Rep	Duty Water Distribution Engineer	Operations Services (Infrastructure Services Group)	n/a
Operations Staff	Duty Water Industry Operator	Operations Services (Infrastructure Services Group)	n/a
Maintenance Staff	Maintenance Delivery	Maintenance Services (Infrastructure Services Group)	n/a

3. Process Monitoring and Compliance Reporting

Treatment Process Monitoring

n/a

Process Specification

Process Step	Target
Catchment Management	The system attempts to reduce the severity and duration of stratification within the reservoir and in doing so beneficially impact the dissolved oxygen concentration of the water, reduce stress on the endangered Macquarie Perch, reduce dissolved metal concentrations, reduce algae numbers, accelerate biological processes, reduce the impacts and severity of turnover and create a greater volume of acceptable water for treatment. "acceptable water for treatment" is quantified in the Drinking Water Quality Management Plan Operational Guidelines (EN05.09.02) for CCP 1 – Selective Abstraction as; Turbidity <5 NTU pH 6.4 – 7.6 True Colour <35 PtCo Total Iron <1 mg/L Total Manganese <0.25 mg/L Dissolved Manganese <0.05 mg/L *E. coli* <100 MPN/100mL *Enterococci* <100 MPN/100mL *Cryptosporidium & Giardia* no detection Pesticides < ADWG health value Dissolved oxygen >6.0 mg/L as measured by the water quality buoys and the tower analysers, at a depth of 3m.

Sources of Process Monitoring Data

Source of Process Monitoring Data	Purpose	Used for Compliance Reporting?
Online water quality instrumentation at the Cotter tower via SCADA	*Monitoring of system performance against specification*	n/a
Online instrumentation at three water quality buoys via SCADA	*Monitoring of system performance against specification*	n/a

Source of Process Monitoring Data	Purpose	Used for Compliance Reporting?
Grab sampling for off-site analysis by NATA certified laboratory	*To monitor important parameters that are not available from online instrumentation* *To provide independent cross-check of parameters monitored from online instrumentation*	n/a
Pierces Crk. Met station (570825) via the ALS web portal	*To interrogate system performance*	n/a

Operator SCADA Monitoring

Refer to table below for list of process parameters monitored continuously and alarm setpoints:

Process	Parameter	Setpoint	Alarm Setpoint	Reason	SCADA Page/Trend Name
Destratification	*Operating speed*	32.5 Hz	n/a	Maximise the effect of the units on the reservoirs water quality	WCT.WCTCRCWQ_3171CP_ACT_SPEED WCT.WCTCRCWQ_3172CP_ACT_SPEED WCT.WCTCRCWQ_3173CP_ACT_SPEED
Destratification	*VSD temperature*	<90ºC	n/a	System protection	WCT.WCTCRCWQ_3171CP_TEMP WCT.WCTCRCWQ_3172CP_TEMP WCT.WCTCRCWQ_3173CP_TEMP
Destratification	*Current*	<22 A	n/a	System capacity	WCT.WCTCRCWQ_3171CP_AMPS WCT.WCTCRCWQ_3172CP_AMPS WCT.WCTCRCWQ_3173CP_AMPS
Water quality buoys & tower analysers	*Dissolved oxygen*	> 6 mg/L	n/a	Protection of Macquarie Perch & Assessment of system performance and management	WCT.WCTCRCDM_410704BW_DOmgL WCT.WCTCRCDM_410704BC_DOmgL

Process	Parameter	Setpoint	Alarm Setpoint	Reason	SCADA Page/Trend Name
					WCT.WCTCRCDM_410704BE_DOmgL WCT.WCT.WC_IL3008_pv1 to _pv7
Tower analysers	*pH*	n/a	n/a	Assessment of system performance and management	WCT.WCT.WC_IL3005_pv1 to _pv7
Tower analysers	*Temperature*	n/a	n/a	Assessment of system performance and management	WCT.WCT.WC_IL3006_pv1 to _pv7
Tower analysers	*Conductivity*	n/a	n/a	Assessment of system performance and management	WCT.WCT.WC_IL3007_pv1 to _pv7
Tower analysers	*Turbidity (low range)*	n/a	n/a	Assessment of system performance and management	WCT.WCT.WC_IL3009_pv1 to _pv7
Tower analysers	*Turbidity (high range)*	n/a	n/a	Assessment of system performance and management	WCT.WCT.WC_IL3020_pv1 to _pv7

Grab Sampling for Off-site Analysis

Refer to table below for list of samples to be collected by a NATA certified laboratory for off-site analysis:

Sample type (Grab/ composite)	Parameter measured/ calculated	Location	Limit	Purpose	Timing	Record location
Grab & composite	Multiple parameters monitored. Refer to ALS SLA for current Cotter reservoir sampled parameters and frequencies.	Cotter reservoir	n/a	System monitoring, verification and assessment.	Monthly (default). More frequent when source is in use.	WDW

Consolidated List of Monitored Parameters

n/a

Process Adjustments

Refer to table below for list of parameters requiring approval for process adjustment:

Operator controlled parameter	Unit	Location	Setpoint	Reason
Operating speed	Hz	Cotter reservoir	15-32.5Hz	Management of the reservoir's water quality, including avoiding resuspension of sediment.
Starting/stopping the unit	On/Off	Cotter reservoir	On/Off	Planned/unplanned maintenance or investigation.

Process Minor Modification Requests

n/a

Compliance Reporting

The Enlarged Cotter Dam Fish Management Plan Version 4 (2019) and the Enlarged Cotter Dam Management of the Macquarie Perch During Filling Phase (2012) contain conditions of approval and are regulator approved documents. The performance of our actions and adherence to these plans are assessed through the Fish Management Program Steering Committee (FMP SC) that meets at least annually, and includes regulators and experts in the field. Water quality and the operation of the destratification system are discussed during these meetings and their impacts on the fish population considered.

4. Operating Plan

Operational Objectives and Priorities

Refer to table below for process objectives in order of priority:

Priority	Process Objective	Performance Indicator
1	Protect the Macquarie Perch population	Dissolved oxygen >6.0 mg/L as measured by the water quality buoys and the tower analysers, at a depth of 3m.
2	Reduce reservoir stratification	Reduced thermal stratification of the reservoir compared to periods of non-operation and an associated improvement in water quality (i.e. reduced dissolved metal concentrations, greater net dissolved oxygen concentration etc.).
3	Manage ramp up speeds	Manage ramp up speeds to avoid adversely affecting the reservoir's water quality, whilst protecting the infrastructure.

Operating Factors that affect Operating budgets

Refer to table below for list of process drivers that affect OPEX:

Process Driver/ Issues	Process Impact	Budget impacts	Reason
Minimise suspension of bottom sediments and maintain a sufficiently thick epilimnion for the Macquarie Perch.	Reduced operating speed of the mixers during periods when the reservoir is mixed or the water level is low.	Reduced power usage and cost. *Potential speed reduction from 32.5Hz to 25Hz, between June and September, equates to a saving of approximately $5,000/yr.*	Operational experience has shown that speed reduction may be required to achieve the systems objectives at certain times of year. Speed reduction may also be possible at certain times of year (i.e. winter), whilst still meeting the systems objectives.

Process Inputs/Considerations

Refer to table below for list of process considerations:

Factors requiring process consideration	Impact on ability to meet process objectives
Ambient Temperature	During warm weather the units are not capable of maintaining a fully mixed state. The motors are run at capacity and heat management becomes an issue.

Factors requiring process consideration	Impact on ability to meet process objectives
Inflow	When the reservoir is stratified inflow will travel along the water layer that corresponds closest with its temperature and may create turbulence at the interface between the epilimnion and the hypolimnion causing aerobic water to mix with anoxic water.
Operating Speed	The destratification system has a recommended operating range of between 15 and 40Hz (as per O&M Manual, 2014); however, based on operational experience the actually operating range is 15-32.5Hz. Below 15Hz the motors are not able to adequately cool themselves and above 32.5Hz the motors exceed their current draw capacity. Operating at the maximum speed during periods of warm calm weather will cause one of more of the units to fault due to their VSD exceeding its maximum operating temperature (i.e. >96^{o}C). To avoid unplanned stops an automated process within SCADA sequentially decreases the operating speed until the temperature reduces to an acceptable level (i.e. <90^{o}C) and then gradually increases the speed back to the pre-defined maximum. The three pairs of mixers were originally intended to be spread apart increasing their area of influence; however, due to the location of the log boom, the risk posed to the units by submerged logs, cost and cable length limitation (i.e. voltage drop) they were installed within the log boom (Appendix 1). Due to their current bound state all three mixers must be operated at the same speed, except for short periods (i.e. <24 hours), to avoid placing additional strain on the pontoon's joins.
Season	During warmer months stratification is most pronounced and the risk to the Macquarie Perch and water quality is greatest. The destratification system should be operating during these periods, not only to control short-term effects, but because failure to manage the stratification during summer has the potential to significantly impact the water quality in winter and the following summer. During cooler months stratification is less pronounced and the epilimnion is thicker. The lower net temperature of the water body combined with lower atmospheric heat input means that the destratification system is more capable of controlling stratification.

Process Plan under Normal Operating Conditions

Refer to the table below for a list of process steps under normal operating conditions:

Process Step	Parameter	Target	Monitoring and Control	Action limit	Response Options	Critical limits	Corrective Action	Reference
Cotter reservoir destratification system	Operating speed	32.5 Hz	SCADA	<32.5Hz	Determine the reason for the reduction.	<15Hz	Raise a WASP task to investigate the cause and rectify.	n/a
Water quality buoys and tower analysers	Dissolved oxygen	>6 mg/L	SCADA	<6mg/L at three or more locations for seven consecutive days.	Determine cause of the reduction and consider reducing the unit's operating speed. Consult with E&S.	<3mg/L at 5 or more locations for three consecutive days.	Determine cause of the reduction and consider reducing the unit's operating speed. Consult with E&S.	Enlarged Cotter Dam Fish Management Plan

Process Plan under Abnormal Operating Conditions

The three destratification units are bound together; therefore, if one unit faults off there is additional strain placed on the connective structure. For this reason all three units should be operated at the same speed. If one unit faults off, then after 24 hours the other two should be reduced to their minimum speed (i.e. 15Hz) and completely stopped if the faulted unit does not return to service within seven days. If two units fault off then the system should be stopped immediately. Once the faults have been resolved then the unit's operating speed should be ramped up gradually over a number of days, giving consideration to the duration the system has been off and the water quality within the reservoir at the time.

If a log or foreign object is found to be lodged against or within the mixers, then the system should be turned off immediately and the object removed. Once the object has been removed and it is confirmed that the system is safe to operate, the unit's operating speed should be ramped up gradually. This may occur over a number of days, with consideration to the duration the system has been off and the water quality within the reservoir at the time. Process Compliance Operations can provide advice on a ramp up increments.

Note: The destratification system contains VSDs that are set to 180 seconds for ramp up and 90 seconds for ramp down, in order to prevent unacceptable strain being placed on the infrastructure and prevent damage to the draft tube.

Unit Process Availability Requirements and Shutdown Planning

The destratification system should be operated continuously to address stratification and the associated effects on water quality and the Macquarie Perch population. The timing and effect of stopping the system must be considered when planning maintenance and responding to issues. As a general rule the duration of the stops should be as short as possible.

During cooler months stratification is less pronounced and the epilimnion is thicker. The lower net temperature of the water body combined with lower atmospheric heat input means that the destratification system is more capable of controlling stratification. Therefore, major maintenance

should be scheduled between June and August when stopping the units will have the least impact on water quality. It is expected that issues will be investigated within 7 days and the system returned to service within 14 days.

During warmer months stratification is a greater risk to water quality. It is important to have the reservoir fully destratified going into summer. Therefore, the system should be operating with the aim of achieving a fully mixed state by August/September when stratification typically begins to develop, before turning over around June. This means that the critical period, when the system should be fully available and operational, is between August and June each year. During this time it is expected that issues will be investigated within 3 days and returned to service within 7 days.

Major component failures, where critical spares have not been identified may lead to longer outage times.

The Macquarie Perch breeding season is between October and December when fish migrate upstream to spawn. Sudden changes to the destratification regime should be minimised, particularly during this period to avoid disruption to fish migration patterns.

Impacts on Operating Philosophy/Configuration

n/a

Resourcing requirements

The following resource skillsets are required to provide adequate monitoring and control of Cotter reservoir destratification system:

Full time staff- Duty Water Distribution Engineer, Water Industry Operator and Maintenance Delivery.

Inspections of the destratification system requires boat access and; therefore, a suitably trained boat operator and a boat cleaned according to the Vehicle Wash-down, Outboard Motor Use and EHN Virus Prevention work instruction (WI03.01.06), is required.

Technical Advice- Process Compliance Operations team, Network Operations team, Maintenance Engineering and Delivery Planning team, and Catchment Protection and Land Management team.

Contractors- Some maintenance and inspection tasks require the units to be landed or the use of divers. The equipment and skills to perform these tasks are likely to be acquired from specialist contractors.

Risks

The filling of the enlarged Cotter reservoir has inundated a large area of the uncleared vegetation that has resulted in a significant amount of debris entering the reservoir. The destratification system has been installed within a log boom to reduce the risk of debris contacting and damaging the system. The logs are removed from within the log boom as required; however, the risk remains.

Failure to operate the system to this plan will increase the severity and duration of stratification within the reservoir and in doing so negatively impact the dissolved oxygen concentration of the water, increase stress on the endangered Macquarie Perch, increase dissolved metal concentrations, inhibit biological processes, increase the impacts and severity of turnover and create a reduced volume of acceptable water for treatment.

Plant trial impacts/ Potential Site improvements

The destratification system has been effectively operated at its maximum operating speed for the entire 2016-17 financial year. During this time the reservoir volume has remained relatively stable at

around 80% and the thermocline has been maintained at approximately 24m throughout summer. The depth of the thermocline is expected to reduce when the reservoir reaches full supply level (FSL), which would affect the volume of available water for treatment. Following further investigation of the systems effects (including at FSL) and performance overtime, Icon Water may decide to investigate improvements to the system.

Project works/ impacts

n/a

Appendix 1 – Cotter Reservoir Destratification System Location