Hunter Power Project

Surface Water Quality and Aquatic Ecology Impact Assessment

Rev 0

1 April 2021

Hunter Power Project

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Project Manager:	K Ivanusic
Author:	K Byrnes and J Vernon
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Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
Level 4, 12 Stewart Avenue
Newcastle West, NSW 2302
PO Box 2147
Dangar, NSW 2309
Australia
T +61 2 4979 2600
F +61 2 4979 2666
www.jacobs.com

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Executive Summary

Snowy Hydro Limited (Snowy Hydro) ('the Proponent') proposes to develop a gas fired power station near Kurri Kurri, NSW ('the Proposal'). Snowy Hydro is seeking approval from the NSW Minister for Planning and Public Spaces under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) for the Proposal. This report has been prepared on behalf of Snowy Hydro for the Proposal to support the environmental impact statement (EIS) and responds to the Secretary's Environmental Assessment Requirements (SEARs) for surface water quality and aquatic ecology.

The assessment presented in this report has included a review of relevant legislation, policy and guidelines related to surface water and aquatic ecology, as well as consideration of existing conditions through desktop assessment and field observations. The report builds on findings from the flooding and hydrology assessment and biodiversity assessment prepared for the Proposal, which are addressed in separate reports.

The desktop review identified that local waterways, with the potential to be impacted by the Proposal, were predicted habitat for the Southern Purple Spotted Gudgeon (DPI, 2016), which is listed as Endangered under the Fisheries Management Act 1994 (FM Act). However, upon further review of literature and assessment of waterway conditions in the field surrounding the Proposal study area, it was determined that the presence of this species within the study area was highly unlikely. As such, no assessment of significance was carried out for the species.

An analysis of existing water quality data and grab samples collected from the surface water sampling sites assessed key indicators of pH, electrical conductivity, dissolved oxygen, nutrients, trace metals, major ions and free cyanide. Generally, pH, electrical conductivity, and the majority of trace metals and ions had concentrations below detection limits or below ANZG (2018) default guideline values (DGVs) for either the protection of aquatic ecosystems (95 per cent species protection), primary industry (livestock drinking water) or recreation water quality guidelines (NHMRC, 2008). The exceptions were chloride, aluminium, lead and zinc, which were above the guideline levels. Dissolved oxygen was below the lower guideline value at all sites, and nutrients (TN and TP) were all higher than guideline values at all sites.

Black Waterholes Creek and Swamp Creek were identified as sensitive receiving environments based on aquatic habitat condition. The tributary of Black Waterholes Creek itself has not been identified as a sensitive receiving environment.

Upon review of the Proposal design and plans for construction and operation, it was determined that there would be no direct impacts to aquatic organisms or their habitat as there would be no instream works required, and only minor works on the river bank associated with the stormwater basin structure. Potential impacts during construction are therefore limited to mobilisation of sediment and contaminants to downstream receiving environments by wind or stormwater runoff and subsequent indirect impacts on aquatic ecosystems. During construction, the following potential impacts were identified:

- Erosion of soils and sedimentation of waterways
- Reduced water quality from elevated turbidity, increased nutrients and other contaminants associated with construction (ie. heavy metals which are bound to sediment or fuels, oils and grease from accidental spills)
- Smothering of aquatic organisms from increased sediments and associated low dissolved oxygen levels
- Potential increased occurrence of algal blooms associated with reduced water quality
- Migration of litter off-site
- Contamination due to accidental leaks or spills of chemicals and fuels.

These potential impacts are considered unlikely to occur, temporary if so, and would be managed through the implementation of proposed erosion and sediment controls and other identified management measures. Any discharges from the construction sediment basin would be carried out in accordance with standard guidelines (the Blue Book – Landcom, 2004) and any Environmental Protection Licence that may be held during construction and commissioning. A water quality monitoring plan has been recommended for implementation during construction and operation to monitor water quality and confirm that controls are working effectively.

During the operational phase, stormwater quality modelling predicted that the stormwater basin (which will also act as a water quality basin) will reduce pollutant loads flowing to the receiving downstream waterway (tributary to Black Waterholes Creek) compared to the current situation. It is possible that other water sensitive urban design alternatives that achieve similar levels of pollutant load reductions to the stormwater basin may be adopted during detailed design.

The potential impacts for uncontrolled release of process water or contaminated stormwater, potential spills or leaks and overflows will be managed by the design and Operational Environmental Management Plan.

Overall, on the basis of the assessment of the existing water quality, aquatic environment, the design of the Proposal, and on the assumption that recommended safeguards and management measures are implemented, the assessment concludes that there would be minimal impacts to the surface water quality of downstream receivers, in fact, it is predicted to result in a reduction in key pollutant loads following a rainfall event. As such, water quality objectives are likely to be met and the functionality, long-term connectivity or viability of their aquatic ecosystems would be maintained.

1. Introduction

1.1 Proposal overview

Snowy Hydro Limited (Snowy Hydro) ('the Proponent') proposes to develop a gas fired power station near Kurri Kurri, NSW ('the Proposal'). Snowy Hydro is seeking approval from the NSW Minister for Planning and Public Spaces under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) for the Proposal.

The Proposal involves the construction and operation of an open cycle gas turbine power station and electrical switchyard, together with other associated supporting infrastructure. The Proposal would have a generation capacity of up to approximately 750 megawatts (MW) which would be generated via two heavy duty gas turbines. Although primarily a gas fired power station, the facility would also be capable of operating on diesel as required, if there were a constraint or unavailability in the natural gas system and there was a need to supply electricity to the National Electricity Market (NEM).

The Proposal would operate as a "peak load" generation facility supplying electricity at short notice when there is a requirement in the National Electricity Market. The major supporting infrastructure that is part of the Proposal would be a 132 kV electrical switchyard located within the Proposal Site. The Proposal would connect into existing 132 kV electricity transmission infrastructure located adjacent to the Proposal Site. A new gas lateral pipeline and gas receival station will also be required and this would be developed by a third party and be subject to a separate environmental assessment and planning approval. Other ancillary elements of the Proposal include:

- Storage tanks and other water management infrastructure
- Fire water storage and firefighting equipment such as hydrants and pumps
- Maintenance laydown areas
- Stormwater basin
- Diesel fuel storage tank(s) and truck unloading facilities
- Site access roads and car parking
- Office/administration, amenities, workshop/storage areas.

Proposed water management infrastructure which is relevant to this assessment includes pits and pipes, pumps, diversion drains and a stormwater basin to capture runoff (refer to Figure 1.1 for proposed stormwater basin location). The stormwater basin would perform several functions during construction and operation. Table 1.1 describes the various names given to the basin and functions at various stages of the Proposal. Water quality controls are further discussed in Section 5 of this report. Stormwater detention is briefly discussed in this report in Section 6.2, however is further detailed in the Hydrology and Flooding Report prepared as part of the EIS.

Table 1.1: Stormwater basin names and functions at various stages of the Proposal.

Proposal stage	Stormwater basin name referred to in this report	Function
Construction	Construction sediment basin	The construction sediment basin would capture runoff for a number of days to allow sediment to settle out whereafter the water would be discharged to the creek in accordance with Environmental Protection Licence requirements.
Operation	Water quality basin	This "wet" lower component of the basin would capture and treat stormwater runoff to an acceptable quality in accordance with Environmental Protection Licence requirements before discharge to the creek.
	Stormwater detention basin	This "dry" upper component of the basin would provide flood attenuation during high flow events that occur when the Proposal is in operation. The stormwater detention basin would be capable of reducing peak discharges to below current peaks for flood events from a 1 in 1 year to a 1 in 100 year average recurrence interval (ARI).

A water quality basin represents the most common and accepted means of ensuring that pollutant loads from the Proposal Site's surface runoff after development are reduced so that they are not higher than pollutant loads from the Proposal Site prior to development. However, where there is limited space, unsuitable topography, contaminated soils or groundwater, other constraints or owner/ operators preferences, it is possible to adopt other water sensitive urban design alternatives that achieve similar levels of pollutant load reductions. These alternatives range from measures to increase stormwater infiltration (porous pavements, vegetated swales, sand filtration pits, rainwater tanks for reuse) to various forms of on-site water quality treatment controls (gross pollutant traps, cartridge filtration). While a stormwater basin that provides both water quality and peak stormwater detention has been proposed and assessed in this report, the final solution will be resolved during the detailed design process with the selected design and installation contractors.

Construction activities are anticipated to commence early 2022 and the Proposal is intended to be operational by the end of 2023. Further description of the Proposal is provided in Chapter 2 of the Environmental Impact Statement.

The Proposal Site is located in the small suburb of Loxford in the Hunter Valley region of New South Wales, approximately three km north of the town of Kurri Kurri, approximately 30 km north west of Newcastle CBD and 125 km north of Sydney. The Proposal Site is located within the Cessnock City Council local government area (LGA). The Proposal Site is shown in Figure 1.1 and forms part of the decommissioned Kurri Kurri aluminium smelter site, which is owned by Hydro Aluminium Kurri Kurri Pty Ltd (Hydro Aluminium), which ceased operation in late 2012 and was permanently closed in 2014. Demolition and site remediation works are ongoing but would be completed prior to construction of the Proposal.

Proposal Site
Detention basin
Existing electrical transmission easement
Motorway
Main roads
Roads
Railway
Waterbodies

1 Proposed Switchyard Area
2 Proposed Plant Area
3 Proposed Buffer Area

0 250 500 m

1:12,000 at A4
Coordinate System: GDA2020 MGA Zone 56

Data sources:
Jacobs
Metromap (Aerometrex) 2020
NSW Spatial Services

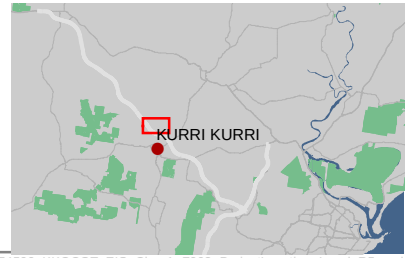

Figure 1-2 Proposal location (local)

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1.2 Purpose and scope of this report

The purpose of this report is to assess the potential impacts to surface water quality and aquatic ecology from the construction and operation of the Proposal. The report:

- Addresses the relevant SEARs listed in Table 1.2
- Describes the existing environment with respect to surface water quality and aquatic ecology
- Assesses the potential surface water quality and aquatic ecology impacts of constructing and operating the Proposal
- Recommends measures to mitigate and manage the impacts identified.

The methodology for the assessment is described in Section 3.

1.3 Secretary's Environmental Assessment Requirements (SEARs)

An environmental impact statement (EIS) for the Proposal has been prepared under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This Surface Water Quality and Aquatic Ecology Impact Assessment has been prepared to support the EIS. The purpose of this report is to address the relevant sections of the Secretary's Environmental Assessment Requirements (SEARs) issued on 5 February 2021 (SSI 12590060). The report preparation has also taken cognisance of any applicable agency comments. Table 1.2 outlines the SEARs relevant to this assessment.

Table 1.2: SEARs relevant to this assessment.

Secretary's requirement
Water – including an assessment of the impacts of the project on water quality having regard to the *NSW Water Quality and River Flow Objectives* (DECCW, 2006), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018) and *ANZECC Guidelines and Water Quality Objectives in NSW* (DEC, 2006)
Water – including a description of the erosion and sediment control measures that would be implemented to mitigate any impacts during construction
Biodiversity – including an assessment of the biodiversity values and the likely biodiversity impacts of the project in accordance with the NSW *Biodiversity Conservation Act 2016*, the Biodiversity Assessment Method (BAM) and documented in a Biodiversity Development Assessment Report (BDAR)

2. Legislation and policy framework

The following section provides consideration of the legislative and policy framework for the Surface Water Quality and Aquatic Ecology Impact Assessment. No Commonwealth legislation was identified as being applicable.

2.1 NSW Legislation

2.1.1 Environmental Planning and Assessment Act 1979 and Environmental Planning and Assessment Regulation 2000

The EP&A Act and the *Environmental Planning and Assessment Regulation 2000* (the Regulation) provide the framework for development assessment in NSW. The EP&A Act and the Regulation include provisions to ensure that the potential environmental impacts of a development are considered in the decision-making process prior to proceeding to construction. The Proposal is declared critical State Significant Infrastructure (CSSI) and an environmental impact statement (EIS) has been prepared under Division 5.2 of the EP&A Act. The SEARs have been issued and this report considers those requirements as relevant to surface water quality and aquatic ecology, including aquatic species, communities and their habitat (refer to Section 1.3).

Section 5.22 of the EP&A Act specifies that environmental planning instruments, including State Environmental Planning Policies (SEPPs), do not apply to projects that are declared CSSI. While Section 5.23 of the EP&A Act states that particular licences, permits and approvals such as a water management work approval under section 90, or an activity approval under section 91 of the *Water Management Act 2000* (WM Act) do not apply to a CSSI project.

2.1.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (NSW) (POEO Act) is administered by the Environmental Protection Authority (EPA). The POEO Act regulates air and water pollution, noise control and waste management. The Act contains pollution controls and requirements for granting environmental protection licences (EPLs) for scheduled activities under Schedule 1, which includes electricity generation, as well as for unscheduled activities or prescribed matters (as listed in Schedule 5 of the Protection of the Environment Operations (General) Regulation 2009) that cover the discharge of water that may cause pollution. This would include water being discharged from sedimentation basins after storm events.

It is expected that an EPL would be secured to cover all construction activities. Similarly, an EPL would be required for the operation of the Proposal.

2.1.3 Fisheries Management Act 1994

The *Fisheries Management Act* (FM Act) provides for the conservation, protection and management of fisheries, aquatic systems and habitats in NSW. The FM Act is administered by NSW Fisheries as part of Department of Planning, Industry and Environment (DPIE) (Regions, Industry, Agriculture and Resources) and establishes mechanisms for:

- The listing of threatened species, populations and ecological communities or key threatening processes (KTPs)
- The declaration of critical habitat
- Consideration and assessment of threatened species impacts in the development assessment process.

The Purple Spotted Gudgeon (*Mogurnda adspersa)*, which is listed as 'Endangered' under Schedule 4, Part 1 of the FM Act, has predicted habitat within Black Waterholes Creek and Swamp Creek based on Department of Primary Industries (DPI) threatened species habitat distribution mapping (DPI, 2016). However, a field assessment undertaken as part of this assessment determined that the aquatic habitat is not suitable, there have been no recorded sightings of the species in the Proposal study area (as defined in section 3.2) to date, and it is predicted that the species is likely to only inhabit coastal catchments north of Clarence River (DPI, 2017).

As such, it is considered highly unlikely that the species inhabits the study area and therefore a 'seven-part' test of significance has not been carried out.

2.2 Policy and guidelines

2.2.1 National Water Quality Management Strategy

The National Water Quality Management Strategy (2018) (NWQMS) was formulated with the objective of achieving sustainable use of the nation's water resources by protecting and enhancing water quality whilst maintaining economic and social development.

The NWQMS contains guidelines for setting water quality objectives to sustain current or likely future environmental values for water resources. The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018) are part of the NWQMS and are relevant to the Proposal as discussed in Section 2.2.2.

2.2.2 Australian and New Zealand Water Quality Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Environment and Conservation Council (ANZECC/ARMCANZ) published *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000) to provide benchmarks against which to assess the existing water quality of waterways. The guidelines were updated in 2018 to incorporate new science and knowledge developed over the past 20 years (ANZG, 2018).

The ANZG (2018) *National Water Quality Guidelines for Fresh and Marine Water Quality* (referred to herein as the ANZG (2018) Water Quality Guidelines) have been applied with guidance from the *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC, 2006) booklet to understand the current health of the waterways in the Proposal study area and the ability to support nominated water quality objectives, particularly the protection of aquatic ecosystems. The ANZG (2018) Water Quality Guidelines provide default guideline values which have been considered when describing the existing water quality and key indicators of concern. However, many of the guideline values are still in a draft form. Currently, physical and chemical stressors for aquatic ecosystems for the Southeast Coast (the geographic region relevant to this Proposal) have not yet been completely updated.

The ANZG (2018) Water Quality Guidelines are not intended to directly apply to contaminant concentrations in industrial discharges or stormwater quality (unless stormwater systems are regarded as having relevant community value). They have been derived to apply to the ambient waters that receive effluent or stormwater discharges and protect the water quality objectives they support.

2.2.3 NSW Water Quality and River Flow Objectives

The NSW Water Quality Objectives (WQOs) (DECCW, 2006) are the agreed long-term goals for NSW's surface water, as determined by the then Department of the Environment, Climate Change and Water (now Department of Planning, Industry and Environment). They set out:

- The community's values and uses (i.e. healthy aquatic ecosystem, water suitable for recreation or drinking water etc) for our waterways (rivers, creeks, lakes and estuaries)
- A range of water quality indicators to assess whether the current condition of the waterway supports these values and uses.

The WQOs identify environmental values for NSW waters and the ANZG (2018) guidelines provide the technical guidelines to assess the water quality needed to protect these values.

The Proposal Site falls within the middle portion of the Hunter River Catchment (DECCW, 2006). The waterways within this section of the catchment have been categorised as "uncontrolled streams". Uncontrolled streams and waterbodies are those that are not in estuaries or other categories. The flow pattern in these streams may have been altered in some way through land-use change and extraction. Many of these streams flow into the

regulated river sections, and so changes to their flow regime will affect downstream flows. Environmental values (DECCW, 2006) and associated default guideline values (ANZG, 2018) that have been nominated for uncontrolled streams are detailed in Section 3.3.3.

2.2.4 Managing Urban Stormwater: Soils and Construction

Managing Urban Stormwater, Soils and Construction, Volume 1 (Landcom, 2004), commonly referred to as the 'Blue Book', outlines the basic principles for stormwater management during construction. It provides guidance on design and construction of sediment and erosion control measures to protect downstream water quality, thereby improving the health, ecology and amenity of rivers and streams.

2.2.5 Guidelines for Managing Risks in Recreational Waters

The *Guidelines for Managing Risks in Recreational Water* (NHRMC, 2008) aim to protect the health of humans from threats posed by the recreational use of coastal, estuarine and fresh waters.

The guidelines provide recommended values for indicators that may pose a risk to human health. These indicators are relevant for waterways that are being used for recreation but have the potential to be polluted. These guidelines are applicable to this assessment because the waterways in proximity of the Proposal Site have been nominated the environmental values of 'Primary contact recreation' and 'Secondary contact recreation'. This is further detailed in Section 3.3.3.

2.2.6 Approved Methods for Sampling and Analysis of Water Pollutants in NSW

The *Approved Methods for Sampling and Analysis of Water Pollutant in NSW* (DECC, 2004) is a guideline which lists the sampling and analysis methods that are approved for use when complying with a requirement by, or under, the POEO Act, or a licence or notice number under that legislation. The process for determining the sampling and analysis methods to be used are outlined in these guidelines.

As part of the water quality protection strategy for the Proposal, a water quality monitoring program will be developed and implemented during the construction and post-construction phases of the Proposal. The water quality monitoring program is further detailed in Section 7.2. Water sampling and analysis methods outlined in the sample collection and handling guideline will be utilised throughout this process.

2.2.7 Policy and Guidelines for Fish Habitat Conservation and Management

The *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) is the guideline applicable to all planning and development proposals and various activities that affect freshwater ecosystems in NSW. The aims of this guideline are to maintain and enhance fish habitat for the benefit of native fish species, including threatened species in freshwater environments. First published in 1999, the 2013 updated document assists developers, their consultants and government and non-government organisations to ensure their actions comply with legislation, as well as policies and guidelines that relate to fish habitat conservation and management. It is also intended to inform land use and natural resource management planning, development planning and assessment processes, and to improve awareness and understanding of the importance of fish habitats and how impacts can be mitigated, managed and offset. The guidelines outlined in this document are taken into account when NSW Fisheries assesses proposals for developments and other activities that affect fish habitats. The document contains:

- Background information on aquatic habitats and fisheries resources in NSW
- An outline of the legislative requirements relevant to planning and development which may affect fisheries or aquatic habitat in NSW
- General policies and classification schemes for the protection and management of fish habitats and an outline of the information that NSW Fisheries requires to be included in development proposals that affect habitat

- Specific policies and guidelines aimed at maintaining and enhancing the free passage of fish through instream structures and barriers
- Specific policies and guidelines for foreshore works and waterfront developments
- Specific policies and guidelines for the management of other activities that affect watercourses.

The aquatic habitat assessment has taken into account the requirements of these guidelines (refer to Section 4.5).

2.2.8 Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings

The DPI guideline *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (*Fairfull and Witheridge, 2003*)* provides practical guidelines for the planning, design, construction and maintenance of watercourse crossings aimed at minimising impacts of fish passage and aquatic ecology in general. It should be used in conjunction with the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) by outlining potential impacts of instream structures and design specifications/recommendations for crossings to avoid erecting barriers to fish passage.

The aquatic habitat assessment has taken into account the requirements of these guidelines (refer to Section 4.5).

2.2.9 Aquatic Ecology in Environmental Impact Assessment – EIA Guideline

DPIE's *Aquatic Ecology in Environmental Impact Assessment - EIA guideline* (NSW Department of Planning, 2003) (the EIA guideline) provides a framework to assist proponents of projects and their consultants, the community and decision-makers in the identification, prediction and assessment of impacts and suggest approaches to the management of impacts that have been predicted or observed through monitoring. The guidelines also aim to facilitate improvement of the environmental impact process in general by:

- Encouraging a standardised, rigorous approach to aquatic investigations in environmental impact assessment
- Providing information which can be used to understand and manage changes to the aquatic environment in NSW.

The guidelines apply to the assessment of impacts on aquatic habitats including coastal waters, estuaries, rivers and streams, natural and artificial lakes and reservoirs, and permanent and ephemeral wetlands. The guidelines may be applied whenever aquatic ecological assessment is required under the EP&A Act. The guidelines provide reference for:

- The extent to which the existing environment needs to be described
- The extent to which a proposal is likely to affect aquatic ecology
- The minimal acceptable standard for assessment of potential impacts on aquatic ecology
- Predicting cumulative impacts within a body of water
- When monitoring should be done and what components of aquatic ecology (biotic and abiotic) should be monitored
- Requirements for adequate information to manage potential impacts and initiate feedback from monitoring to management.

The existing environment, assessment and sampling methodology, potential impacts, as well as recommendations for mitigation measures which are outlined in this report have taken into consideration the EIA guidelines.

3. Methodology

3.1 General

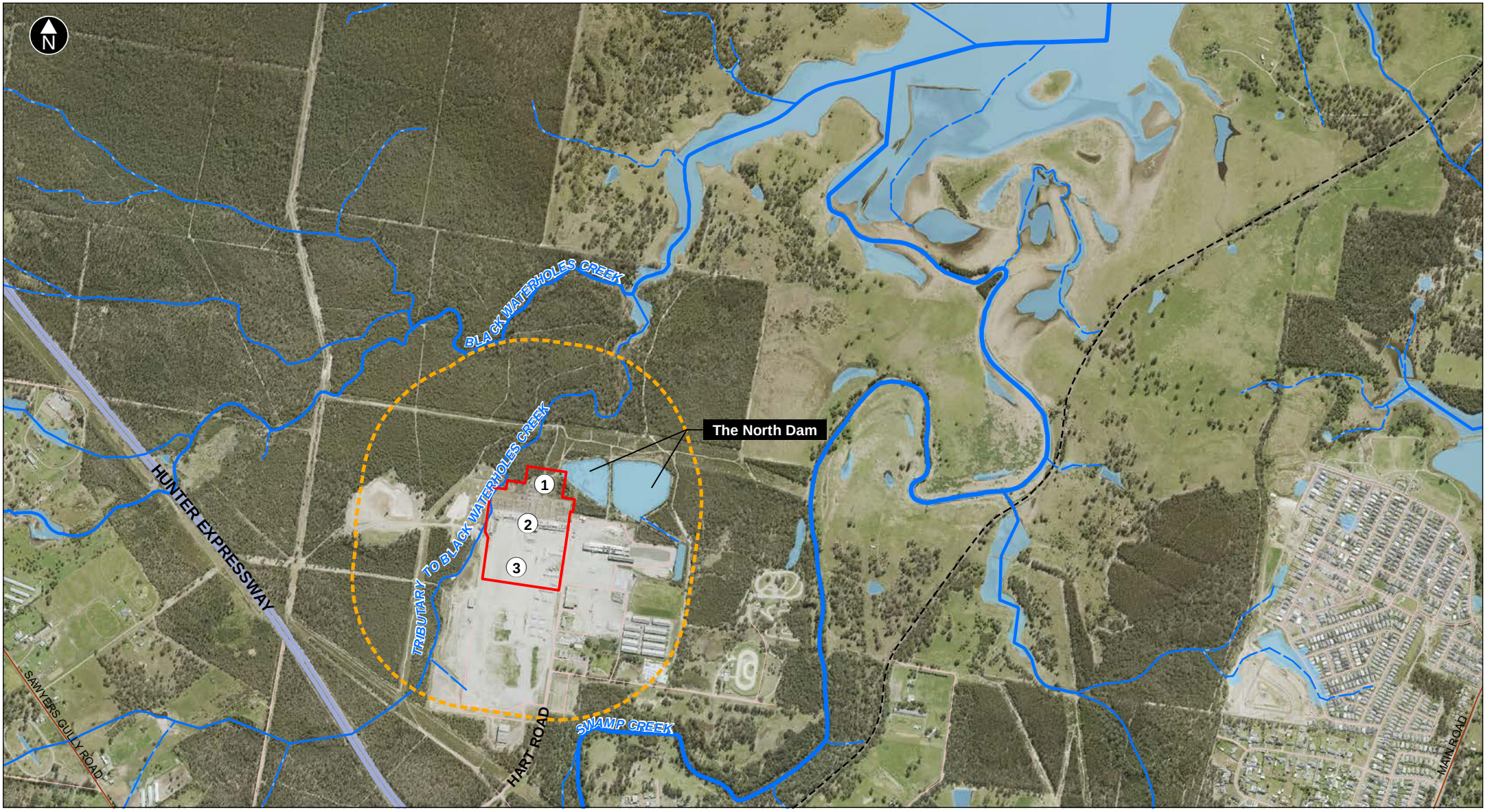
The methodology for assessment of potential surface water quality and aquatic ecology impacts arising from the Proposal is outlined in the following sections and has broadly included:

- Desktop review and analysis of existing surface water quality information to understand the existing environment and identify potential waterway-specific risks
- Field assessment including collection of surface water grab samples and aquatic habitat assessment at nominated sites within the study area to support and enhance findings of the desktop analysis and refine the understanding of potential issues
- A qualitative assessment of the quality and quantity of pollutants that may be introduced during construction and operation of the Proposal, and the impact that this may have on surface water quality (with reference to the ANZG (2018) *Water Quality Guidelines* and with regard to relevant environment values as identified in the DECCW (2006) *NSW Water Quality and River Flow Objectives*
- Recommendations for appropriate treatment measures to mitigate the impacts of construction and operation on surface water quality and aquatic ecosystems, including water quality controls and water quality monitoring program during construction and operation of the Proposal.

3.2 Study area

The Proposal study area for the surface water quality and aquatic ecology impact assessment is the area directly affected by the Proposal and any additional areas likely to be indirectly affected by the Proposal. The study area generally comprises the construction and operational footprints and a 500 m buffer around the Proposal footprint. In addition, Black Waterholes Creek and Swamp Creek (which form part of Wentworth Swamp) have also been considered in this assessment despite their location being outside the nominated study area as they are important downstream waterways with potential to be impacted by Proposal activities.

Due to the anthropogenic activities that have been historically undertaken at the Proposal Site and surrounds, waterways within the study area have been classified as 'slightly to moderately disturbed ecosystems', which is defined as 'Ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity' (ANZG, 2018).



Data sources:
Jacobs 2020
Metromap (Aerometrex) 2020
NSW Spatial Services

Figure 3-1 Study area – Surface water quality and aquatic ecology impact assessment

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snowy hydro renewable energy Jacobs

3.3 Desktop assessment

3.3.1 Desktop review

The desktop assessment involved a review of existing surface water and aquatic habitat conditions across the Proposal study area to assess the likely and potential impacts of the Proposal on surface water quality and aquatic ecology during construction and operation. The review of information has included review of available literature, water quality data, background information on land use and information about the design and operation of the Proposal. Information sources included:

- The Bionet – the Atlas of NSW Wildlife Threatened Species Profile Database (EESG, 2020) (accessed December 2020), which was searched for records of Commonwealth and state listed aquatic flora and fauna within a 10 km radius of the Proposal Site
- Atlas of Living Australia (ALA, 2020) (accessed December 2020), which was searched for records of Commonwealth and state listed aquatic flora and fauna within the Proposal study area
- Key fish habitat (KFH) Mapping (DPI, 2007) and threatened species distribution maps (DPI, 2016) (accessed December 2020) available on the NSW Fisheries website, which were examined for the potential presence of threatened species in the Proposal study area
- 2015 Annual Environment Report – Hydro Aluminium Kurri Kurri Smelter (Hydro Aluminium, 2015)
- 2016 Annual Environment Report – Hydro Aluminium Kurri Kurri Smelter (Hydro Aluminium, 2016)
- 2017 Annual Environment Report – Hydro Aluminium Kurri Kurri Smelter (Hydro Aluminium, 2017).

It is important to note that for the purposes of this report and assessment, the aquatic ecology assessment focuses on aquatic fauna species which live most, if not all, of their life in the aquatic environments within the study area. A particular focus is given to potential threatened fish and dragonfly species predicted or observed within the study area (refer to Section 4.4). Amphibians and reptiles are considered in the Biodiversity Development Assessment Report prepared as part of the EIS.

3.3.2 Sensitive Receiving Environments

Sensitive receiving environments (SREs) are environments that have a high conservation value or support ecosystems/human uses of water that are particularly sensitive to pollution or degradation of water quality. It is important to identify SREs that are directly impacted by the Proposal or are located downstream of Proposal activities so that these values may be adequately protected.

SREs have been determined using aquatic habitat as an indicator. The level of sensitivity of an aquatic environment was determined through classification of key fish habitat "Type" and waterway "Class" in accordance with criteria outlined in the Department of Primary Industries *Policy and Guidelines for Fish Habitat Conservation and Management* (2013) and *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge, 2003), respectively. The assessment of KFH "Type" is based on the presence of habitat structures such as woody debris, macrophytes and substrate characteristics, as well as on the predicted presence of threatened aquatic species (DPI, 2013). Assessment of waterway "Class" is determined by physical characteristics of the waterway (Fairfull & Witheridge, 2003).

SREs within the Proposal study area have been identified and described in Section 4.5.

3.3.3 Environmental values

As described in Section 2.2.3, DECCW (2006) waterways in the study area are categorised as "uncontrolled streams" which have been nominated a number of water quality objectives/environmental values. These are:

- **Protection of aquatic ecosystems:** Aquatic ecosystems comprise the animals, plants and micro-organisms that live in water and the physical and chemical environment in which they interact. Aquatic ecosystems have historically been impacted upon by multiple pressures including changes in flow regime, modification and destruction of key habitats, development and poor water quality. Water quality parameters can be divided into those that have a direct toxic effect on organisms and animals (toxicants) and those that indirectly affect ecosystems causing a problem for a specific environmental value (stressors). Toxicants which are relevant to this assessment are primarily metals/metalloids, while the stressors include nutrients, which consist of nitrogen (total nitrogen (TN), ammonia, oxidised nitrogen (NO_x)) and phosphorus (total phosphorus (TP) and filterable reactive phosphorus (FRP)), turbidity, total suspended solids (TSS), salinity and pH which have the potential to cause degradation of aquatic ecosystems. The DECCW (2006) objectives for aquatic ecosystems are consistent with the agreed national framework for assessing water quality set out in the ANZG (2018) guidelines.
- **Visual amenity:** The aesthetic appearance of a waterbody is an important aspect with respect to visitation and recreation. The water should be free from noticeable pollution, floating debris, oil, scum and other matter. Substances that produce objectionable colour, odour, taste or turbidity and substances and conditions that produce undesirable aquatic life should not be apparent (NHMRC, 2008). The key aesthetic indicators are transparency, odour and colour
- **Secondary contact recreation:** Secondary contact recreation implies some direct contact with the water would be made but ingestion is unlikely in activities such as boating, fishing and wading. Bacteriological indicators are used to assess the suitability of water for recreation
- **Primary contact recreation:** Primary contact recreation implies some direct contact with the water would be made during activities such as swimming in which there is a high probability of water being swallowed. Bacteriological indicators, nuisance organisms, algal blooms, pH, temperature, chemical contaminants, surface films, visual clarity and colour are used to assess the suitability of water for recreation
- **Livestock water supply:** The purpose of the livestock water supply objective is to protect water quality to maximise the production of healthy livestock. Indicators monitored for this objective include algae and blue-green algae, salinity, faecal coliforms and chemical contaminants
- **Irrigation water supply:** The purpose of the irrigation water supply objective is to protect quality of waters applied to crops and pasture. Indicators monitored for this objective include algae and blue-green algae, salinity, faecal coliforms and heavy metals
- **Aquatic food (cooked):** Aquaculture generally involves the production of food for human consumption, and suitable water quality is needed for maintaining viable aquaculture operations. The guidelines primarily relate to toxicant concentrations and reducing the potential for these to accumulate in the tissues of seafood that is likely to be consumed by humans.

Additionally, objectives for streams within the catchment have also been nominated, namely:

- Homestead water supply
- Drinking water at point of supply – Disinfection only
- Drinking water at point of supply – Clarification and disinfection
- Drinking water at point of Supply – Groundwater.

However, these do not apply to streams within the Proposal study area as the area is not included in the drinking water catchment.

The environmental values have been considered in the assessment of existing water quality and potential impacts as a result of the Proposal.

Key water quality indicators and related numerical criteria (default guideline values) have been nominated for each environmental value using the ANZG (2018) Water Quality Guidelines. As mentioned in Section 3.2 the Proposal Site has been classified as 'slightly to moderately disturbed' and therefore ANZG (2018) recommend applying the guidelines for 'slightly to moderately disturbed ecosystems' for physical and chemical stressors and assessing toxicants against the 95 per cent species protection level and 99 per cent species protection level for bioaccumulating toxicants. These values and indicators are provided in Table 3.1.

Table 3.1: Key water quality indicators and related numerical criteria for environmental values using the ANZG (2018) Water Quality Guidelines

Environmental value	Indicator	Guideline value
Aquatic ecosystems – maintaining or improving the ecological condition of waterbodies and riparian zones over the long term	Total phosphorus	0.025mg/L
	Total nitrogen	0.35mg/L
	Chlorophyll-a	0.003mg/L
	Turbidity	6-50NTU
	Salinity (electrical conductivity)	125-2200µS/cm
	Dissolved oxygen	85-110% saturation
	pH	6.5-8.5
	Toxicants	As per ANZG (2018) toxicant default guideline values (95% level of protection for slightly to moderately disturbed ecosystems and 99% level of protection for toxicants that bioaccumulate) Relevant indicators include: Filterable reactive Phosphorus – 0.02mg/L Aluminium – 0.055mg/L Arsenic – 0.024mg/L Boron – 0.37mg/L Cadmium – 0.00006mg/L Chromium – 0.001mg/L Lead – 0.0034mg/L Mercury – 0.00006mg/L Nickel – 0.011mg/L Zinc – 0.008mg/L Free cyanide – 0.007mg/L
Visual amenity – aesthetic qualities of waters	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
	Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter n/a (no quantitative value specified)

Environmental value	Indicator	Guideline value
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts n/a (no quantitative value specified)
Secondary contact recreation – maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed	Faecal coliforms, enterococci, algae and blue-green algae	Median over bathing season of <230 enterococci per 100 mL (maximum number in any one sample: 450-700 organisms/100 mL) Median over bathing season of <1000 faecal coliforms per 100 mL, with 4 out of 5 samples < 4000/100 mL Algae <15000 cells/mL
	Nuisance organisms	As per the visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable of recreation. Toxic substances should not exceed values in Table 9.3 of NHMRC (2008) guidelines.
	Visual clarity and colour	As per the visual amenity guidelines.
	Surface films	As per the visual amenity guidelines.
Primary contact recreation – maintaining or improving water quality for activities such as swimming where there is a high probability of water being swallowed	Faecal coliforms, enterococci, algae and blue-green algae	Median over bathing season of < 35 enterococci per 100 mL (maximum number in any one sample: 60 – 100 organisms/100 mL) Median over bathing season of < 150 faecal coliforms per 100 mL, with 4 out of 5 samples < 600/100 mL Algae <15000 cells/mL.
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water.
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation. Toxic substances should not exceed values in table 9.3 of the NHMRC (2008) guidelines. Relevant contaminants include: Filterable reactive phosphorus – 0.02mg/L Arsenic – 0.007mg/L Boron – 4mg/L Cadmium – 0.002mg/L Chloride – 250mg/L Chromium – 0.05mg/L Cyanide – 0.08mg/L Fluoride – 1.5mg/L Lead – 0.01mg/L Nickel – 0.02mg/L Zinc – 3mg/L

Environmental value	Indicator	Guideline value
	Visual clarity and colour	As per the visual amenity guidelines.
	Temperature	15°-35°C for prolonged exposure.
Irrigation water supply – protecting the quality of waters applied to crops and pastures	Algae and blue-green algae	Should not be visible. No more than low algal levels are desired to protect irrigation equipment.
	Salinity (electrical conductivity)	To assess the salinity and sodicity of water for irrigation use, a number of interactive factors must be considered including irrigation water quality, soil properties, plant salt tolerance, climate, landscapes and water and soil management. For more information, refer to Chapter 4.2.4 of ANZECC/ARMCANZ 2000 Guidelines.
	Thermotolerant coliforms (faecal coliforms)	Trigger values for thermotolerant coliforms in irrigation water used for food and non-food crops are provided in Table 4.2.2 of the ANZECC/ARMCANZ 2000 Guidelines.
	Heavy metals and metalloids	Long term trigger values (LTV) and short-term trigger values (STV) for heavy metals and metalloids in irrigation water are presented in Table 4.2.10 of the ANZECC/ARMCANZ 2000 guidelines.
Livestock water supply – protecting water quality to maximise production of healthy livestock.	Algae & blue-green algae	An increasing risk to livestock health is likely when cell counts of microcystins exceed 11 500 cells/mL and/or concentrations of microcystins exceed 0.0023mg/L expressed as microcystin-LR toxicity equivalents.
	Salinity (electrical conductivity)	Recommended concentrations of total dissolved solids in drinking water for livestock are given in Table 4.3.1 of the ANZECC/ARMCANZ 2000 Guidelines.
	Thermotolerant coliforms (faecal coliforms)	Drinking water for livestock should contain less than 100 thermotolerant coliforms per 100 mL (median value).
	Chemical contaminants	Refer to Table 4.3.2 (ANZECC/ARMCANZ 2000 Guidelines) for heavy metals and metalloids in livestock drinking water. Refer to Australian Drinking Water Guidelines (NHMRC and NRMMC 2011) for information regarding pesticides and other organic contaminants, using criteria for raw drinking water.
Aquatic foods (cooked) – refers to protecting water quality so that it is suitable for production of aquatic foods for human consumption and aquaculture activities	Algae and blue-green algae	No guideline is directly applicable, but toxins present in blue-green algae may accumulated in other aquatic organisms.
	Faecal coliforms	Guideline in water for shellfish: The median faecal coliform concentration should not exceed 14 MPN/100 mL; with no more than 10 per cent of the samples exceeding 43 MPN/ 100 mL. Standard in edible tissue: Fish destined for human consumption should not exceed a limit of 2.3 MPN E Coli/g of flesh with a standard plate count of 100,000 organisms /g.

Environmental value	Indicator	Guideline value
	Toxicants (as applied to aquaculture activities)	Metals: Copper – less than 0.005mg/L Mercury – less than 0.001mg/L Zinc – less than 0.005mg/L. Organochlorines: Chlordane – less than 0.004mg/L (saltwater production) PCBs – less than 0.002mg/L.
	Physico-chemical indicators (as applied to aquaculture activities)	Suspended solids: less than 0.04mg/L Temperature: less than 2°C change over one hour.

Often in modified environments there is the potential for the current water quality to not meet the existing guidelines and trigger values for protecting nominated environmental values. Irrespective of the current condition of waterways, the Proposal should not further degrade water quality. As such, the key objective of the Proposal is to minimise the potential impacts on downstream receiving waters, so that the Proposal changes the existing water regime by the smallest amount practicable.

3.4 Field assessment

3.4.1 Water quality sampling and aquatic habitat assessment

Water quality samples and aquatic habitat assessments were undertaken by environmental scientists at nominated sites within the Proposal study area on 12 November 2020. Nominated water sampling sites were chosen on natural waterways with the potential to be impacted by the Proposal, and at locations that corresponded closely to several sampling sites (Site 1, 9 and 62) of the Hydro Aluminium surface water monitoring program (refer to Section 3.5 for detail) to aid data analysis by ensuring grab sample data was comparable with previous available data.

According to Heddon Greta – Kurri Kurri Golf Club (#61414) weather station (BOM, 2021a), no rain had fallen within five days prior to sampling. The sampling event is therefore classified as a dry weather sampling event.

The purpose of the site visit to the Proposal study area was to collect surface water grab samples and to visually assess the condition of aquatic habitat at sites on waterways within the study area. Aquatic habitat was assessed against criteria outlined in the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) and *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge, 2003), whereby assessment sites have been classified into KFH "Type" and waterway "Class". Outcomes of this assessment are detailed in Section 4.5. Nominated surface water and aquatic habitat assessment sites are listed in Table 3.2 and shown in Figure 3.2. Applicable surface water monitoring sites (Site 1, 9 and 62) from the Hydro Aluminium surface water monitoring program are also shown on Figure 3.2.

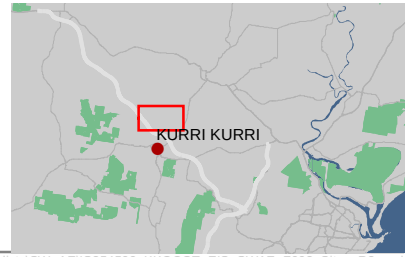
Table 3.2: Aquatic habitat assessment and water sampling sites

Site Number	Site Details	Eastings	Northings	Description
SW 1	Tributary of Black Waterhole Creek	357390.1	6371336.9	Immediately west of the Proposal Site. Approximately 150 m upstream of Site 9 (Hydro Aluminium 2015 – 2017 Surface water monitoring program).
SW 2	Black Waterholes Creek	358059.6	6372376.2	Approximately 800 m north of the Proposal Site at its nearest point. Approximately 100 m downstream of Site 1 (Hydro Aluminium 2015 – 2017 Surface water monitoring program).
SW 3	Swamp Creek	359509.0	6372899.8	Approximately 900 m east of the Proposal Site at its nearest point. Approximately 600 m downstream of Site 62 (Hydro Aluminium 2015 – 2017 Surface water monitoring program).

Proposal site
Study area
Motorway
Main roads
Roads
Railway
Waterbodies
Nominated surface water sampling and aquatic habitat assessment sites
Hydro Aluminium 2015 - 2017 surface water monitoring program sampling sites

0 500 1000 m

1:20,000 at A4
Coordinate System: GDA2020 MGA Zone 56



Data sources:
Jacobs 2020
Metromap (Aerometrex) 2020
NSW Spatial Services

Figure 3-2 Nominated surface water and aquatic habitat assessment sites

snowy hydro renewable energy Jacobs

Date: 5/03/2021 Path: \\Jacobs.com\ANZ\IE\Projects\04_Eastern\IS354500\22_Spatial\GIS\Directory\Templates\Figures\KurriKurriEIS\Specialists\SW_AE\IS354500_KKOCGT_EIS_SWAE_F002_Sites_R2.mxd
Created by : AA | QA by : KI

Water quality sampling was carried out where sufficient water was present. In-situ water quality parameters including temperature, conductivity, salinity, pH and dissolved oxygen were measured using a calibrated *YSI Pro Plus* multi-parameter water quality meter. Turbidity was also measured in situ using a *Hach* turbidimeter.

Measurements were generally collected at the edge of the waterway (so as to not disturb the streambed) between 15 and 30 cm below the surface of the water. Sampling depth was recorded in the field. For each parameter measured in situ, three replicate measurements were recorded about 10 m apart. Each parameter was then recorded as the average (arithmetic mean) of the three measures.

Grab samples were also collected at each site and sent to the laboratory for analysis. Grab sampling occurred at the same location and depth as in situ monitoring. Grab samples were collected in pre-sterilised laboratory supplied bottles, labelled, stored on ice and sent to a National Association of Testing Authorities (NATA) accredited laboratory for analysis. The analytical suite for laboratory analysis included:

- Dissolved metals (aluminium, boron, cadmium, chromium, copper, lead, mercury, nickel, and zinc)
- Oxidised nitrogen (NO_x)
- Total Kjeldahl Nitrogen (TKN)
- Total nitrogen (TN)
- Total phosphorus (TP)
- Filterable reactive phosphorus (FRP)
- Dissolved major cations (Ca)
- Fluoride (F)
- Total and free cyanide (free CN).

Monitoring Quality Assurance and Quality Control (QA/QC) comprised of calibration of field equipment prior to sampling and laboratory QA/QC at the NATA accredited laboratory where samples were submitted for analysis. Holding times were met for all analytes.

3.5 Existing water quality data analysis

Water quality data used in this report to establish existing water quality is sourced from available historic data (Hydro Aluminium, 2015; Hydro Aluminium, 2016; Hydro Aluminium, 2017) discussed below, and grab samples collected for this assessment from nominated waterways within the Proposal study area (refer to Section 3.4).

Historic water quality data that was readily available included three years of monitoring data (2015 to 2017), collected during a surface water monitoring program undertaken by Hydro Aluminium as a condition of their EPL that was held for the Kurri Kurri aluminium smelter operations and decommissioning. Monitoring was carried out monthly at 16 sites in 2015, 18 sites in 2016 and 20 sites in 2017 (Hydro Aluminium, 2015; Hydro Aluminium, 2016; Hydro Aluminium, 2017). Monitoring sites were located across the Hydro Aluminium owned land and encompassed the creek systems of Wentworth Swamp, ephemeral ponds located on the surrounding land also owned by Hydro Aluminium and catchment dams located between two km and seven km from the Kurri Kurri aluminium smelter site. Monitoring results were reported annually by Hydro Aluminium in an annual environmental monitoring report (Hydro Aluminium, 2015; Hydro Aluminium, 2016; Hydro Aluminium, 2017) and were compared against ANZECC/ARMCANZ (2000) (now ANZG, 2018) water quality guideline limits for stock watering (fluoride only), irrigation (pH and fluoride), and aquatic ecosystems (pH, conductivity and free cyanide).

The methodology for determining existing water quality conditions included:

- Collating water quality data
- Calculating summary statistics for each site including number of samples, mean, median, maximum and minimum value
- Reporting the median historical data and mean sampled data in comparison with DECCW (2006) water quality objectives and ANZG (2018) default guideline values (DGVs).

4. Existing Environment

4.1 Hunter River catchment overview

The Proposal Site is situated in the Hunter River catchment in NSW, which drains a total area of about 22,000 square kilometres (EPA, 2013). The Hunter River flows in a south-westerly direction from Glenbawn Dam in the Liverpool ranges to meet Goulburn River near Denman. From Denman, the river flows generally in a south-easterly direction through Singleton and Maitland to the north of the Proposal Site before reaching the Tasman Sea at Newcastle (DIPNR, 2004). Elevations across the catchment vary from over 1,500 m above sea level in the mountain ranges, to less than 50 m above sea level on the floodplains of the lower valley. Four major rivers discharge into the Hunter River along its length – these are Pages River, Goulburn River, Williams River and Paterson River.

4.1.1 Land use

Broadly, the Hunter region supports a range of agricultural activities including wineries, dairying, vegetables, fodder, beef and horse breeding as well as over 20 of the largest coal mines in Australia and two operational coal-fired power stations. Redbank Power Station, which is currently not in operation, is also located within the Hunter River catchment. The Hunter River is regulated from Glenbawn Dam to Maitland, spanning a distance of approximately 250 km. Regulated rivers typically have flows controlled or supplemented from dams in order to supply irrigation, town and industrial water to for substantial distances downstream (DECCW, 2006).

On a local scale, the Proposal Site forms part of the former Kurri Kurri aluminium smelter which operated from 1969 to late 2012 and was closed in 2014. Since the closure of the Kurri Kurri aluminium smelter, extensive remediation works have taken place at the site, including Stage 1 of a two-stage demolition program of existing structures, asbestos removal and recycling of waste materials.

The site's current condition is that of a brownfield site, extensively disturbed by past industrial development. Only a small portion of the Proposal Site would require disturbance of undisturbed land (vegetation clearing).

The Proposal Site and vicinity is currently the subject of a rezoning application. Currently, the Proposal Site and its surrounds are zoned RU2 Rural Landscape under the *Cessnock Local Environmental Plan 2011* (Cessnock LEP), with small pockets of surrounding land zoned E2 Environmental Conservation. There is some native vegetation adjacent to the Proposal Site to the north, east and west. Land further east and north of the Proposal Site comprises low-lying open rural land, and the waterways of Swamp Creek, Black Waterholes Creek and the Swamp Creek wetlands, which lead to the Wentworth swamps and are part of the extensive Hunter River floodplain (refer to Section 4.2). The Hunter River is approximately nine km north-east of the Proposal Site in Maitland.

4.1.2 Climate

The climate of the Hunter region is classified as warm and temperate, generally experiencing mild to hot summers and cool to mild winters. Average maximum temperature approaches 31 degrees in January and average maximum July temperatures are about 18 degrees (BOM, 2021b).

Between 2007 and 2020, average annual rainfall is approximately 770 mm (BOM, 2021c). During this period, the highest mean monthly rainfall for the Hunter region near Kurri Kurri occurred in June. High monthly rainfall also occurred between February and April which accounts for approximately one third of the average annual rainfall (refer to Figure 4.1) (BOM, 2021c).

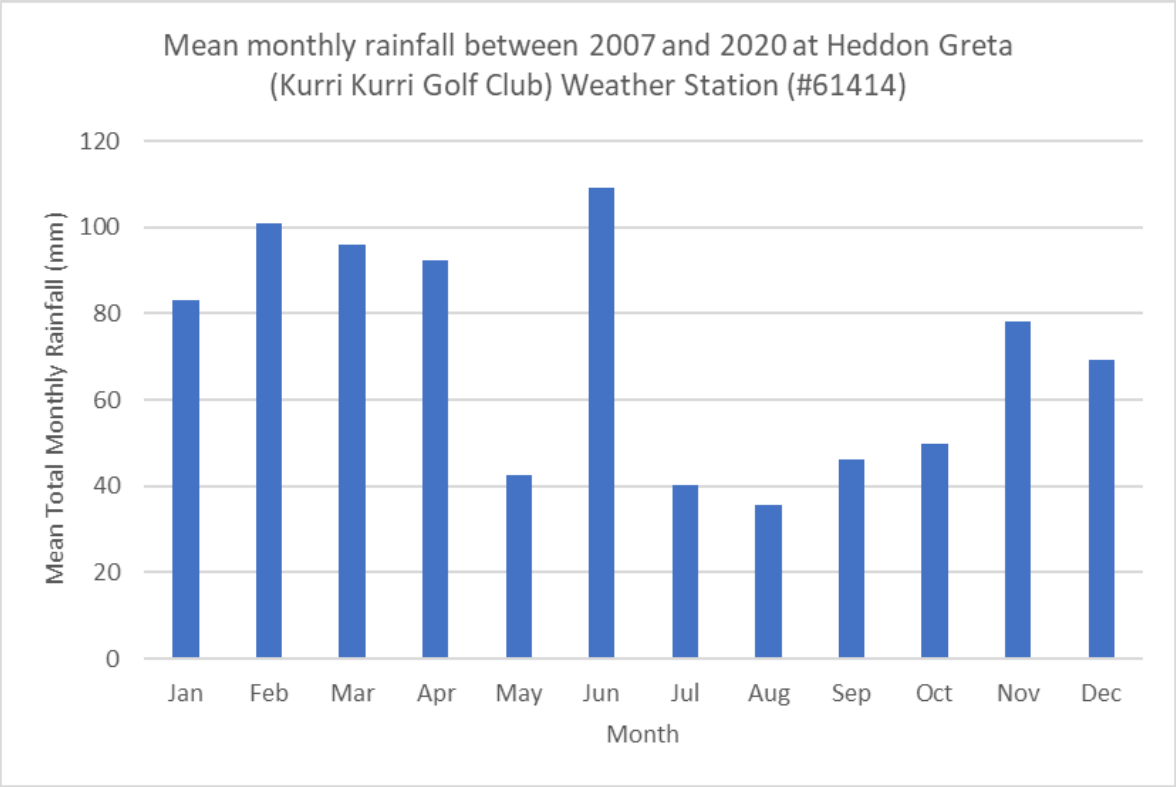


Figure 4.1: Mean total rainfall between January 2007 and December 2020

4.1.3 Site topography and drainage

The proposed topographic profile of the Proposal Site would have an overall slope of approximately 0.5 per cent falling from the southern boundary to the northern boundary and from east to west. The lowest point of the Proposal Site is estimated to be approximately 13 m Australian Height Datum (AHD) at the northwest corner of the Proposal Site. The highest point of the Proposal Site would be at the south-east corner and is estimated to be approximately 14.2 m AHD. The exact levels for the Proposal Site will be confirmed during detailed design.

The current surface water hydrology over the Proposal Site is suggested to comprise approximately 50 per cent of stormwater runoff (untreated) draining west to Black Waterholes Creek, and the remaining 50 per cent being diverted to the stormwater retention ponds located to the north-east of the Proposal Site via an existing stormwater drainage system. Further information about site drainage is available in the Flooding and Hydrology Assessment prepared as part of the EIS.

4.1.4 Soils landscapes and characteristics

The Proposal Site was raised by localised cut and fill activities during construction of the Kurri Kurri aluminium smelter and has been heavily disturbed by previous aluminium smelter activities between 1969 and 2014, including widespread foundations and footings extending to more than 1.5 m in depth. The Proposal Site is currently subject to an intensive, staged remediation program which would be completed to a suitable standard prior to construction of the Proposal.

Soil landscapes

A geotechnical review and intrusive investigation completed for the Proposal indicated deep alluvial soils across the Proposal Site, with siltstone bedrock at approximately 14 m to 18 m depth. Laboratory testing undertaken on near surface soils indicates that they are sodic and hence have the potential to be dispersive in nature.

Acid Sulphate Soils

Acid Sulphate Soils (ASS) are unlikely at the Proposal Site according to probability mapping (DPIE, 2021a). Soils approximately 500 m north and east of the Proposal Site, surrounding and within Black Waterholes Creek and Swamp Creek, are classified as 'Class 2 - high probability of ASS greater than one metre below ground surface' and 'Class 4 - low probability of ASS greater than three metres below ground surface', respectively. However, laboratory testing results from geotechnical investigations indicate that some of the alluvial soils at depth are Acid Sulfate Soils.

4.2 Waterways and other water features

The Proposal Site is located in proximity to three waterways, these include:

- Swamp Creek, which drains to Wentworth Swamp, which is a perennial waterway that flows south to north and is located about 900 m east of the Proposal Site at its nearest point
- An unnamed tributary of Black Waterholes Creek, which is an ephemeral waterway that flows generally south west to north east immediately adjacent to the Proposal Site on the western boundary
- Black Waterholes Creek which is a perennial waterway located downstream of the tributary and subsequently flows into Swamp Creek about 1.5 km downstream. Black Waterholes Creek is located about 800 m north of the Proposal Site at its nearest point.

All three waterways eventually converge to Swamp Creek which continues flowing north and drains a large network of low lying, floodplain environments known as Wentworth Swamp. Swamp Creek ultimately flows into Wallis Creek about 10 km downstream of the Proposal Site and Wallis Creek joins to the Hunter River a further seven km downstream.

Other important water features within the Proposal study area are two large artificial stormwater retention ponds (both approximately one metre deep) associated with the stormwater management system of the Kurri Kurri aluminium smelter. Following the closure of the Kurri Kurri aluminium smelter, the ponds still receive site runoff which Hydro Aluminium is licenced (under their EPL) to discharge to an irrigation area on an adjacent heavily vegetated property north of the ponds. The ponds currently have a combined capacity of approximately 130,000 m^3.

4.3 Existing surface water quality

At the time of this assessment, available water quality data for waterways within the Proposal study area was limited. Water quality data was requested from Maitland City Council, Cessnock City Council, Department of Planning, Industry and Environment (DPIE), Hunter Water and Local Land Services (LLS). Maitland City Council, Cessnock City Council and DPIE confirmed that they do not monitor the aforementioned waterways. Local Land Services advised that they have water quality data collected by community groups which due to QA/QC is not of an acceptable quality to use in environmental assessments. No response was received from Hunter Water.

Historic water quality data that was readily available for review was therefore limited to three years of monthly monitoring data collected by Hydro Aluminium between 2015 and 2017 (Hydro Aluminium 2015; Hydro Aluminium 2016; Hydro Aluminium 2017). Data collected during the Hydro Aluminium surface water monitoring program has been analysed and the median value across all sampling events for each parameter has been presented. Water quality grab samples which were collected from assessment sites (refer to Table 3.2, Table 4.2 and Figure 3.2) have also been analysed to complement the historic data. It should be noted, however that the grab sample data is solely reflective of water quality at the time of collection and should not be interpreted as long-term water quality trends.

The existing water quality data has been compared to the ANZG (2018) water quality guideline DGVs for the protection of aquatic ecosystems for slightly to moderately disturbed lowland rivers (95 per cent species protection). Where there are no guideline values available for toxicants and stressors for the protection of

aquatic ecosystems, other guideline values (irrigation water supply and livestock water supply) have been adopted.

Table 4.1 provides results of the water quality analysis. Based on available data the following observation are made:

- pH and electrical conductivity were within the default guideline limits at all sites
- Dissolved oxygen was below the lower guideline value at all sites
- The majority of trace metals and ions had concentrations below detection limits or below ANZG (2018) DGVs for either the protection of aquatic ecosystems (95 per cent species protection), primary industry (livestock drinking water or irrigation) (ANZECC,ARMCANZ, 2000), or the reactional water quality guidelines (NHMRC, 2008). The exceptions were chloride, aluminium, lead and zinc, which were above the guideline levels at a minimum of one sampling site
- At the time of sampling, nutrients (TN and TP) were above the guidelines at all sampling sites, with TN concentrations up to 6.8 higher, and TP concentrations up to 19.6 times higher than the default guideline value. These waterways therefore could be susceptible to eutrophication.

Results outside the recommended guidelines are shown in bold.

Table 4.1: Median water quality data (Source: Hydro Aluminium, 2015 - 2017)

Parameter	**Unit**	**Default Guideline Value (ANZG, 2018)**	**Tributary of Black Waterholes Creek**		**Black Waterholes Creek**		**Swamp Creek**	
			Site 1[1]	**SW1[2]**	**Site 9[1]**	**SW2[2]**	**Site 62[1]**	**SW3[2]**
pH		6.5 – 8.5	7.4	6.7	6.7	5.9	7.6	6.7
Turbidity	NTU	6-50	-	18.0	-	38.6	-	**370**
Dissolved Oxygen	% saturation	85-110	**-**	**76.9**	-	**37.6**	-	**79.4**
Electrical conductivity	µS/cm	125-2200	1600	790	1500	1313	1250	858
Total Nitrogen	mg/L	0.35	-	**1.3**		**2.4**		**2.4**
Total Phosphorus	mg/L	0.025	-	0.2	-	**0.28**	-	**0.49**
Filterable Reactive Phosphorus	mg/L	0.020	-	**0.06**	-	<0.01	-	<0.01
Calcium	mg/L	1000[3]	-	16	-	10	-	19
Fluoride	mg/L	1.5[4]	**4.2**	**1.7**	**1.9**	**2.1**	0.85	0.8
Chloride	mg/L	250		191		**422**		148
Aluminium	mg/L	0.055		0.001		**0.34**		**0.27**
Arsenic	mg/L	0.024	-	<0.0001	-	<0.0001	-	<0.0001
Boron	mg/L	0.37	-	<0.05	-	<0.05	-	<0.05
Cadmium	mg/L	0.00006	-	<0.001	-	<0.001	-	<0.001
Chromium	mg/L	0.001	-	<0.001	-	<0.001	-	<0.001

Parameter	Unit	Default Guideline Value (ANZG, 2018)	Tributary of Black Waterholes Creek		Black Waterholes Creek		Swamp Creek	
			Site 1[1]	SW1[2]	Site 9[1]	SW2[2]	Site 62[1]	SW3[2]
Copper	mg/L	0.0014	-	<0.001	-	<0.001	-	<0.001
Lead	mg/L	0.0034	-	**0.004**	-	<0.001	-	<0.001
Mercury	mg/L	0.00006	-	<0.0001	-	<0.0001	-	<0.0001
Nickel	mg/L	0.011	-	0.008	-	0.009	-	0.009
Zinc	mg/L	0.008	-	<0.005	-	**0.01**	-	<0.005
Free cyanide	mg/L	0.007	-	<0.004	-	<0.004	<0.005	<0.004

Note:

1. Sample sites from the Hydro Aluminium surface water monitoring program (2015 – 2017). [2] Project-specific grab sample sites collected by Jacobs in November 2020. [3] DGVs for primary industry (livestock drinking water) (ANZECC/ARMCANZ, 2000). [4] DVGs for recreational water quality (NMHRC, 2008)

4.4 Aquatic biodiversity

Freshwater fish habitats in the Hunter region include swamps, floodplains, wetlands, streams and rivers which support a diverse array of native and exotic aquatic species (DPI, 2006). There was, however, no species data available for review for waterways within the Proposal study area except for records documented on the Bionet Atlas database (EESG, 2020). In December 2020, the Bionet Atlas only recorded presence of the longfin eel (*Anguilla reinhardtii*) and several exotic species including the Common Carp (*Cyprinus carpio*), Mosquito Fish (*Gambusia holbrooki*), and Gambusia (*Gambusia sp*.) within waterways in a 10 km radius of the Proposal study area (EESG, 2020).

The Southern Purple Spotted Gudgeon, which is listed as endangered under the FM Act, is a benthic species that is found in northern NSW freshwater rivers, creeks and billabongs with slow-moving or still waters, or in streams with low turbidity. Swamp Creek and Black Waterholes Creek are mapped as predicted habitat for this species (DPI, 2016), however a field assessment found the aquatic environment within the study area to be disturbed and degraded. There are no known records of the species in the study area to date (EESG, 2020; ALA, 2020), and according to *Primefact: Southern Purple Spotted Gudgeon (Mogurnda adspersa)* it is suggested that the species is likely to only inhabit coastal catchments north of Clarence River (DPI, 2017). As such, it is considered highly unlikely that the species inhabits the area therefore a 'seven-part test' of significance for the species has not been undertaken (refer to Section 2.1.3).

Other aquatic species which were observed during the site visit included several species of dragonfly. While no dragonflies were caught for close evaluation, individuals that were observed during the field assessment resembled the Common Bluetail (*Ischnura heterosticta*), Australian Duskhawker (*Austrogynacantha heterogena*) and Eastern Pygmyfly (*Nannophya dalei*).

4.5 Aquatic habitat

As outlined in Section 3.3.2, sensitive receiving environments have been identified based on aquatic habitat as an indicator. Aquatic habitat condition at sites visited during the field assessment in November 2020 was assessed against criteria outlined in the NSW *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) and *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge 2003). Aquatic habitat features and habitat condition at field assessment sites (see Figure 3.2) are described in Table 4.2.

Table 4.2: Site descriptions – Aquatic habitat assessment

Site	Photo	Site description
SW1 – Tributary of Black Waterholes Creek	 Assessment site SW1 facing upstream  Assessment site SW1 facing downstream	The unnamed tributary of Black Waterholes Creek is an ephemeral, second order stream (Strahler, 1952) which had low water level and no flow at the time of inspection. The water was mostly clear, had a slight hydrogen sulphide odour and there was an oily sheen, some scum and floating green algae present on the surface of the water. Some nuisance aquatic weed species including *Hydrocotyle* (Water pennyworts) were also growing on the surface of the water. The channel was approximately 10 m wide at this location. The site was located immediately upstream of a large box culvert and west of the recently demolished Aluminium Smelter site. The riverbanks were moderately steep on the eastern bank and mostly flat on the western bank. The eastern bank was mostly cleared containing invasive species including *Briza maxima*. The western bank is mapped as a Kurri Sand Swamp Woodland community, being densely vegetated with species such as *Melaleuca linariifolia* and *Accacia longifolia. Cotula coronopifolia* (Brass buttons), an invasive marsh flower, was present along both embankments. The substrate consisted of sandy silt. There was evidence of past bank failure on the eastern bank upstream and downstream of the culvert. Physical aquatic habitat features at the site consisted of dense riparian vegetation on the western bank, and dense instream macrophyte beds including *Phragmites australis* (Common Reed), *Typha orientalis* (Bulrush), *Typha domingensis* (Southern cattail) and *Schoenoplectus validus* (Softstem bulrush) which spanned the width of the channel at the upstream extent of the site. Other observations at the site included presence of several dragonfly species hovering above the waterway. Threatened fish are not predicted to occur (DPI, 2016), however due to proximity and connection with Black Waterholes Creek and Swamp Creek, there is potential for Purple Spotted Gudgeon (*Mogurnda adspersa*) to be found in the creek, although this is highly unlikely due to barriers to fish passage downstream, poor water quality and lack of suitable aquatic habitat features. This waterway is not mapped as key fish habitat (DPI, 2007) and does not meet the minimum criteria of KFH, therefore has been classified as 'Not KFH' (DPI, 2013). With respect to fish passage, it is

Site	Photo	Site description
		classified 'Class 3 – Minimal fish habitat' (Fairfull and Witheridge, 2003) due to the presence of the existing culvert downstream. Tributary of Black Waterholes Creek has not been identified as a sensitive receiving environment.
Site 2 – Black Waterholes Creek	 Assessment site SW2 facing upstream  Assessment site SW2 facing downstream	Black Waterholes Creek is a perennial, third order stream (Strahler, 1952) which had moderate water level and no flow at the time of inspection. The water appeared highly turbid, had a strong hydrogen sulphide odour and there was an oily sheen present on the surface of the water. The channel was approximately 50 m wide at this location. The site was located immediately upstream of a small culvert structure (0.5 m diameter) which flowed out to the swampy area of Black Waterholes Creek. The riverbanks were mostly flat on both banks and the riparian zone was heavily vegetated with open forest dominated by *Casuarina glauca* (Swamp oak), *Eucalyptus amplifolia* (Cabbage Gum) and *Melaleuca linariifolia* (Flax-leaved Paperbark). The substrate consisted of sandy silt. There was no evidence of past bank failure on the eastern bank upstream and downstream of the culvert. Physical aquatic habitat features at the site consisted of riparian vegetation, dense instream macrophyte beds including *Phragmites australis* (Common Reed), *Typha orientalis* (Bulrush) and *Cycnogeton procerum* (Water Ribbons) and a large fallen tree submerged instream. Other observations at the site included presence of several dragonfly species hovering above the waterway and native frog species Striped Marsh frog (*Limnodynastes Peronii*). There was also a large infestation of *Salvinia molesta* (Giant salvinia) downstream of the culvert structure. The threatened Purple Spotted Gudgeon (*Mogurnda adspersa*) has been mapped as having potential to occur in this waterway, although due to presence of the culvert downstream and poor condition of the waterway, it is highly unlikely at this location. This waterway is mapped as key fish habitat (DPI, 2007), and has been classified as 'Type 2 – moderately sensitive key fish habitat' (DPI, 2013) as it is a contains some aquatic habitat features and permanent water, however is largely disconnected to downstream due to the culvert therefore is not expected to be utilised by native species. With respect to fish passage, it is classified 'Class 3 –

Site	Photo	Site description
		Minimal fish habitat' (Fairfull and Witheridge, 2003) due to the presence of the existing culvert downstream. Black Waterholes Creek has been identified as a sensitive receiving environment.
Site 3 – Swamp Creek	 Assessment site SW3 facing upstream  Assessment site SW3 facing downstream	Swamp Creek is a perennial, fifth order stream (Strahler, 1952) which had moderate water level and little to no flow at the time of inspection (except for some wind-blown surface ripples). The water appeared highly turbid, had a slight hydrogen sulphide odour and there was an oily film and some frothing present on the surface of the water near the bank. Additionally, several gross pollutants were observed within the waterway including floating cattle faeces. The channel was approximately 600 m wide at this location. The site was located on the southern bank of Swamp Creek, about 500 m downstream of the confluence of Black Waterholes Creek and within a low-lying swampy area that is surrounded by cleared paddock. The banks appeared to be flat on both sides and the riparian zone was largely cleared of vegetation, apart from a dense layer of *Cynodon dactylon* (Couch grass). The substrate consisted of sandy silt. There was no evidence of past bank failure. Physical aquatic habitat features at the site consisted of some scattered instream macrophyte beds including *Phragmites australis* (Common Reed), and two large, flat island formations in the centre of the waterway. Other observations at the site included presence of several aquatic weed species including *Myriophyllum aquaticum* (Parrot feather) and *Salvinia molesta* (Giant salvinia). Several fauna species were also present at the site, such as dragonflies, swans, ducks, as well as cows on the banks and in the waterway. The threatened Purple Spotted Gudgeon (*Mogurnda adspersa*) has been mapped as having potential to occur in this waterway, however due to poor water quality and the condition of the waterway, presence of the species is considered highly unlikely at this location. Despite its condition, the waterway is mapped as key fish habitat (DPI, 2007), and has been classified as 'Type 2 – moderately sensitive key fish habitat' (DPI, 2013) due to being a significant waterway and wetland habitat. With respect to fish passage, it is classified 'Class 2 – Moderate fish habitat' (Fairfull and Witheridge, 2003) due to having permanent

Site	Photo	Site description
		water and its connection to important aquatic habitats downstream. Despite Swamp Creek not exhibiting high quality aquatic habitat features and having poor water quality, the site is mapped as KFH and is connected to downstream aquatic ecosystems. As such, Swamp Creek has been identified as a sensitive receiving environment.

5. Surface water quality controls

5.1 Introduction

Construction and operation of the Proposal has the potential to impact the water quality of receiving creeks and waterways. If unmitigated, construction activities can increase sediments in site runoff, and changes to the proposed land use and impervious surfaces under operational conditions can increase pollutant deposition that is washed to downstream waterways during rainfall events. Mitigation will therefore be required for both the construction and operational phases of the Proposal. This section outlines the water quality concept strategy recommended for the Proposal. This concept strategy would be developed during the detailed design stages of the Proposal.

5.2 Construction phase water quality strategy

5.2.1 Design criteria

The water quality design criteria for the construction phase are to minimise potential water quality impacts in accordance with measures outlined in *Managing Urban Stormwater, Soils and Construction guidelines, Volume 1* (Landcom, 2004) ('the Blue Book'). As per the Blue Book, the pollutants of concern during the construction process are total suspended solids (TSS), pH and oil and grease.

The most critical erosion and sediment controls during the construction stage are diversion drains and sediment basins. The diversion drains allow:

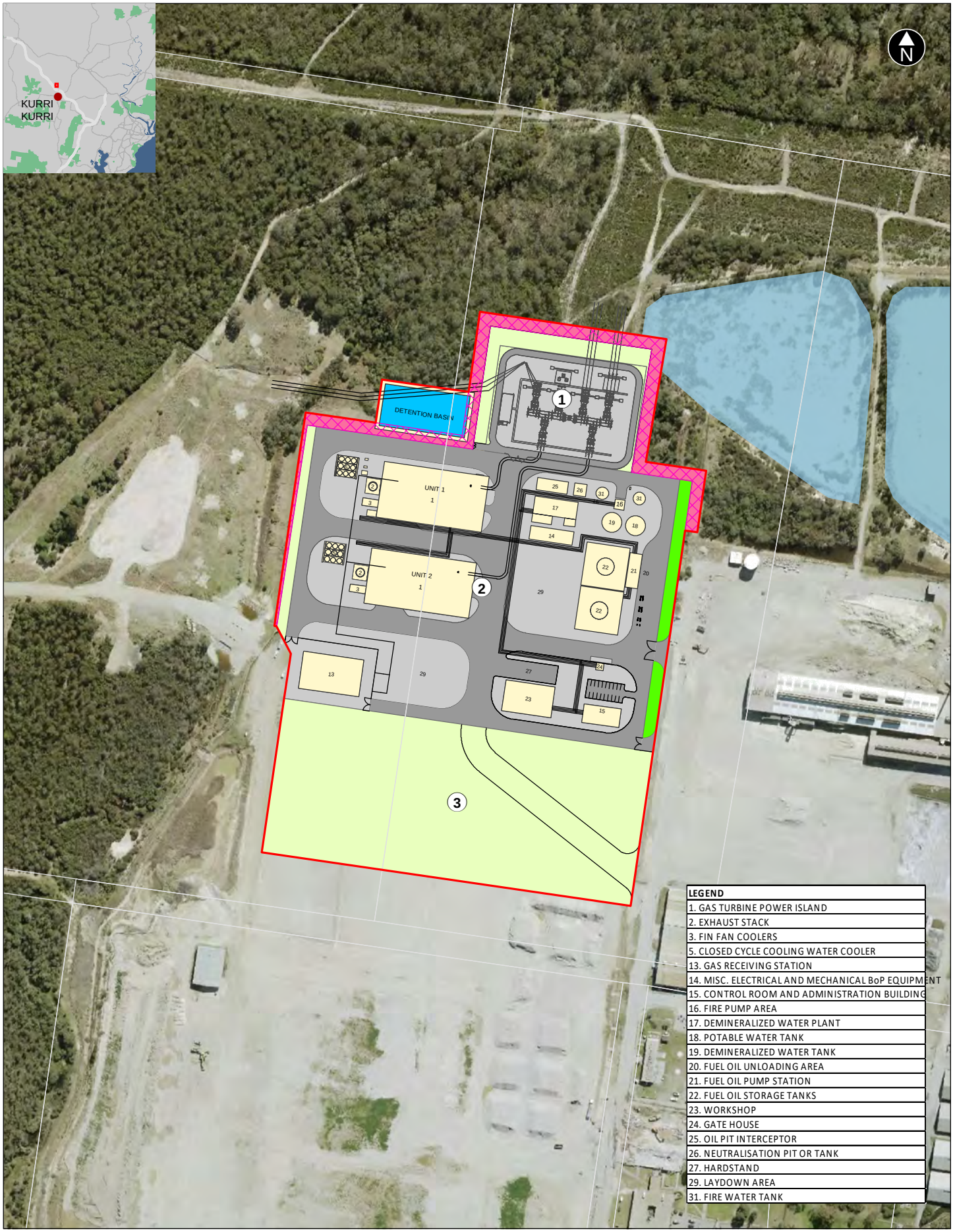
- External 'clean' runoff to not enter and mix with site runoff
- Internal 'dirty' runoff to be conveyed to the proposed sediment basin for treatment.

During construction, erosion and sediment controls and a construction sediment basin are proposed to capture and treat runoff from all disturbed areas of the Proposal Site before discharging into the receiving waterways.

5.2.2 Sediment basin location

A review of the Proposal has been undertaken to identify the location where a construction sediment basin can be located so that it can collect a high proportion of sediment-laden runoff from disturbed areas of the Proposal Site, and where it is accessible for maintenance.

The location of the proposed sediment basin is shown on Figure 5.1.



Proposal Site
Asset protection zone
Detention basin
Sealed roadway
Crushed rock
Landscaping
Grass / Road base
Existing waterbodies
Existing cadastre
1 Proposed Switchyard Area
2 Proposed Plant Area
3 Proposed Buffer Area

0 100 200 m

1:4,000 at A4
GDA2020 MGA Zone 56

Data sources:
Jacobs
Metromap (Aerometrex) 2020
NSW Spatial Services

Figure 5-1 Proposal Site Layout

snowy hydro renewable energy
Jacobs

5.2.3 Sediment basin sizing

The three key elements that were used in the assessment of locating and sizing the construction sediment basin are:

1) Catchment areas contributing to the construction sediment basin (disturbed and undisturbed areas). The required volume of the sediment basin was determined according to an estimate of the maximum disturbed catchment area that drains to the basin during various stages of the construction.
2) Whether the basin would be located upstream of a "sensitive" receiving environment, thus requiring a larger basin to treat water to a higher standard.
3) Other input parameters include soil type, rainfall erosivity (which is a function of local rainfall intensity), soil hydrologic group, volumetric runoff coefficients and soil erodibility.

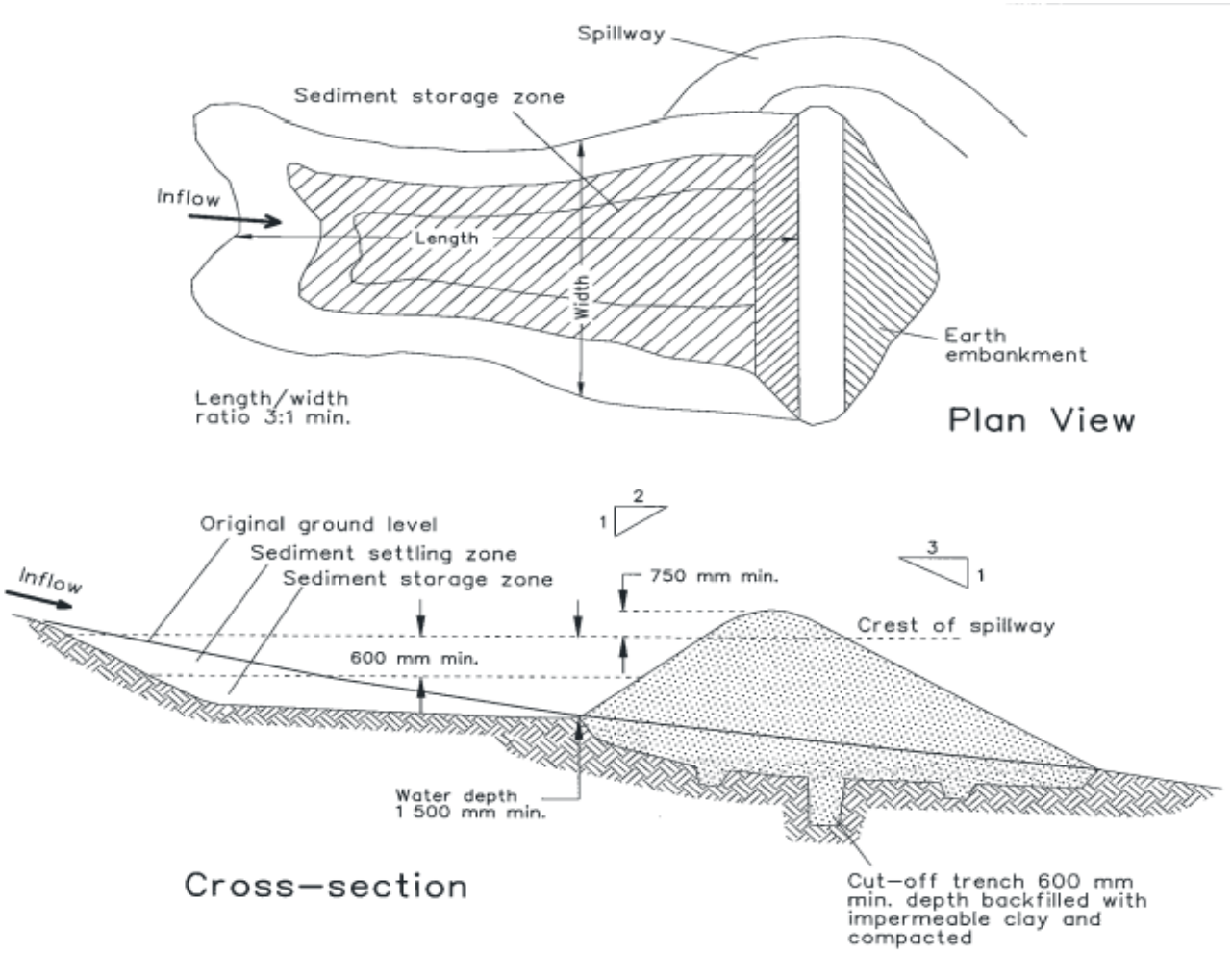
The key site-specific design parameters that were used to approximate the size of the sediment basin are listed in Table 5.1.

Table 5.1: Site specific parameters for sizing the construction sediment basin (construction phase)

Parameter	Value	Comments
Rainfall Parameters		
Rainfall depth duration (days)	5 day	5 days adopted as standard duration used in a typical EPA EPL
Rainfall percentile	85th	85th has been adopted as suitable for sensitive receiving environments (Black Waterholes Creek and Swamp Creek) and duration of disturbance greater than 6 months.
Rainfall depth (mm) – 5 day	31.0 mm	For Cessnock region as per MUSIC model parameter
Volumetric Runoff Coefficient, cv	0.64	Assumed
RUSLE Parameters		
Soil/Sediment Type	Type D	
Erodibility, k	k=0.05	
Rainfall erosivity, R	2000	Based the Blue Book Erosivity Map 8.
Hydrologic Soil Group	D	For high runoff potential Reference: Appendix F of the Blue Book
Soil Cover, C	1	Corresponding to expected type of activities on site
Soil Conservation Practices, P	1.3	Corresponding to expected type of activities on site
Length Slope Factors, LS	Predominantly 0.5%	Determined separately for flatter and steeper construction areas. The assessment has used an LS factors of 0.5% for predominantly flatter areas with only a small area (less than 10% of the total Proposal Site) assumed to be steep, representing some batters.
Sediment Yield Time Period (months)	4 months	2 to 6 months adopted as a reasonable period that accounts for the likely maintenance frequency during construction for the removal of captured sediments.

The construction sediment basin would require maintenance for the removal of sediments when the sediment depth reaches approximately 300 mm. The runoff in the basin would need to be emptied within 5 days of a storm event in anticipation for the next storm event and in accordance with any EPA EPL requirements. The construction sediment basin would need to remain in operation until all disturbed surfaces have been covered with pavement, crushed rock or vegetation.

A typical design for a sediment basin is provided in Figure 5.2. The final sediment basin design would be confirmed during detailed design.



Source: Blue Book

Figure 5.2: Typical sediment basin design

The required construction sediment basin size is listed in Table 5.2.

Table 5.2: Sediment basin for the construction stages

Water volume	Water surface area (m^2)	Approximate dimensions at water line (m)	Side slopes below the water line	Water depth (m)
3100 m^3	1950	Length = 65, width = 30	V:H= 1:2	2

5.3 Operational water quality strategy

5.3.1 Design criteria

For the operational phase, a water quality basin is proposed to capture and treat runoff from the Proposal Site before discharging into the receiving waterway. The water quality objective for the operational phase of the Proposal is to ensure there are no adverse impacts on downstream receiving waters. That is, to treat stormwater runoff such that water quality is equal to or better than pre-development water quality. This requires a long term assessment of annual average pollutant loads for existing and also for proposed conditions with mitigation measures.

5.3.2 Water quality basin location

Following a review of the Proposal and the proposed gradients for the Proposal Site, the recommended location of the proposed water quality basin has been identified on Figure 5.1. This location is the same as the construction sediment basin location.

5.3.3 Surface water quality modelling

The eWater *Model for Urban Stormwater Improvement Conceptualisation* (MUSIC model) is the industry standard model used to quantify pollutant loads for existing and proposed conditions. The MUSIC model has been applied during the concept design to derive pollutant loads from the Proposal Site, specifically Total Suspended Solids (TSS), Total Nitrogen (TN) and Total Phosphorous (TP) and to determine the water quality basin size.

The total catchment area of the Proposal Site was divided into sub catchments according to the different land use characteristics and perviousness of the proposed groundcover (Table 5.3). Appropriate rainfall and other key input parameters such as event mean concentrations and soil permeability were applied.

Table 5.3: Catchment areas within Proposal Site

Area	Catchment area (ha)	Existing conditions - Percent impervious	Proposed (with development) conditions - Percent impervious
Switchyard	1.29	10	15
Power Station	6.81	10	40
Buffer	3.73	10	0
Total	11.83		

5.3.3.1 Rainfall inputs and event mean concentrations

The MUSIC model used recorded data from the pluviograph (1 hour rainfall data or smaller increments) local to the Proposal Site (Newcastle University BOM Station #061390).

The adopted event mean concentrations (EMCs) for the proposed development areas are outlined in Table 5.4 based on:

- CRC for Catchment Hydrology (1999), Urban Stormwater Quality, A Statistical Overview
- CRC for Catchment Hydrology and Monash University (2004), Stormwater Flow and Quality and the Effectiveness of Non-Proprietary Stormwater Treatment Measures, A review and Gap Analysis
- The recommended Music model EMCs for the proposed type of landuse development.

The EMCs for existing conditions are higher than for proposed conditions based on site observations.

Table 5.4: Typical stormwater runoff concentrations for operational phase in mg/L

Pollutant concentration (mg/L)	TSS		TP		TN	
	Event (wet)	Base (dry)	Event (wet)	Base (dry)	Event (wet)	Base (dry)
Proposed Industrial landuse	141	15.8	0.25	0.14	2.0	1.29
Existing landuse	200	22.0	0.35	0.20	2.4	1.50

5.3.3.2 Operational water quality basin size

Water quality modelling in the MUSIC model was carried out to derive pollutant loads from the Proposal Site, specifically TSS, TN and TP. Together with the adopted design criteria, these loads were used iteratively in the model to determine the size of the proposed basin.

Table 5.5 below provides a summary of the critical dimensions of the recommend permanent water quality basin.

Table 5.5: Water quality basin dimensions

Min Water volume	Depth (m) and side slopes	Comments
950 m^3	Max depth =2 with V:H=1:2 side slopes	Indicative level of permanent water is in the range of 10 m to11 m RL

5.3.3.3 Surface water quality modelling results

A comparison of pollutant loads from the existing and proposed Proposal Site conditions is made to understand any potential impacts onto the downstream environment.

The three scenarios that were assessed in the water quality modelling were:

1) Annual average pollutant loads for existing conditions
2) Annual average pollutant loads for proposed conditions without any water quality treatment measures
3) Annual average pollutant loads for proposed conditions with the proposed water quality treatment measures.

The results of the water quality assessment are shown in Figure 5.3 (TSS), Figure 5.4 (TP), and Figure 5.5 (TN) and summarised in Table 5.6. These results indicate that the unmitigated pollutant loads for the proposed conditions increase when compared to existing conditions. However, with the proposed mitigation measures, pollutant loads were reduced to better than existing conditions. The results in Table 5.6 indicate that the proposed water quality control measures (a 950 m^3 water quality basin) would reduce the current annual average pollutant loads from the Proposal Site by more than five per cent. These results demonstrate compliance with the Proposal's water quality design criteria.

Following the construction phase, the construction phase sediment basin size can be retained at approximately 3,000 m^3 and used as a permanent water quality basin. This would provide significantly higher pollutant load improvements than those shown in Table 5-6; however, the required compliant size of the permanent water quality basin is approximately 950 m^3.

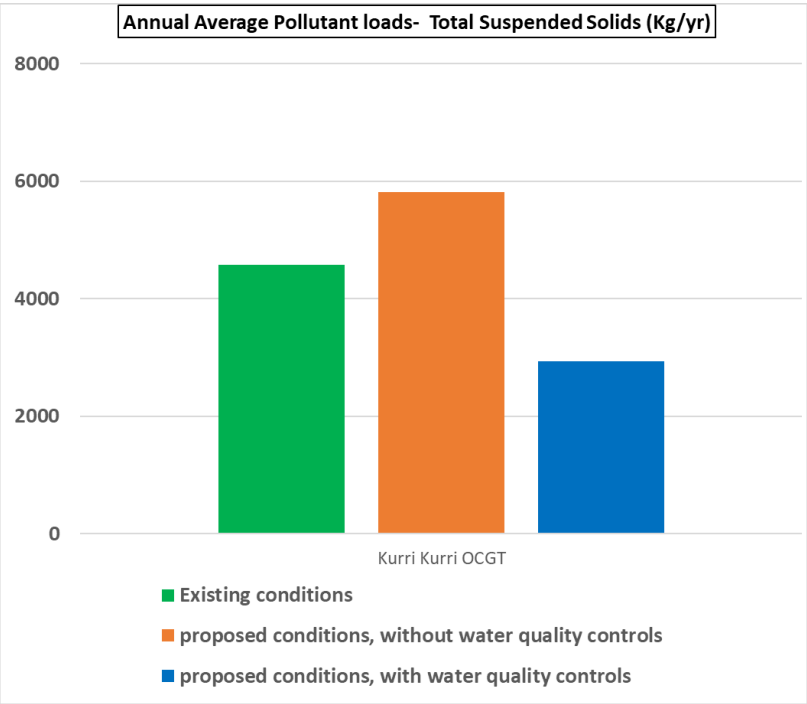


Figure 5.3: Annual average pollutant loads for Total suspended solids

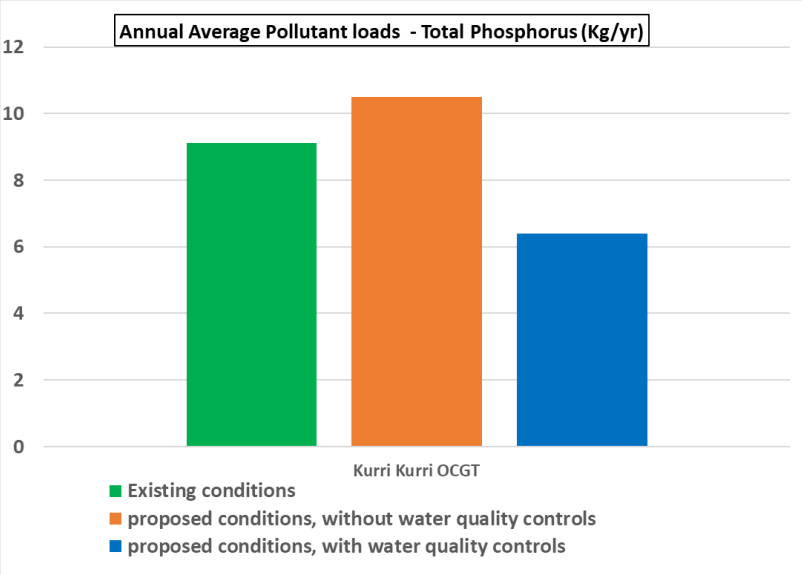


Figure 5.4: Annual average pollutant loads for Total Phosphorus

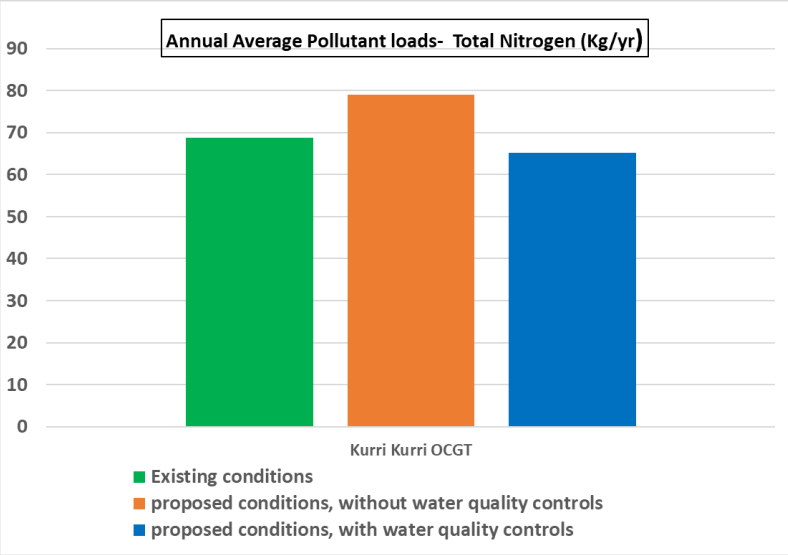


Figure 5.5: Annual average pollutant loads for Total Nitrogen

Table 5.6: Annual average pollutant loads and percentage improvements from the 950 m^3 basin

Parameter	Existing conditions	Proposed conditions without any water quality controls	Proposed conditions with water quality controls	Percentage improvements (%)[1]
TSS (kg/year)	4580	5820	2930	36.0
TP (kg/year)	9.12	10.50	6.40	29.8
TN (kg/year)	68.7	79.0	65.2	5.1

Note:

1. The percentage improvement is between existing and the proposed development with water quality controls (i.e. the 950 m^3 basin)

6. Impact Assessment

6.1 Construction

Construction of the Proposal presents a risk of degradation of downstream surface water quality if management measures are not implemented, monitored and maintained throughout the construction phase. No in-stream works are planned for the Proposal however there would be a small amount of work adjacent to the stream bank of the tributary of Black Waterholes Creek for the stormwater basin discharge outlet. Considering this, direct impacts to aquatic ecology are not anticipated, however there is potential risk of indirect impacts to aquatic ecosystems from mobilisation of sediments resulting in poor water quality discharged to downstream receivers.

Potential impacts to water quality could occur through the following construction activities:

- Vegetation clearance at the switchyard site
- Earthworks to prepare the Proposal Site and construction areas
- Installation and maintenance of environmental controls (including surface water discharges from the construction sediment basin)
- Installation of foundations and underground services
- Movement and use of construction equipment and heavy machinery on site
- Construction and upgrading of internal access roads
- Installation of above ground civil, mechanical and electrical plant and equipment within the Proposal Site
- Establishment of site landscaping.

Potential impacts to water quality during construction and the risk of their occurrence are described in the sections below.

6.1.1 Erosion and sedimentation

There are a number of Proposal construction activities that have the potential to result in soil erosion and subsequent sedimentation in downstream environments if stormwater runoff or wind mobilises exposed soils, including:

- Vegetation clearance as discussed in the Biodiversity Development Assessment Report prepared for the EIS. Vegetation removal would expose soils to weathering processes, increasing the risk of erosion and sedimentation.
- Earthworks, including stripping topsoil and excavation – construction of the Proposal would require general earthworks to prepare the Proposal Site and construction areas, construction of internal access roads and installation of environmental controls (i.e. construction of the stormwater basin and discharge outlet). Soils exposed during earthworks have the potential to be mobilised to downstream environments via wind and stormwater runoff. Construction of the discharge outlet from the basin would require excavation of the stream bank that may result in short term localised erosion should a large flow event occur before the works were completed. Further, while considered unlikely, the existing fill or natural material that could be disturbed as a result of excavation activities may contain contaminants or acid sulphate soils.
- Movement and use of heavy vehicles – construction of the Proposal will require movement and use of heavy machinery, plant and equipment for the installation of civil, mechanical and electrical components of the Proposal. This could result in generation of dust and increase ground disturbance resulting in increased risk of erosion and sedimentation.

The impacts of erosion and sedimentation on water quality and aquatic environments may include:

- Increased turbidity and poor water clarity, which can potentially lead to smothering of aquatic ecosystems due to clogging fish gills or decreasing trophic interactions due to reduced visibility.

- Sediments may also contain high concentrations of nutrients which can lead to algal blooms, and subsequently result in reduced light penetration that limits the growth of aquatic vegetation. Algal blooms may also cause a reduction of dissolved oxygen content in water which can lead to the creation of 'dead zones' where aquatic life cannot survive.
- Mobilised sediments may contain elevated concentrations of metals and other contaminants which can negatively impact aquatic organisms that may be sensitive to changes in water quality.
- Any potential acid sulphate soils that may be encountered in the Proposal Site could also result in increased acidity of downstream receiving environments and may impact on aquatic life that cannot tolerate changes in pH.

While sediment-laden runoff and pollutants from soil disturbance have the potential to temporarily reduce downstream water quality, they are unlikely to cause major or long-term impacts to the overall condition of surrounding waterways as they would be managed with the implementation of erosion and sediment controls (as detailed in Section 5.2) and additional environmental management measures outlined in Section 7. Erosion and sediment controls and other management measures would be established prior to commencement of construction activities (including vegetation clearing) to avoid and/or manage erosion and sedimentation impacts from construction activities. In addition, the discharge outlet will be designed and constructed so that the structural integrity of the riverbank is retained, and bank failure or bank erosion is avoided.

Given the limited areas of deeper excavation and limited dewatering (if any) anticipated, low pH runoff associated with ASS is unlikely. In the event that any acid sulphate soils are disturbed during excavation, an acid sulphate management strategy would be prepared and implemented as part of the Construction Environmental Management Plan (CEMP) in accordance with the Acid Sulfate Soil Manual (ASSMAC, 1998).

6.1.2 Vegetation clearing

In addition to increased risk of erosion and sedimentation from exposure of topsoil, vegetation clearing may result in the release of tannin leachate that could mobilise to downstream receiving waterways via stormwater runoff. Tannin leachate is a dark coloured water which can alter downstream pH, reduce visibility and light penetration. Tannins can also increase biochemical oxygen demand (BOD) which can decrease in-stream dissolved oxygen concentrations that may lead to fish kills.

The risk of tannin leachate mobilising to downstream receivers is considered low as vegetation clearing required for the Proposal is minimal and erosion and sediment controls (outlined in Section 5.2), as well as additional management measures (detailed in Section 7.1) would be established on-site prior to any vegetation clearance works being carried out.

6.1.3 Concreting

Concrete works are required for the installation of above ground civil components of the Proposal. Concrete works can result in concrete dust, concrete slurries or washout water entering downstream waterways. Concrete by-products are alkaline, with a pH of around 12, and therefore have the potential to alter the pH of downstream watercourses which can be harmful to aquatic life that are sensitive to changes in water quality.

The risk of transportation of concrete waste, from the Proposal Site, is considered low as concreting will not occur within proximity of waterways and water quality controls (outlined in Section 5.2) and additional management measures (detailed in Section 7.1) would be implemented to enable that no runoff is mobilised downstream prior to being captured and treated in the construction sediment basin.

6.1.4 Accidental spills and litter

The release of litter and potentially harmful substances to the environment may occur accidentally during construction. Spills or leaks may also occur as a consequence of equipment malfunction, maintenance or refuelling. Accidental spills may be as a result of inappropriate storage, handling and use of plant and

equipment. These contaminants could include acids and chemicals from washing down of vehicles, construction fuels, oils, lubricants and hydraulic fluids. Spills may cause oily films to be transported to downstream receiving waters via stormwater runoff which may accumulate on the surface water and reduce visual amenity or result in loss of habitat and aquatic organisms from increased concentrations of toxicant and altered pH levels. Mobilisation of litter to waterways may lead to the introduction of gross pollutants (rubbish), nutrients, hydrocarbons and heavy metals into waterways which may be harmful to aquatic life and reduce visual amenity.

While there is potential for littering and accidental spills from construction machinery on construction sites, it is unlikely to result in any major or long-term impact to downstream water quality and aquatic ecosystems as impacts would be temporary and manageable through water quality controls (outlined in Section 5.2) and additional management measures (as outlined in Section 7.1) which would be further developed and implemented as part of the CEMP for the Proposal.

6.1.5 Surface water discharges

The potential source of water discharges during construction of the Proposal is associated with dewatering the construction sediment basin (see Section 5.2).

Surface water runoff and sediment basin dewatering would be managed in accordance with Blue Book. The requirements of the Blue Book are that local erosion and sediment controls be provided within the construction catchment area and adequately sized construction sediment basin at the discharge points of all outlets from construction sites. As per the Blue Book, the pollutants of concern during the construction process are total suspended solids (TSS), pH and oil and grease. The treatment criteria of these pollutants would be in accordance with the Blue Book or any applicable EPL. Often nutrients and metals are bound to sediments and transported from the construction site. The capture of the sediments via the construction sediment basin would subsequently result in the capture of nutrients and toxicants thereby reducing risks to downstream water quality.

With the implementation of controlled dewatering from the construction sediment basin in accordance with the Blue Book (refer to Section 5.2) and the additional management measures (outlined in Section 7.1), the risks to water quality from the Proposal is expected to be low and unlikely to cause a major or long-term impact to downstream receiving environments.

6.1.6 Performance against NSW Water quality objectives

There are a number of potential pollutants associated with the construction of the Proposal including contaminated soils, heavy metals, oils and fuels from construction works and use of machinery, tannins from cleared and mulched vegetation and sediment laden runoff. Each of these pollutants pose a risk to water quality and subsequent environmental values of the downstream environment if discharged in high concentrations.

The proposed management measures, namely diversion drains and the construction sediment basin, are designed to minimise pollutant loading to downstream waterways during the construction of the Proposal. Runoff from the construction phase of the Proposal is designed to meet standards outlined in the Blue Book, including <50mg/L total suspended solids (TSS) and pH concentration between 6.5 – 8.5.

Areas identified as potentially containing contaminated soils, including ASS, has been addressed in the EIS (Soils and Contamination Assessment Report) and should be referred to for further details and proposed management measures (in addition to those provided in Section 7.1).

6.2 Operation

The Proposal will include a stormwater drainage system that will be designed to minimise release of contaminants (generally oil and sediments) utilising the proposed water quality basin located within the north-west corner of the Proposal Site (refer to Section 5.3). Refer to the EIS (Hydrology and Flooding assessment) for information regarding stormwater flows.

Risks during operation of the Proposal would therefore be associated with uncontrolled release of process water or contaminated stormwater, potential spills or leaks. Potential impacts to water quality during operation and the risk of their occurrence are described in the sections below.

6.2.1 Erosion and sedimentation

Following construction of the Proposal, the potential for impacts to water quality due to soil erosion and subsequent transport of sediment to downstream receiving waterways would be limited as there would be no on-going ground disturbance and all exposed surfaces would be sealed or landscaped as required.

6.2.2 Surface water discharges

Process water and stormwater

Operation of the Proposal presents a potential risk to downstream water quality if process wastewater or contaminated stormwater is discharged into the stormwater drainage system without treatment. The Proposal, however, does not propose any process water discharge to the stormwater system and potentially contaminated stormwater runoff will be treated prior to discharge. This will be achieved by the following:

- Small areas of the Proposal Site that could pose a water quality risk, such as the diesel unloading areas will be collected in a Dirty Water drainage system that would be routed to a local sump for treatment via an oil water separator or equivalent. Separated oil shall be collected in a waste oil storage pit or tank for off-site disposal
- Stormwater runoff from all other areas of the Proposal Site will flow via the Clean Water drainage system through a triple interceptor and then to the stormwater basin
- Chemically contaminated and industrial effluents including blowdown from the evaporative coolers and wastewater from the demineralisation water plant shall be neutralised as required before discharge into the local Hunter Water sewer network as 'trade waste'.

As such, the risk of water quality impacts from the Proposal as a result of stormwater discharge during operation is considered low and unlikely to cause a major or long-term impact on water quality of downstream receiving environments.

Completed stormwater quality modelling that was carried out for the proposed water quality basin which would be part of the stormwater basin (outlined in Section 5.3) predicts there to be a reduction in pollutant loads flowing to the receiving downstream waterway. Therefore, there is potential for the Proposal to improve water quality in the tributary to Black Waterholes Creek.

6.2.3 Accidental spills or leaks

General operation of the Proposal may result in spills or leaks as a consequence of plant or equipment malfunction, maintenance or refuelling. Accidental spills may occur as a result of inappropriate storage, handling and use of plant and equipment (including vehicles on-site).

While there is potential for spills and leaks, the design of the Proposal includes capture and treatment of stormwater from any process areas where contamination could be expected. Additionally, all stormwater passes through the stormwater basin before being discharged from the Proposal Site. Additional management measures to be implemented during operation (outlined in Section 7.1) would further allow impacts to water quality to be are avoided or adequately managed.

6.2.4 Performance against NSW Water Quality Objectives

With the implementation of permanent water quality controls and management measures (as outlined in Section 5.2 and Section 7.1) the runoff that could potentially be mobilised to the tributary of Black Waterholes Creek (and subsequently Black Waterholes Creek and Swamp Creek) during operation of the Proposal would be of a

quality that would maintain or improve the water quality of the receiving aquatic environment, therefore is not expected to impact on achieving the environmental values of protection of aquatic ecosystems or visual amenity.

The operation of the Proposal is also not expected to impact on achieving the environmental values of primary or secondary contact recreation, as the key indicators of concern relevant are pathogens, algae and toxicants. Bacteriological indicators are not a source of pollutants from the operation of the Proposal, and increased algae is not likely due to a reduction on sediment laden runoff and thereby a reduction in nutrients. This reduction in sediment laden runoff will also reduce the level of toxicants entering downstream waterways which could have posed a risk to human health and aquatic species.

The default guideline values for indicators relevant to the environmental values of irrigation water supply and homestead water supply are less stringent than those which have been outlined for the protection of aquatic ecosystems and recreational water use. Therefore, by meeting the water quality objectives for protection of aquatic ecosystems, primary contact recreation and secondary contact recreation, the objectives of irrigation water supply and homestead water supply will also be achieved. As such, it is expected that the operation of the Proposal will not impact on achieving the environmental values of irrigation water supply and homestead water supply.

6.3 Cumulative impacts

For an EIS, cumulative impacts can be defined as the successive, incremental, and combined effect of multiple impacts, which may in themselves be minor, but could become significant when considered together.

This section provides an assessment of potential cumulative surface water quality and aquatic ecology impacts based on the most current and publicly available information regarding other projects nearby the Proposal Site that are under construction or have begun the planning approvals process.

6.3.1 Demolition and remediation of the Hydro Aluminium smelter

The Proposal Site forms part of the decommissioned Kurri Kurri aluminium smelter site which ceased operation in late 2012 and was permanently closed in 2014. Demolition of the former Kurri Kurri aluminium smelter and remediation of the land is an approved State Significant Development, and was the subject of an Environmental Impact Statement that was publicly exhibited in 2016. The extensive works are ongoing but would be completed within the Proposal Site prior to construction of the Proposal. Demolition and remediation of the former Kurri Kurri aluminium smelter land outside of (adjacent) the Proposal Site is estimated to be ongoing to late 2023 and therefore concurrent with construction of the Proposal.

During timeframes when construction activities are concurrent, there is potential for additional surface water quality impacts in the tributary of Black Waterholes Creek which flows north to Black Waterholes Creek. In particular, it is likely that demolition and remediation works would result in an increased amount of exposed soils within proximity of the waterway which increases the risk of erosion and subsequent downstream sedimentation and water quality impacts. It is expected, however, that construction activities are being and will continue to be managed to avoid downstream water quality impacts from erosion and sedimentation. Importantly, stormwater runoff from the demolition and remediation site is predominantly , if not entirely, directed to the existing stormwater retention ponds north-east of the Proposal Site (refer to Section 4.2). As such, no significant discharges to natural waterways are occurring during the Kurri Kurri aluminium smelter demolition and remediation project. Assuming that site management practice continues, the adjacent project does not pose a risk for cumulative impacts in regard to surface water quality and aquatic ecology.

6.3.2 ReGrowth Kurri Kurri Rezoning, subdivision and industrial development

The rezoning, subdivision and industrial development of the Hydro Aluminium Kurri Kurri Pty Ltd land is a major planning proposal by Regrowth Kurri Kurri to rezone approximately 329 hectares of land at and around the former Kurri Kurri aluminium smelter from Rural Landscape (RU2) to residential and public recreation, business, heavy and general industrial, infrastructure and environmental conservation (B1, B5, IN1, IN3, R2, RE1 and SP2 (in part)), to reduce the minimum lot size from 40 ha to 450 m2 (in part) and to identify the site as an urban

release area. The rezoning proposal affects land in both the Cessnock and Maitland local government areas. Under this plan, Proposal Site would be designated Heavy Industrial. On 1 December 2020 the NSW Department of Planning, Industry and Environment issued a Gateway Determination enabling Cessnock City Council to place the Hydro Kurri Kurri Planning Proposal on public exhibition for a minimum of 28 days. Submissions close on 1 February 2021.

The rezoning proposal is subject to further approval and physical works would be subject to lodgement and approval of separate development applications. Development applications for development of the land following rezoning and subdivision are not expected until 2023, by which time the Proposal is anticipated to be under construction or even in operation by late 2023. There are not currently any development applications, nor any further detail around the type of future development that might occur adjacent to the Proposal Site.

Therefore, potential cumulative impacts from the ReGrowth Kurri Kurri rezoning, subdivision and industrial development have not been assessed in detail. It is assumed, however, that the rezoning proposal will be approved and that additional water quality impacts to downstream receivers will occur as a result of increased pollutant loads from new industrial and urban uses.

7. Environmental safeguards and management measures

7.1 Recommended measures

With regard to surface water quality and aquatic ecology, the key objective is to ensure downstream waterways are protected against potential impacts from construction and operation of the Proposal. Measures to avoid, minimise or manage surface water and aquatic ecosystem impacts as a result of the Proposal are detailed in Table 7.1.

These measures would be outlined in the Construction Environment Management Plan (CEMP) and Operational Environment Management Plan (OEMP) and would include (but not limited to) preparation of a Construction Soil and Water Management Plan (CSWMP), Erosion and Sediment Control Plan (ESCP), emergency spill response procedures, and additional mitigation measures specific to design of the Proposal.

Further, the environmental management measures should include a surface water quality monitoring program which would include the collection of baseline data for comparison to construction and operational monitoring data where applicable. Refer to Section 7.2 for further details regarding the recommended water quality monitoring program.

Table 7.1: Recommended environmental safeguards and management measures

Impact	Reference	Environmental Management Measure	Responsibility	Timing
Erosion and Sedimentation	SW01	A CSWMP will be prepared as a sub-plan of the CEMP for the Proposal. The plan will outline measures to manage soil and water impacts associated with the construction and commissioning works. The CSWMP will include but not be limited to: ▪ Measures to minimise/manage erosion and sediment transport both within the construction footprint and off-site including requirements for the preparation of erosion and sediment control plans (ESCP) for all stages of construction ▪ Processes for dewatering of construction sediment basins, including relevant discharge criteria ▪ Measures to manage accidental spills including the requirement to maintain materials such as spill kits ▪ Measures to manage any potential Acid Sulphate Soils found in excavated fill material, in accordance with the Acid Sulphate Soil Guidelines ▪ Measures to manage potential tannin leachate ▪ Details of surface water quality monitoring to be undertaken throughout and following construction (refer to Section 7.2 for further details).	Construction Contractor	Pre-construction, Construction

Impact	Reference	Environmental Management Measure	Responsibility	Timing
	SW02	A Construction ESCP would be developed as a sub plan of the CEMP and would detail the erosion and sediment control measures to be implemented at the Proposal Site in accordance with the principles and requirements of *Managing Urban Stormwater – Soils and Construction, Volume 1* (Landcom, 2004), commonly referred to as the "Blue Book". The Construction ESCP would include but not be limited to: ▪ Plans for temporary drainage, scour protection and control measures to reduce erosion and water quality impacts from increased sediment loads from the construction site. The ESCP would identify locations of the proposed construction sediment basin ▪ Dust suppression to enable no downstream sedimentation or air quality impacts to occur.		
Construction - Spills and litter	SW03	Proposal Site specific controls and procedures would be developed and implemented as part of the CSWMP to reduce the risk of litter and spills and leaks entering downstream waterways. The CSWMP would include (but not be limited to) the following measures: ▪ All fuels, chemicals and liquids would be stored on level ground at least 20 m away from waterways (including existing stormwater drainage systems) and would be stored in a sealed bunded area within the construction site ▪ An emergency spill response procedure would be prepared as part of the CSWMP ▪ Regular visual water quality checks (for hydrocarbon spills/slicks, turbid plumes and other water quality issues) will be carried out at waterways in proximity to works (particularly tributary of Black Waterholes Creek) ▪ Installing and maintaining control measures such as silt fencing and gross pollutant traps, etc.	Construction Contractor	Pre-construction, Construction

Impact	Reference	Environmental Management Measure	Responsibility	Timing
Concrete works	SW04	To avoid ingress of concrete waste material into downstream waterways, the CEMP would outline procedures to capture, contain and appropriately dispose of any concrete waste from concrete works.	Construction Contractor	Pre-construction, Construction
Dewatering the construction sediment basin	SW05	Dewatering the construction sediment basin will be in accordance with the Blue Book and any EPL licence conditions which may be held for construction and commissioning. Dewatering procedures would be outlined in the ESCP and will include (but not be limited to): ▪ The methodology for dewatering ▪ Supervision requirements ▪ Staff responsibilities and training ▪ Approvals required before any dewatering activity commences.	Construction Contractor	Construction
Operation – Spills and leaks	SW06	Site specific controls and procedures would be developed and implemented as part of the Operational Environment Management Plan (OEMP) to reduce the risk of litter off-site and spills and leaks entering downstream waterways. The OEMP would include (but not be limited to) the following measures: ▪ An emergency spill response procedure ▪ Bunding requirements (already part of the Proposal design) for process areas in accordance with AS1940 ▪ A surface water monitoring program including regular visual water quality checks (for hydrocarbon spills/slicks, and other water quality parameters) will be carried out at waterways in proximity to the Proposal Site (refer to Section 7.2 for further detail).	Snowy Hydro	Operation

7.2 Recommended surface water quality monitoring

Surface water monitoring is recommended to observe any changes in surface water quality that may be attributable to the Proposal and to inform appropriate management responses.

Monitoring would be undertaken in accordance with the following guidelines:

- ANZECC/ARMCANZ (2000) and ANZG (2018) Water Quality Guidelines
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DECC, 2004)
- Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ, 2000b).

The following surface water quality monitoring is recommended during construction and operation of the Proposal.

7.2.1 Construction monitoring

A construction monitoring program will be developed and included in the CSWMP for the Proposal to observe any changes in surface water quality during construction and inform appropriate management measures.

Sampling locations and monitoring methodology to be undertaken during construction will be further developed during the detailed design phase of the Proposal in accordance with the ANZG (2018) water quality guidelines. It will include collection of samples for analysis from sedimentation basin discharge point/s, visual monitoring of other points of release of construction waters and monitoring downstream waterways where appropriate.

The monitoring frequency during construction will be confirmed during detailed design, however, it will include at least monthly construction monitoring at all monitoring sites which will preferentially monitored following wet weather events.

Should the results of monitoring identify that the water quality management measures are not effective in adequately mitigating water quality impacts, additional mitigation measures will be identified and implemented as required.

Surface water quality monitoring should include both field parameters and indicators for laboratory analysis. The following indicators are proposed for monitoring:

- Field parameters (electrical conductivity, pH, turbidity, dissolved oxygen and temperature)
- Heavy metals (aluminium, arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, zinc, iron and manganese)
- Nutrients (including ammonia, oxidised nitrogen, total nitrogen, total phosphorus, filtrable reactive phosphorous (FRP))
- Oil and grease
- Total dissolved solids (TDS)
- Total suspended solids (TSS).

7.2.2 Operational monitoring

An operational monitoring program will be developed and included in the OEMP for implementation following completion of construction to observe any changes in surface water from operation of the Proposal and inform appropriate management responses.

The monitoring program will include:

- In the event of any uncontrolled surface water discharge from the Proposal Site, should there be concerns in relation to water quality, a monitoring process would be implemented
- Six monthly monitoring of discharge from the oily water separator pit for physical parameters and oil and greases
- Visual assessment of downstream waterway condition including the tributary to Black Waterholes Creek and Black Waterholes Creek.

8. Conclusion

The surface water quality and aquatic ecology assessment for the construction and operation of the Proposal has been prepared based on a review and analysis of available water quality data, aerial photography, topography, database searches, relevant literature, background reports, applicable legislation, policies and guidelines, and a site visit comprising of an aquatic habitat assessment and water quality sampling.

The desktop review identified that local waterways in proximity of the Proposal Site was predicted habitat for the Southern Purple Spotted Gudgeon (DPI, 2016), which is listed as Endangered under the FM Act. However, upon review of literature and assessment of waterway condition in the field, it was determined that the presence of this species within the Proposal study area was highly unlikely. As such, no assessment of significance was carried out for the species.

An analysis of existing water quality data and grab samples collected from the surface water sampling sites assessed key indicators of pH, electrical conductivity, dissolved oxygen, nutrients, trace metals, major ions and free cyanide. Generally, pH, electrical conductivity, and the majority of trace metals and ions had concentrations below detection limits or below ANZG (2018) DGVs for either the protection of aquatic ecosystems (95 per cent species protection) or primary industry (livestock drinking water or irrigation and general water use). The exceptions were chloride, aluminium, lead and zinc, which were above the guideline levels. Dissolved oxygen was below the lower guideline value at all sites, and nutrients (TN and TP) were all higher than guideline values at all sites.

Black Waterholes Creek and Swamp Creek were identified as sensitive receiving environments based on aquatic habitat condition. The tributary of Black Waterholes Creek itself has not been identified as a sensitive receiving environment.

Upon review of the Proposal design and plans for construction and operation, it was determined that there would be no direct impacts to aquatic organisms or their habitat as there would be no instream works required, with the exception of some minor works to the riverbank associated with the discharge outlet from the stormwater pond. Potential impacts during construction are therefore limited to mobilisation of sediment and contaminants to downstream receiving environments by wind or stormwater runoff and subsequent indirect impacts on aquatic ecosystems. During construction, the following potential impacts were identified:

- Erosion of soils and sedimentation of waterways
- Reduced water quality from elevated turbidity, increased nutrients and other contaminants
- Smothering of aquatic organisms from increased sediments and associated low dissolved oxygen levels
- Potential increased occurrence of algal blooms associated with reduced water quality
- Migration of litter off-site
- Contamination accidental leaks or spills of chemicals and fuels.

These potential impacts are considered unlikely to occur, temporary if so and would be managed through the implementation of proposed erosion and sediment controls and other identified management measures. Any discharges from the construction sediment basin would be carried out in accordance with the Blue Book and any Environmental Protection Licence that may be held during construction and commissioning of the Proposal. A surface water quality monitoring plan has been recommended for implementation during construction and operation of the Proposal to monitor water quality and confirm that controls are working effectively.

During operation, potential impacts would be associated with uncontrolled release of process water or contaminated stormwater, potential spills or leaks. Whilst impacts are considered unlikely, other options to address discharges from the Proposal Site that will achieve a similar water quality outcome will be further investigated during detailed design. Completed stormwater quality modelling that was carried out for the proposed water quality basin predicts there to be a reduction in pollutant loads flowing to the receiving downstream waterway (tributary to Black Waterholes Creek).

Overall, on the basis of the assessment of the existing water quality, aquatic environment, the design of the Proposal, and on the assumption that recommended safeguards and management measures are implemented, the assessment concludes that there would be minimal impacts to the surface water quality of downstream receivers, in fact, it is predicted to result in a reduction in key pollutant loads following a rainfall event. As such, water quality objectives are likely to be met and the functionality, long-term connectivity or viability of their aquatic ecosystems would be maintained.

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