
Technical report 10

Surface water impact assessment



Hunter Transmission Project

Surface water assessment

Prepared for the Energy Corporation of NSW

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Hunter Transmission Project

Surface water assessment

the Energy Corporation of NSW

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Glossary

Term	Definition
Access tracks	Temporary and permanent tracks used to access the project. Refer to <i>Chapter 4 – Project description</i> of the EIS for further details.
Bayswater Power Station	Existing power station at Bayswater owned by AGL.
Bayswater South switching station	The new switching station that would be constructed south of Bayswater Power Station.
Construction impact area	The area that would be directly impacted by the construction of the project, including (but not limited to) transmission towers and lines, stringing sites, access roads, access tracks, substations, switching stations, adjustments and upgrades to existing lines, communications infrastructure, temporary worker accommodation, construction support sites, laydown areas and utility adjustments.
Construction access routes	Roads used by construction vehicles (light and heavy).
Construction support site	An area used as the base for construction activities, usually for the storage of plant/equipment and materials, processing facilities (concrete batching, aggregate crushing, grinding and screening), maintenance facilities/workshops, staff facilities, firefighting equipment, helicopter landing pad and support facilities, access and parking, and wastewater treatment. Some construction support sites would also include temporary worker accommodation. Construction support sites are discussed in <i>section 4.3.5</i> of the EIS.
Critical State significant infrastructure (CSSI) application area	The critical State significant infrastructure (CSSI) application for the HTP covers 5 local government areas (Muswellbrook, Singleton, Cessnock, Central Coast and Lake Macquarie).
Cumulative impact	The combined impacts of the project on a matter with other relevant future projects.
Disturbance area	This is used primarily to assess potential impacts on biodiversity values in <i>Technical Report 1 – Biodiversity development assessment report</i>. Includes the following categories: • Disturbance area A • Disturbance area A (centreline) • Disturbance area B • Disturbance area HZ.

Term	Definition
Disturbance area A	The area where vegetation would be completely removed. It includes areas at and around transmission towers (including tower pads and batters), stringing sites, laydown areas, switching stations, substation upgrades, construction support sites, new and upgraded access tracks and road upgrades. Impacts within this area would include sub-surface disturbance from construction activities such as grading, excavation, and full tree removal. With the exception of areas that only require temporary disturbance (i.e. temporary access tracks and stringing sites), this area would also be subject to ongoing maintenance during operation (including vegetation removal to ground level) for operational and safety requirements (including bushfire).
Disturbance area A (centreline)	A 20 m wide centreline area between transmission towers where all vegetation would be removed to ground level during construction. This area would also be subject to ongoing maintenance during operation (i.e. removal to maintain vegetation clearance requirements) for operational and safety requirements (including bushfire).
Disturbance area B	The area within the transmission line easement, excluding disturbance area A and disturbance area A (centreline), where partial clearing would be undertaken. Removal of vegetation (including trees) would be required if there is a risk of vegetation exceeding the designated clearance heights. These heights are set for operational and safety requirements, including bushfire risk management (indicatively 13.5 m below the conductors at maximum operating temperature). Vegetation with mature growth heights up to 2 m can remain, while vegetation exceeding 2 m will be managed to maintain these clearance heights. This area would be subject to ongoing maintenance during operation.
Disturbance area hazard tree zone (HZ)	Hazard trees are those that have the potential to pose a risk to safe operation of the transmission line by falling onto the transmission towers, conductors and associated infrastructure within the easement. A hazard tree zone has been identified in limited areas on either side of the transmission line easement through LiDAR analysis of tree heights and topography. Hazard tree management would occur during operation to maintain safe operating clearances for the conductors and tower structures. The hazard tree zone will be inspected for trees in the height range of 20 m or more, which is typically in the high-risk category. High-risk category trees will be assessed for structural instability and managed according to the risk present, including tree removal if required.
EnergyCo	The Energy Corporation of New South Wales constituted by section 7 of the NSW <i>Energy and Utilities Administration Act 1987</i> as the NSW Government-controlled statutory authority appointed as the infrastructure planner for the NSW <i>Electricity Infrastructure Investment Act 2020</i> responsible for the delivery of NSW's REZs. The proponent for the HTP.
Eraring Power Station	Existing power station at Eraring operated by Origin Energy.

Term	Definition
Exclusion zone	A safe clearance area around the transmission line and towers to protect public safety, the network and to maintain access to the asset. It delineates the area where most land use activities are prohibited. The zone is located within the easement and is defined according to the operational voltage and design of the infrastructure.
Hunter Transmission Project (HTP) or project	The HTP as described in <i>Chapter 4 (Project description)</i> of the EIS and identified in the overview figures of the EIS.
HTP corridor	Comprises: - the transmission line corridor connecting Bayswater South switching station to Olney switching station - the transmission line corridor connecting the Bayswater South switching station to the existing 500 kV transmission line near Bayswater Power Station - the transmission line corridor connecting the Olney switching station to the existing 500 kV transmission line between Eraring and Kemps Creek. The HTP corridor is around 140 m wide.
HTP North, HTP Central and HTP South	Three geographical zones defined as: - HTP North – Bayswater to Broke includes the Bayswater Power Station, major coal mining complexes in the Upper Hunter Valley, Mount Thorley Industrial Estate, Singleton Military Area, and several rural properties generally on the alluvial floodplains of the Hunter River - HTP Central – Pokolbin to Corrabare includes the Pokolbin and Corrabare State forests and the rural residential areas between these forests at Cedar Creek, Millfield and Laguna - HTP South – Olney to Eraring includes the Watagan and Olney State forests, Watagans National Park, the residential areas in Martinsville and Cooranbong, and Eraring Power Station.
Indicative riparian zone	An area applied in this assessment to estimate the possible extents of riparian corridors across the project impact area. This definition varies from the term 'riparian corridor' as bed and banks have not been verified for individual watercourses.
Laydown areas	Established to allow for flexibility in construction and to minimise the need for vehicle movements to and from the construction support sites. These would act as temporary staging, storage, and complex plant/equipment setup areas. They would also act as traffic control nodes during construction of the HTP.
No clearing zone	Areas within the transmission line easement where vegetation removal is not required. These areas would occur where there is sufficient separation of 10 m or more between the maximum operating temperature conductor position and the existing vegetation. This area is excluded from the disturbance area.
Olney switching station	The new switching station that would be constructed in Olney State Forest.

Term	Definition
Operation impact area	The area that would be occupied by permanent components of the project and/or maintained, including transmission line easements, transmission lines and towers, substations, switching stations, communications infrastructure, maintenance facilities, permanent access roads to substations and switching stations and access tracks to the transmission line easement.
Pre-construction minor works	Activities with a low potential to impact the environment that may be permissible in advance of construction and without the requirement for an approved environmental management strategy/construction management plan.
Project impact area	The area that has been assumed for the purpose of the EIS to be directly affected by the construction and operation of the project. It includes the indicative location of project infrastructure, the area that would be directly disturbed during construction and any easement required during operation.
(the) proponent	The Energy Corporation of NSW (EnergyCo).
Refinement	A change that fits within the limits set by the project description contained in the EIS for the HTP and does not change what the proponent is seeking approval for and/or does not require an amendment to the application for the HTP.
Renewable Energy Zone (REZ)	A geographic area identified and declared by the NSW Government as a Renewable Energy Zone.
Riparian buffer	An area that extends across any mapped or unmapped watercourse from 5 metres either side of the top of bank of (as defined in Transgrid's <i>Environmental Guidance Notes</i>) where alternative clearance procedures are applied.
Riparian corridor	Forms a transition zone between the land, also known as the terrestrial environment, and the river or watercourse or aquatic environment.
Sensitive receiving environment	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.
Stringing site	Used for the preparation, assembly and operation of stringing equipment to connect the transmission line to the towers. Stringing sites would be positioned along the HTP corridor. On other transmission projects, they may be referred to as 'brake and winch' sites.
Study area	Relates to the assessment area for this technical assessment - the study area for this surface water assessment encompasses the project and watercourses and catchments both interacting with and extending downstream of the project.
Substation	A facility used to increase or decrease voltages between incoming and outgoing lines (e.g. 330 kV to 500 kV).
Switching station	A facility used to connect 2 or more distinct transmission lines of the same designated voltage.
Temporary worker accommodation	Temporary accommodation that would be erected and used during construction to house the construction workforce. Worker accommodation would be located at some construction support sites.
Transgrid	Preferred network operator for the HTP.

Term	Definition
Transmission line easement	An area surrounding and including the transmission lines which is a legal proprietary right and allows for ongoing access and maintenance of the transmission lines. Landowners can typically continue to use most of the land within transmission line easements, subject to some restrictions for safety and operational reasons.
Transmission tower	For 500 kV transmission lines, this is typically a free-standing steel lattice structure (suspension or tension tower). Transmission towers for the HTP would generally be up to 85 m high.

Executive summary

ES1.1 Introduction

The Hunter Transmission Project (HTP, the project) involves the construction of a new overhead 500 kilovolt (kV) transmission line around 110 kilometres connecting the existing 500 kV transmission line at Bayswater to the existing 500 kV transmission line in the Olney State Forest near Eraring in the Hunter region of New South Wales (NSW).

Due to its strategic importance, the NSW Minister for Planning and Public Spaces has declared the HTP to be critical State significant infrastructure (CSSI) under the [NSW Environmental Planning and Assessment Act 1979](#) (EP&A Act).

Under this process, the Energy Corporation of NSW (EnergyCo, the proponent) is required to prepare an environmental impact statement (EIS) in accordance with the [NSW Environmental Planning and Assessment Regulation 2021](#). This Surface Water Assessment accompanies the EIS for the HTP and addresses the [Secretary's environmental assessment requirements](#) (SEARs) issued on 13 August 2024.

The HTP also includes:

- a new overhead 500 kilovolt (kV) double circuit transmission line of around 110 kilometres
- 2 new switching stations (Bayswater South and Olney)
- upgrades to the existing Bayswater and Eraring substations
- adjustments and upgrades to existing transmission lines
- property adjustment works to facilitate access to the transmission lines and switching stations
- utility adjustments required for the construction of the transmission network infrastructure
- ancillary works to support construction including road upgrades, establishment of new access tracks and upgrade of existing access tracks, construction support sites (some with temporary worker accommodation), and other construction facilities such as laydown areas.

ES1.2 Assessment methodology

Available desktop information has been used to inform the surface water setting and assessment of impacts. This includes review of publicly available data, reports and databases. The assessment is supported by a surface water monitoring program to describe the baseline surface water quality of the receiving environment.

To assess potential surface water risks resulting from the project the following has been undertaken:

- desktop review of publicly available data and reports relating to receiving catchments and watercourses
- identification of potential risks to receiving watercourses, including sensitive receiving environments, and potential impacts to water quality, streamflow regime, watercourses and riparian corridors
- water quality sampling at 20 locations within the study area
- qualitative assessment of the potential impacts to the receiving environment from the construction and operation of the project

- assessment of the project's potential impacts against the *NSW Water Quality and River Flow Objectives (DECCW 2006)*
- identification of potential mitigation measures to avoid, mitigate and manage any potential impacts to receiving watercourses.

ES1.3 Existing environment

The surface water study area encompasses the project impact area, along with all watercourses and catchments which interact with, and extend downstream of the project impact area. The study area is within the 3 major catchment areas of the Hunter River, Lake Macquarie and Tuggerah Lakes. The majority of the project impact area ultimately drains to the Hunter River via numerous watercourses. The southern portion of the project impact area drains to Lake Macquarie via Dora Creek and Tuggerah Lakes via Wyong River.

From north to south, the project impact area traverses through and adjacent to mining and energy generating areas, across agricultural land of the Hunter River floodplain, rises to the elevated ranges of the Pokolbin, Corrabare, Watagan and Olney State forests, and descends into the Lake Macquarie coastal fringe.

Surface water quality of watercourses across the study area exhibits significant variability, influenced by the diverse land uses present. Deviations from water quality objectives (WQOs) are present across the study area, particularly for dissolved oxygen and nutrients. The geomorphic condition of watercourses and riparian corridors also vary significantly across the study area, reflective of variable topography, cleared land practices, soil and underlying geology.

Due to the large project extent and its interaction with various land uses of varying levels of disturbance, the sensitivity of the receiving environment varies widely. Sensitivity of the receiving environment in the north of the study area is low, where ecosystems are highly disturbed by coal mining and energy generation industries. The sensitivity of the receiving environment is highest in the elevated State forests where receiving watercourses and/or their catchments are largely undisturbed, watercourses are more susceptible to instabilities (due to steep terrain) and watercourses have been identified by the biodiversity development assessment report (*Technical Report 1 – Biodiversity development assessment report*) to contain threatened amphibian species.

ES1.4 Proposed water management

Prior to construction, a soil and water management plan (SWMP) will be developed as part of the overall environmental management strategy (EMS) to address temporary and site-specific risks to surface water during the construction phase. Key principles and objectives for stormwater management, vegetation clearance practices, erosion and sediment control and water supply and disposal will be developed in the EMS and supporting management plans. These management practices form the basis for the management and mitigation of potential impacts.

It is estimated that a total of around 1580 megalitres of water would be required for the construction of the HTP, including 170 megalitres of potable water and 1410 megalitres of non-potable water. A combination of water sources would be required to meet water demand for the project. The project will prioritise accessing water from existing water sources such as recycled water, project related water management infrastructure and consider fit-for-purpose wastewater from nearby industries, such as mining. Where alternative water sources are not suitable, water may be sourced from environmental sources including surface water and groundwater sources, of which there are sufficient water entitlements available in the water trading market to meet demand for the project.

Wastewater from temporary worker accommodation would be transported to a licensed waste facility. Disposal of wastewater from construction activities, such as concrete batching or excavations that intercept groundwater, would be reused or disposed of appropriately, depending on water quality.

ES1.5 Predicted impacts

The majority of potential surface water impacts would take place during the construction phase. The following potential impacts to the receiving surface water environment were identified:

- changes to water quality
- changes to streamflow regime
- interactions with watercourses and riparian corridors.

Risks to surface water quality are higher in the State forests where the topography is steep and disturbance activities are located upstream of sensitive biodiversity areas. Steep topography increases the risk of erosion and sediment mobilisation due to higher velocity of runoff which can increase erosive forces, causing greater scour and mobilisation of sediments. Erosion and mobilisation of sediments can affect water quality by increasing turbidity and suspended sediments, increasing nutrients, and mobilising a range of contaminants that bind to soil particles such as pesticides and metals

Risks to surface water quality are substantially lower in areas of the Hunter Valley of low to moderate grades where the receiving environment is highly modified as a result of land clearing, coal mining, and energy generation. With the implementation of mitigation measures, predicted impacts to water quality are considered low to moderate, depending on the sensitivity of the receiving environment.

Predicted impacts to streamflow regime are localised and largely associated with stormwater control measures. These impacts would, however, be very localised, short term, dissipate downstream and insignificant to streamflow. Predicted impacts to streamflow regime are low. The extraction of water from any surface water source would be undertaken in accordance with the NSW water regulatory framework including any conditions on water access licences (WALs) and water supply works and use approvals as well as rules in the relevant water sharing plan (WSP). This framework considers measures to manage extractions such that there are minimal impacts to downstream water users and the environment

Potential impacts to riparian corridors would be highest in the State forests where there is a greater presence of vegetation and disturbance activities are located in or upstream of sensitive biodiversity areas. The removal of vegetation from riparian corridors can affect bed and bank stability of watercourses, alter the suitability of habitats for terrestrial and aquatic species and alter the conveyance functionality and geomorphic form of watercourses. Construction of watercourse crossings, as well as vegetation clearing, would also impact riparian corridors. The potential impacts to riparian corridors would be substantially lower in low lying areas of the Hunter Valley where vegetation clearing is extensive and the receiving environment is highly modified as a result of land clearing, coal mining, and energy generation.

ES1.6 Management and mitigation measures

The ongoing design refinement process has the objective of developing an efficient project design that avoids and minimises environmental impacts. With the implementation of mitigation measures, predicted impacts to watercourses and riparian corridors are considered low to moderate, depending on the sensitivity of the receiving environment. The implementation of the mitigation and management measures in *Chapter 8 (Management)* are key to managing risks to surface water quality, streamflow regime and physical works within watercourses and riparian corridors.

Mitigation measures to avoid or minimise potential surface water impacts from the construction and operation of the project are listed in Table ES1. Specifically, a soil and water management plan will be developed for the project. This management plan will outline site specific surface water and groundwater measures to be implemented to prevent potential negative impacts to water resources during the construction and operational phases.

Other technical reports in the EIS with mitigation measures relevant to the management of surface water include:

- Soils and land assessment (*Technical Report 9– Soils and land impact assessment*): provides specific measures for effective erosion and sediment control for the project
- Flood impact assessment (*Technical Report 12 – Flooding impact assessment*): provides specific measures to minimise the impacts of the project on flooding and hydraulic regime
- Biodiversity development assessment report (*Technical Report 1 – Biodiversity development assessment report*): measures to manage activities in vegetated riparian zones and minimise impacts to aquatic environments
- Groundwater impact assessment (*Technical Report 11 – Groundwater impact assessment*): measures to ensure incidental water take during construction is in accordance with regulatory conditions
- Contamination preliminary site investigation (*Technical Report 13 – Contamination preliminary site investigation*): measures relating to the storage of fuel and oil within the construction disturbance area and accidental disturbance of contaminated material.

Table ES1 **Proposed mitigation measures – surface water**

ID	Project element	Management and mitigation measures	Timing	Relevant location(s)
SW1	Impacts to surface water	A project specific SWMP would be prepared, which provides mitigation measures to minimise impacts on soils and water. The SWMP would be prepared in accordance with <i>Chapter 8 (Management)</i> and would: • Identify foreseeable risks relating to soil erosion and water pollution during construction and describe how these risks would be managed • Include a description of soil and water management approaches, methods for impact assessment and monitoring, and mitigation measures • Include erosion and sediment control plans (ESCPs) • Include surface water quality monitoring requirements • Include stormwater management plans (SMPs) At the completion of construction, appropriate measures would be carried into the Network Operator's environmental management system (EMS).	Detailed design and construction	All
SW2	Water quality and geomorphology	Scour protection will be considered for any infrastructure within a watercourse. Design will incorporate features that minimise impact on flow conditions and natural function of the watercourse, where feasible and reasonable. Works within or near watercourses will consider and adhere to the following guidelines: • <i>Controlled activities - Guidelines for watercourse crossings on waterfront land</i> (DPE 2022a) • <i>Controlled activities - Guidelines for instream works on waterfront land</i> (DPE 2022c) • <i>Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings</i> (DPI 2003) • <i>Policy and Guidelines for Fish Habitat Conservation and Management</i> (DPI 2013).	Detailed design and construction	All

ID	Project element	Management and mitigation measures	Timing	Relevant location(s)
SW3	Erosion and sedimentation	ESCPs will be developed, prior to construction, and implemented in consultation with a Certified Professional in erosion and sediment control for all disturbance activities. The plans will detail the processes, responsibilities and measures to manage potential soil and water quality impacts in accordance with the principles and requirements in: - Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004), Volume 2A (DECC 2008a) and 2C (DECC 2008b), commonly referred to as the 'Blue Book' - Best Practice Erosion and Sediment Control (IECA 2008) - Guidelines for controlled activities (Riparian corridors (DPE Water 2022a) and Watercourse crossings (DPE Water 2022b)) - ESCPs will include additional considerations for areas of high risk (e.g. high slopes) and located upstream of sensitive biodiversity areas (i.e. State forest areas) including at Olney switching station.	Detailed design and construction	All
SW4	Water quality monitoring	As part of a SWMP, a water quality monitoring program will be prepared and implemented to establish baseline water quality conditions in watercourses of high sensitivity that may be impacted by nearby construction and to detect changes in water quality that may be attributable to the project during construction. The frequency, location and duration of sampling will be detailed in a monitoring program. Monitoring will: - Be positioned upstream and downstream of project disturbance areas, focusing on locations with sensitive receiving environments. Where upstream and downstream monitoring is not possible, pre-construction water quality conditions will be established through baseline monitoring - Be carried out in accordance with water quality objectives and criteria for the project and in accordance with Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)	Detailed design and construction	All
SW5	Hazardous chemicals	- All chemicals or other hazardous substances will be stored in a bunded area and away from any drainage lines/pits. The capacity of the bunded area will be at least 130% of the largest chemical volume contained within the bunded area - No refuelling or bulk herbicide preparation will occur within 40 m of natural drainage lines - Environmental spill kits containing spill response materials suitable for the works being undertaken will be kept on site at all times and be used in the event of a spill - Any spills will be contained, cleaned up promptly and immediately reported to the relevant site representative	Construction and operation	All

ID	Project element	Management and mitigation measures	Timing	Relevant location(s)
SW6	Stormwater management – general	General stormwater management principles to be applied within the project impact area will include: • Appropriate siting of proposed infrastructure within the project impact area, which will minimise (and avoid where possible) disturbance to existing drainage lines, riparian vegetation and overland flow paths • Grading of earthworks to minimise changes to existing catchments and flow paths • Surface drainage infrastructure that diverts upslope runoff around infrastructure and excavations to receiving drainage lines • Infrastructure areas that contain oil and/or grease will include suitable containment measures • Scour protection will be considered downstream of areas that increase runoff into receiving watercourses • Consideration of appropriate water quality and stormwater controls (for ancillary areas) upstream of sensitive receiving environments, such as at Olney switching station	Detailed design and construction	All
SW7	Stormwater management – concrete batching plants	Stormwater management measures for concrete batching plants (both mobile and temporary) will include: • The separation of clean and potentially contaminated runoff by a bunded cementitious areas • The collection of first flush runoff from cementitious areas • Offsite disposal of contaminated water not suitable for reuse to a licenced waste facility	Detailed design and construction	All
SW8	Stormwater management – excavations	Stormwater management measures for excavations (particularly for transmission towers) will include bunding around excavations to prevent runoff into excavations.	Detailed design and construction	Excavations
SW9	Stormwater management – spoil	Runoff from spoil piles, topsoil stockpiles and other excavated material will be managed through: • Minimising the number of stockpiles, stockpile areas and the time they are exposed • Locating stockpiles away from drainage lines and natural watercourses and from where they will be susceptible to erosion • Bunding stockpiles in accordance with Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition (Landcom 2004) • Stabilising stockpiles, establishing sediment controls and suppressing dust as required	Detailed design and construction	All
SW10	Water supply	Water supply management will be undertaken in accordance with agreements between the construction contractors, relevant landowners and relevant water users and suppliers. Groundwater and surface water allocations purchased from existing registered bores/users must be extracted in accordance with the conditions stated in the associated water access license(s) and water supply works approval(s).	Prior to and during construction	Water extraction locations

ID	Project element	Management and mitigation measures	Timing	Relevant location(s)
SW11	Dewatering	In the event that dewatering is required: - The management of discharge water will be documented in the SWMP and will consider options for containment, reuse, application to grassed areas and transport to licensed waste facilities In the event that discharge water is discharged to grassed areas: - Application will be limited to grassed areas within the project impact area, away from watercourses. If the discharge water is highly turbid, dewatering through a filter sock (or similar) or via transportable sedimentation tanks will be considered, where appropriate, to minimise sedimentation	Detailed design and construction	Excavations
SW12	Construction impact area – clearance (general)	Clearance practices will include: - Immediate laying of mulch where ground disturbance has occurred (except in riparian corridors) - Stabilisation of mulch where mobilisation by wind or runoff is possible - Management of mulching activities and stockpiles to minimise tannin production and avoid discharge to watercourses - Ground stabilisation using felled vegetation placed across the slope to minimise the concentration of flows, especially upstream of riparian corridors	Construction	All
SW13	Construction impact area – clearance (riparian buffer areas)	Riparian buffer areas include 5 m from the top of bank of any mapped or unmapped watercourse. Clearance practices in riparian buffer areas will include: - Hand clearing methods that minimise ground disturbance and disturbance of the understorey - No placement of mulch (and measures to avoid the transport of mulch into watercourses) - Stabilisation of the watercourse bed and banks will be installed as soon as practical, where disturbance to the understorey or ground has occurred - Where vegetation clearance is oblique or parallel to the watercourse (i.e. not perpendicular), stabilisation works with minimal impact will be designed prior to disturbance and installed as soon as practical	Construction	Riparian corridors

Abbreviations

Term	Description
AHD	Australian height datum
BC Act	<i>Biodiversity Conservation Act 2016</i>
BDAR	Biodiversity development assessment report
BoM	Bureau of Meteorology
CSSI	Critical State significant infrastructure
DCCEEW (Cth)	Department of Climate Change, Energy, the Environment and Water – Commonwealth
DCCEEW (NSW)	Department of Climate Change, Energy, the Environment and Water – NSW
DGV	Default guideline value
DPHI	Department of Planning, Housing and Infrastructure (previously DPI, DPIE and DPE)
DPI	Department of Primary Industries
EIS	Environmental impact statement
EMS	Environmental Management Strategy
EnergyCo	The Energy Corporation of New South Wales constituted by section 7 of the <i>NSW Energy and Utilities Administration Act 1987</i> as the NSW Government-controlled statutory authority responsible for the delivery of NSW's REZs. The proponent for the HTP.
EPA	Environment Protection Authority
EP&A Act	<i>NSW Environmental Planning and Assessment Act 1979</i>
EP&A Regulation	Environmental Planning and Assessment Regulation 2021
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ESCP	Erosion and sediment control plan
FM Act	<i>Fisheries Management Act 1994</i>
GDE	Groundwater dependent ecosystem
ha	hectare
HRSTS	Hunter River Salinity Trading Scheme
HTP	Hunter Transmission Project (the project)
HVO	Hunter Valley Operations
IRZ	Indicative riparian zones
KFH	Key fish habitat
km	kilometre
kV	kilovolts (1000 volts)
LGA	Local government area
m	metre

Term	Description
MNES	Matters of national environmental significance
NSW	New South Wales
REZ	Renewable energy zone
RFO	River flow objective
SEARs	Secretary's environmental assessment requirements
SEPP	State Environmental Planning Policy
SILO	Scientific information for landowners
SMA	Singleton Military area
SMP	Stormwater management plan
SWA	Surface water assessment
SWMP	Soil and water management plan
WAL	Water access licence
WM Act	<i>Water Management Act 2000</i>
WM Regulation	Water Management (General) Regulation 2018
WQMP	Water quality monitoring plan
WQO	Water quality objective
WSP	Water sharing plan

1 Introduction

The Hunter Transmission Project (HTP, the project) involves the construction of a new overhead 500 kilovolt (kV) transmission line around 110 kilometres connecting the existing 500 kV transmission line at Bayswater to the existing 500 kV transmission line in the Olney State Forest near Eraring in the Hunter region of New South Wales (NSW).

Due to its strategic importance, the NSW Minister for Planning and Public Spaces has declared the HTP to be critical State significant infrastructure (CSSI) under the [NSW Environmental Planning and Assessment Act 1979](#) (EP&A Act).

Under this process, the Energy Corporation of NSW (EnergyCo, the proponent) is required to prepare an environmental impact statement (EIS) in accordance with the [NSW Environmental Planning and Assessment Regulation 2021](#).

This surface water assessment (SWA) accompanies the EIS for the HTP and addresses the [Secretary's environmental assessment requirements](#) (SEARs) issued on 13 August 2024. Table 1.1 includes all SEARs relevant to water and soils and sets out those addressed within this SWA and those addressed in other reports.

In addition to the SEARs, advice from several government agencies was received on the HTP. Agency advice relevant to and considered in this SWA is provided on the [Major Projects website](#) maintained by the NSW Department of Planning, Housing and Infrastructure (DPHI).

Table 1.1 **HTP SEARs – water and soils**

HTP SEARs:

SEARs addressed in this SWA:

- An assessment of the impacts of the project on the quantity and quality of the region's surface water resources, including the Hunter River, having regard to NSW Water Quality Objectives
- Where the project involves works within 40 metres of the high bank of any river, lake or wetlands (collectively waterfront land), identify likely impacts to the waterfront land, and how the activities are to be designed and implemented in accordance with the Department of Primary Industries' (DPI) *Guidelines for Controlled Activities on Waterfront Land* (2018) and (if necessary) *Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (DPI 2003); and *Policy & Guidelines for Fish Habitat Conservation & Management* (DPI 2013)
- Details of water requirements and supply and wastewater disposal arrangements for construction

SEARs addressed in other reports:

Groundwater assessment:

- An assessment of the impacts of the project on groundwater aquifers and groundwater dependent ecosystems having regard to the *NSW Aquifer Interference Policy* and relevant Water Sharing Plans

Flooding assessment:

- An assessment of the potential flooding impacts and risks of the project

Soils and land capability assessment:

- A description of the erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with *Managing Urban Stormwater: Soils & Construction* (Landcom 2004)

1.1 Related reports

Other reports that have been prepared to support the EIS and closely relate to this SWA include:

- Flood impact assessment (*Technical Report 12 – Flooding impact assessment*) which considers the potential impact of the project on flooding and hydraulics and the impact of flooding on the project. The assessment of instream structures on flooding and hydraulics is included in the flooding assessment
- Soils and land impact assessment (*Technical Report 9 – Soils and land impact assessment*) which documents the potential impacts of the project on soils and land capability of the project impact area and surrounds, including the provision of erosion and sedimentation control measures
- Contamination preliminary site investigation (*Technical Report 13– Contamination preliminary site investigation*) which documents the potential impacts of contamination during the construction and operation of the project
- Groundwater impact assessment (*Technical Report 11 – Groundwater impact assessment*) which documents the potential impacts on groundwater aquifers and groundwater dependent ecosystems and includes the consideration of groundwater supply for the project demands
- Biodiversity development assessment report (*Technical Report 1– Biodiversity development assessment report*) which details the potential impact of the project on biodiversity
- Aquatic biodiversity impact assessment (*Appendix L to Technical Report 1 - Biodiversity development assessment report*) which details the potential impact of the project on aquatic species.

2 The Hunter Transmission Project

The Hunter Transmission Project (HTP, 'the project') is critical State significant infrastructure (CSSI). It must be built by the end of 2029 to protect energy security in New South Wales (NSW) as the remaining coal-fired power stations close.

The HTP includes:

- a new overhead 500 kilovolt (kV) double circuit transmission line of around 110 kilometres
- 2 new switching stations (Bayswater South and Olney)
- upgrades to the existing Bayswater and Eraring substations
- adjustments and upgrades to existing transmission lines
- property adjustment works to facilitate access to the transmission lines and switching stations
- utility adjustments required for the construction of the transmission network infrastructure
- ancillary works to support construction including road upgrades, establishment of new access tracks and upgrades to existing access tracks, construction support sites (some with temporary worker accommodation), and other construction facilities such as laydown areas.

The new transmission line would transport electricity generated in the Central-West Orana and New England Renewable Energy Zones (REZs). It would connect the existing 500 kV transmission line at Bayswater to the existing 500 kV transmission line in the Olney State Forest near Eraring. This would strengthen the State's core electricity grid and supply clean and reliable energy to NSW consumers for generations to come.

The HTP involves development across 5 local government areas (Muswellbrook, Singleton, Cessnock, Central Coast and Lake Macquarie). Most of this development would be concentrated in and around the HTP corridor.

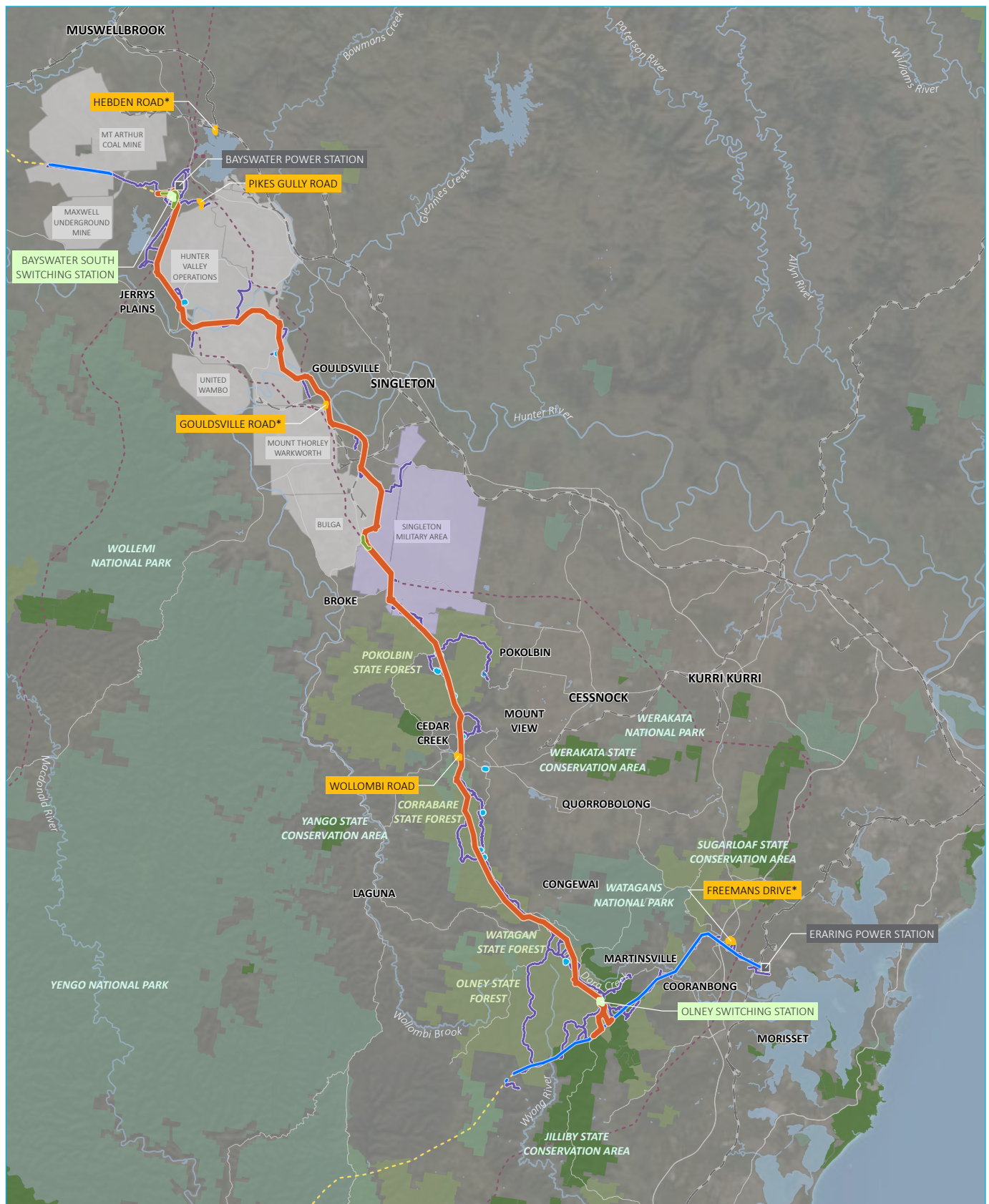
An overview of the HTP is provided in Table 2.1 and shown in Figure 2.1. The key project elements are shown in Figure 2.2.

Further details are provided in *Chapter 4 (Project description)* of the HTP environmental impact statement (EIS).

Table 2.1 **Project overview**

The project	• The critical State significant infrastructure application for the HTP covers 5 local government areas • Most development would be concentrated in and around the HTP corridor. Some ancillary development such as construction support sites and temporary worker accommodation, road upgrades and laydown areas would be outside the HTP corridor
Project impact area	• The area that has been assumed for the purpose of this EIS to be directly affected by the construction and operation of the project. It includes the indicative location of project infrastructure, the area that would be directly disturbed during construction and any easement required during operation
Construction and operation	• Construction impact area around 2351 ha • Operation impact area around 1261 ha
Disturbance area	• Disturbance area around 1266 ha • Disturbance area A around 683 ha • Disturbance area A (centreline) around 214 ha • Disturbance area B around 367 ha • Disturbance area HZ around 1.84 ha
New transmission line and transmission towers	• Overhead 500 kV double circuit transmission line of around 110 km between Bayswater South 500 kV switching station and Olney 500 kV switching station • Steel lattice towers generally up to 85 m high and that are spaced anywhere between 75 m to around 1.3 km apart (typically between 300 m and 600 m) • 500 kV transmission lines with a minimum ground clearance of 13.5 m • Ancillary infrastructure such as earth wire and communications systems • Construction easement of around 140 m wide • Operational easement around 70 m wide
Switching stations/ substation works	• New Bayswater South 500 kV switching station – construction impact area around 26.6 ha • Modifications at the existing Bayswater 500 kV/330 kV substation within the existing footprint • New Olney 500 kV switching station – construction impact area around 20 ha • Augmentation and modifications at the existing Eraring 500 kV/330 kV substation, including installation of 2 new transformers
Adjustments and crossings - existing transmission lines	• Adjustments to existing double circuit 500 kV transmission lines: – Line 5A1 and 5A2: Eraring – Kemps Creek 500 kV at Ravensdale to connect to the new Olney 500 kV switching station – Line 5A3: Bayswater – Mt Piper 500 kV at Bayswater to connect to the new Bayswater South 500 kV switching station – Line 5A4: Bayswater – Wollar 500 kV at Bayswater to connect to the new Bayswater South 500 kV switching station • Adjustments to existing double circuit 330 kV transmission lines: – Line 31: Bayswater – Regentville 330 kV – Line 32: Bayswater – Sydney West 330 kV – Line 81: Newcastle – Liddell 330 kV • Crossing of existing double circuit 330 kV transmission lines: – Line 31: Bayswater – Regentville 330 kV at Bayswater – Line 32: Bayswater – Sydney West 330 kV at Bayswater – Line 81: 330 kV: Newcastle – Liddell 330 kV at Lemington and again at the Singleton Military Area • Line 82: 330 kV: Tomago – Liddell 300 kV at Warkworth and again at the Singleton Military Area

Upgrades – existing transmission lines and towers	- Upgraded earth wire on Line 5A3 and Line 5A4 - Upgraded earth wire and communications systems on Line 5A1 and Line 5A2 - Tower strengthening on various existing towers on Line 5A1, Line 5A2, Line 5A3 and Line 5A4
Road works	- Modifications to the existing public road network - New and upgraded access tracks for construction and operation
Construction support sites	- Five construction support sites: Hebden Road, Pikes Gully Road, Gouldsville Road, Wollombi Road and Freemans Drive - Helicopter pads (helipads) indicatively at: Hebden Road, Pikes Gully Road, Gouldsville Road and Freemans Drive
Ancillary sites	Laydown areas, which would be established to allow for flexibility in construction and to minimise the need for vehicle movements to and from the construction support sites
Utility adjustments	Third party utility works including gas, telecommunications, water, sewer and stormwater
Timing	- Construction to start in 2027 - Operation by end of 2029



Source: EMM (2025); Beca (2025); ESRI (2025); DCSSS (2024); FCNSW (2022); DFSI (2017)

KEY

Project impact area

- HTP corridor
- Switching station
- Construction support site (*with temporary worker accommodation)
- Laydown area
- Adjustment to existing transmission line
- Upgrades to existing transmission line
- Access track

Existing environment

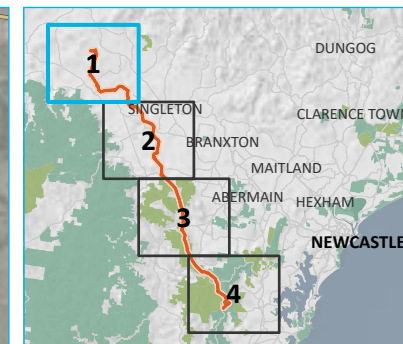
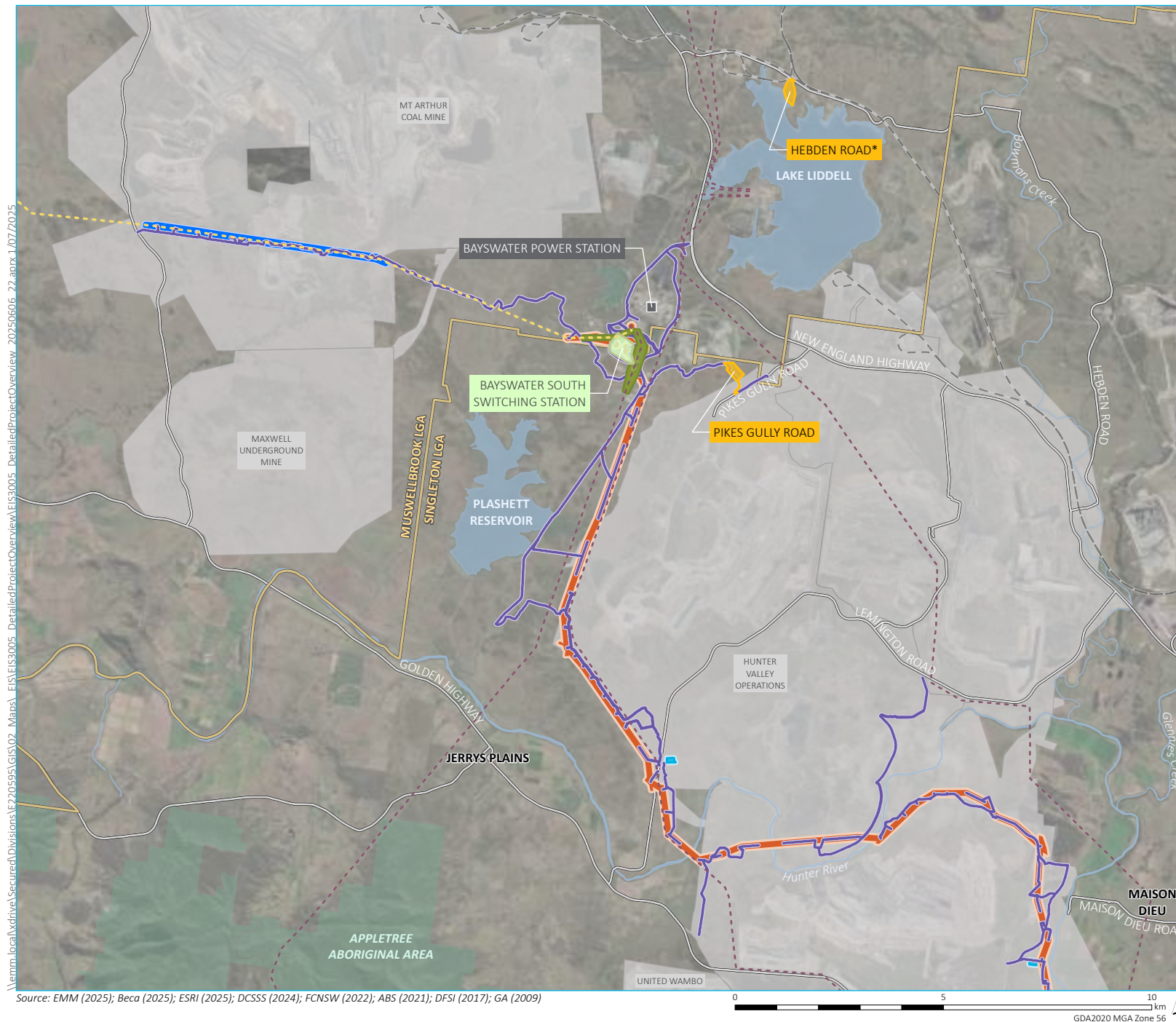
- Power station
- 330 kV transmission line
- 500 kV transmission line
- Railway
- Major road
- Named watercourse

Named waterbody

- NPWS reserve
- State conservation area
- State forest
- Defence
- Mining

Project overview

Hunter Transmission Project
Surface Water Assessment
Figure 2.1

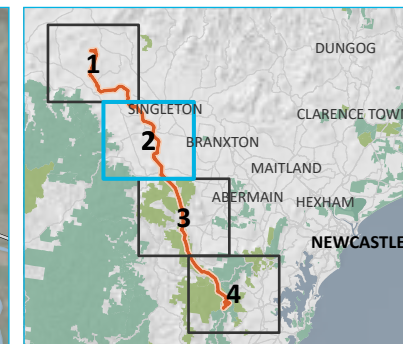
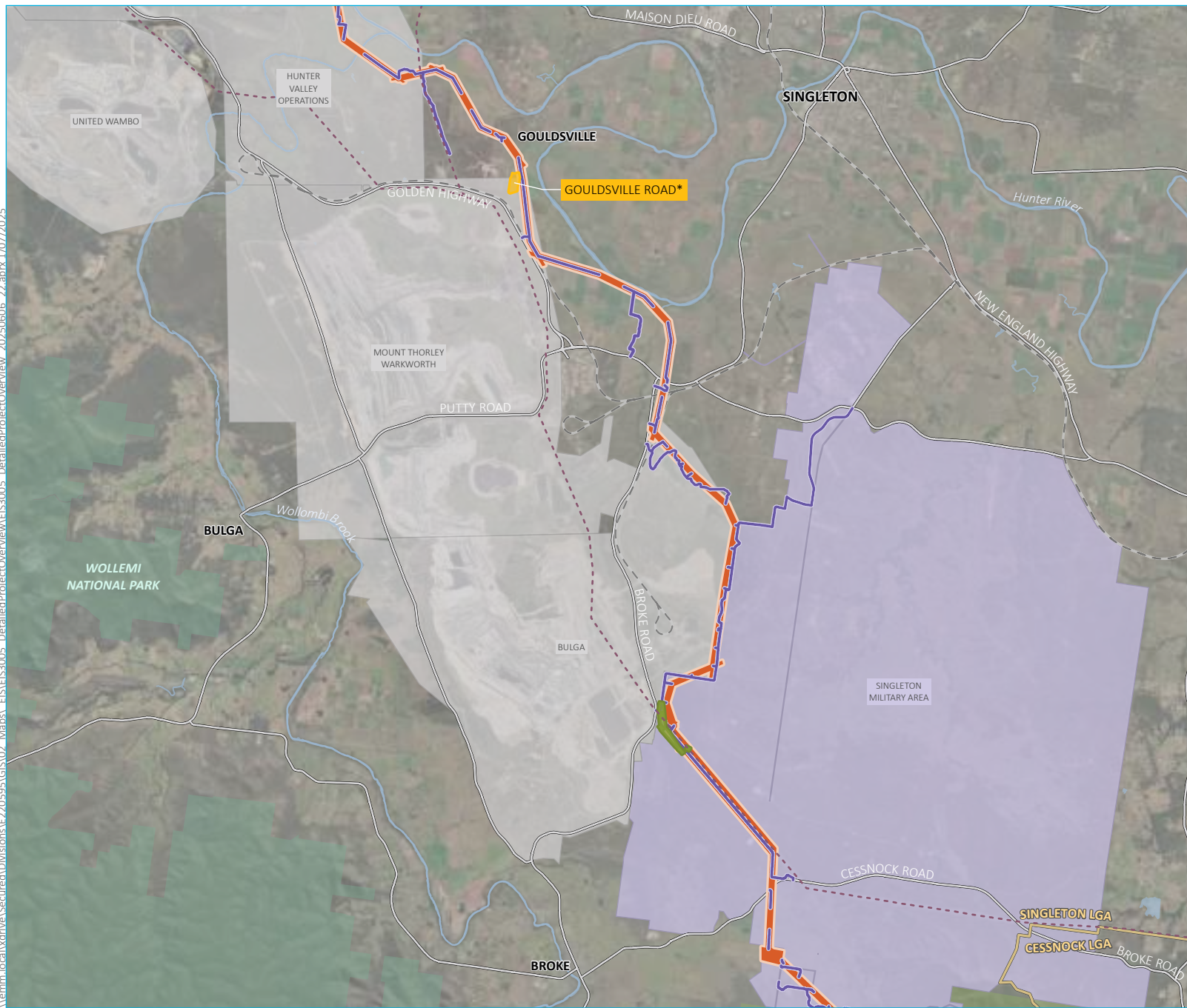


- KEY**
- Project impact area**
- HTP corridor
 - Bayswater South switching station
 - Construction support site (*with temporary worker accommodation)
 - Laydown area
 - Adjustment to existing transmission line (lines 31 and 32)
 - Upgrades to existing transmission line (lines 5A3 and 5A4)
 - Access track
- Existing environment**
- Power station
 - 330 kV transmission line
 - 500 kV transmission line
 - Railway
 - Major road
 - Named watercourse
 - Named waterbody
 - NPWS reserve
 - Mining
 - Local government area

Key project elements
Map 1 of 4

Hunter Transmission Project
Surface Water Assessment
Figure 2.2

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KEY

Project impact area

- HTP corridor
- GOULDSVILLE ROAD* Construction support site (*with temporary worker accommodation)
- ADJUSTMENT TO EXISTING TRANSMISSION LINE (LINE 81) Adjustment to existing transmission line (line 81)
- Access track

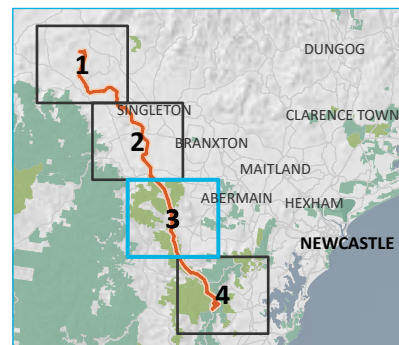
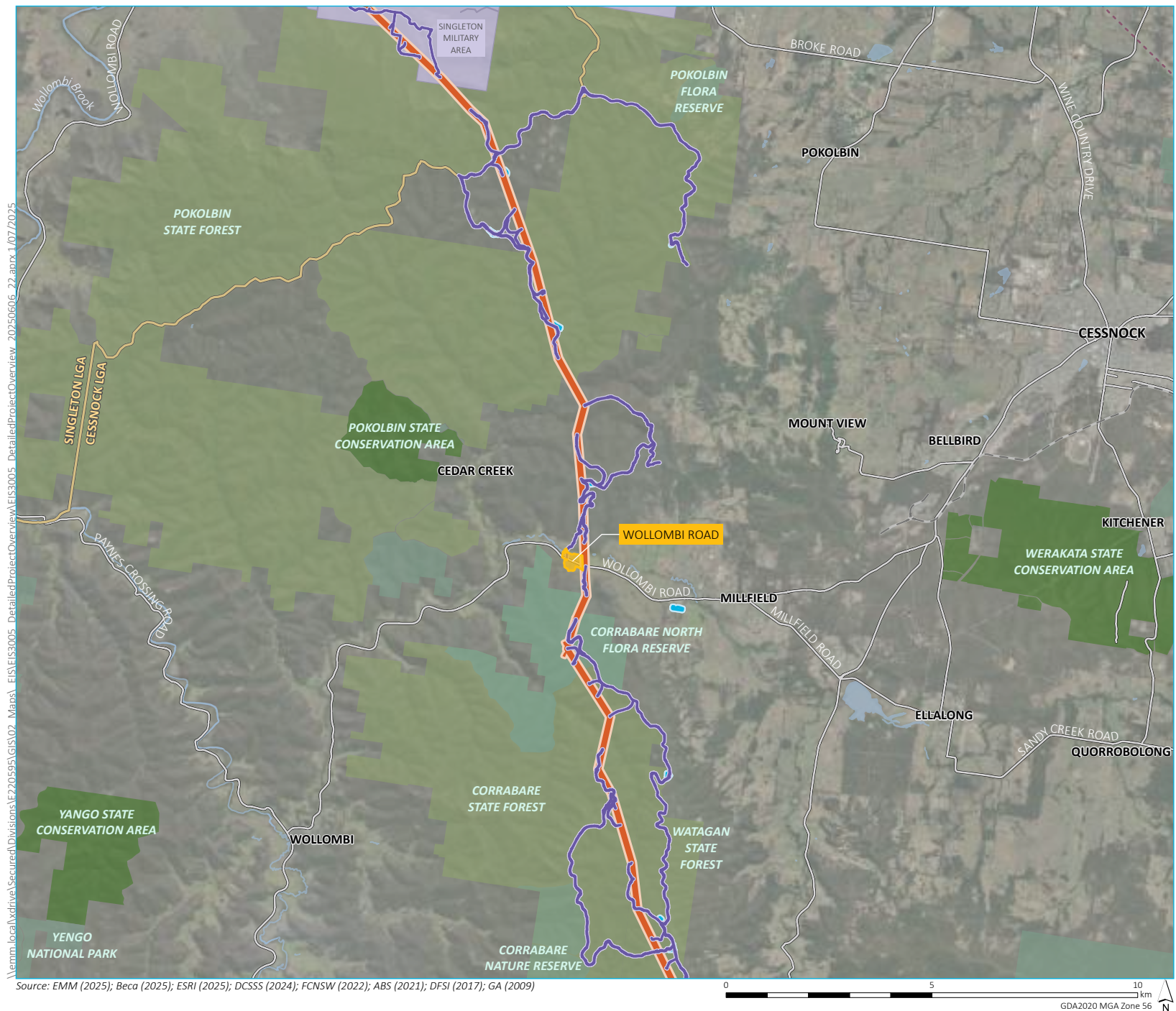
Existing environment

- 330 kV transmission line
- Railway
- Major road
- Named watercourse
- WATERBODY Named waterbody
- NPWS RESERVE NPWS reserve
- STATE FOREST State forest
- DEFENCE Defence
- MINING Mining
- LOCAL GOVERNMENT AREA Local government area

Key project elements Map 2 of 4

Hunter Transmission Project
Surface Water Assessment
Figure 2.2



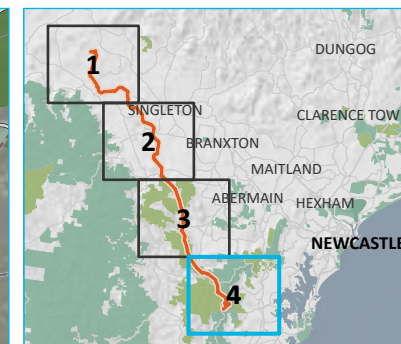
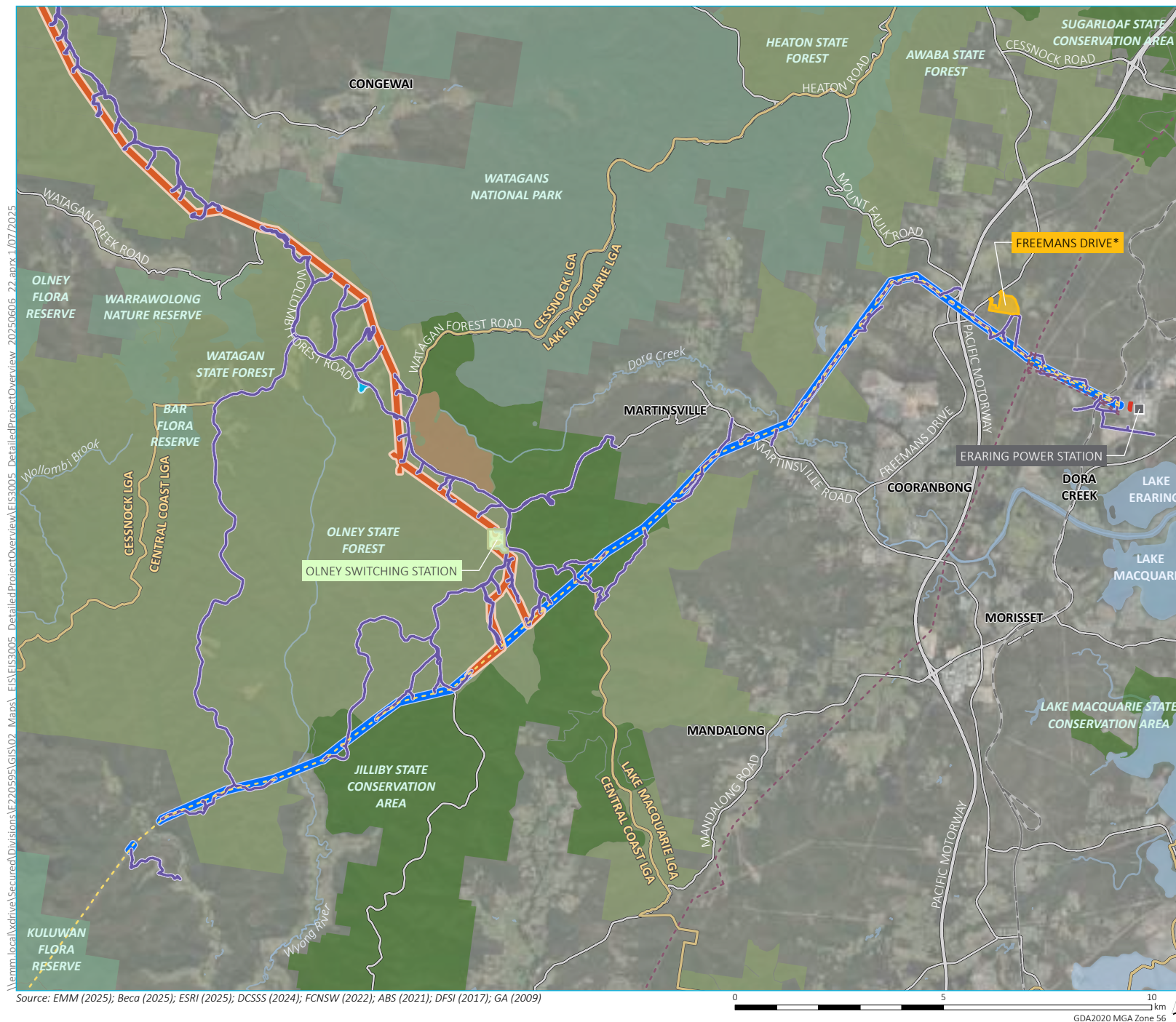


- KEY**
- Project impact area
 - HTP corridor
 - Construction support site (*with temporary worker accommodation)
 - Laydown area
 - Access track
 - Existing environment
 - 330 kV transmission line
 - Railway
 - Major road
 - Named watercourse
 - Named waterbody
 - NPWS reserve
 - State conservation area
 - State forest
 - Defence
 - Local government area

Key project elements
Map 3 of 4

Hunter Transmission Project
Surface Water Assessment
Figure 2.2





KEY

Project impact area

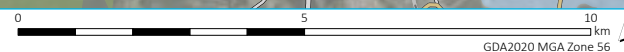
- HTP corridor
- Olney switching station
- Construction support site (*with temporary worker accommodation)
- Laydown area
- Eraring Substation upgrade
- Upgrades to existing transmission line (lines 5A1 and 5A2)
- Access track

Existing environment

- Power station
- 330 kV transmission line
- 500 kV transmission line
- Railway
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- State conservation area
- State forest
- Recreation area
- Local government area

Key project elements
Map 4 of 4

Hunter Transmission Project
Surface Water Assessment
Figure 2.2



3 Assessment methodology

3.1 Overview

The methodology for the SWA considered surface water resources within the study area, including permanent and intermittent resources, rivers, creeks, lakes and any other features that either store, transport or use surface water.

Potential impacts to surface water that may occur from the construction and operation of the Hunter Transmission Project (HTP, the project) were considered in terms of:

- water quality
- streamflow regime
- watercourses and riparian corridors
- water supply and water resources.

The methodology for the SWA included:

- a desktop review of legislation and policy context for assessing surface water impacts
- determining the study area to be considered by the assessment
- a desktop review of publicly available water quality data, guidelines and studies for the surface water study area
- a water quality assessment, which included:
 - conducting a water quality monitoring program to further inform baseline water quality conditions of the surface water study area
 - characterisation of baseline water quality against relevant water quality objectives (WQOs), informed by publicly available information and results of the water quality monitoring program
 - a qualitative assessment of potential impacts to water quality from construction and operation of the project, which included:
 - identifying project activities that have the potential to impact surface water quality
 - identifying the risks to surface water quality from the identified project activities and their potential impact pathways
 - identifying mitigation and management measures to minimise water quality risks, during design, construction and operation of the project, specific to project activities that have potential to impact water quality (see *Chapter 8 (Management)*)
 - determining the residual impact rating for each activity, considering the scale of the activity within the project impact area, the sensitivity of the receiving environment where the project activity is being undertaken and the mitigated risk to water quality
 - assessing the potential impacts of the project to surface water quality during construction and operation, with consideration of the WQOs

- an assessment of the potential impacts of construction and operation of the project on catchment hydrology and streamflow regime/geomorphology, which included:
 - identifying project activities that have the potential to impact catchment hydrology and streamflow regime
 - incorporating design measures and deriving mitigation measures to minimise impacts on streamflow regime (see *Chapter 8 (Management)*)
 - assessment of the potential impacts to streamflow regime from construction and operation of the project, with consideration of the relevant river flow objectives (RFOs)
- an assessment of the potential impacts of the project on watercourses and riparian corridors, which included:
 - identifying watercourses within the study area and determining their associated riparian corridors in accordance with relevant policy and guidelines
 - undertaking a desktop mapping assessment to identify what project components would occur within identified riparian corridors
 - determining the residual impact rating for each project activity, considering the scale of the activity, the sensitivity of the receiving environment, and the mitigated risk to watercourses and riparian corridors.

3.2 Legislation, plans, policies and guidelines

This section summarises the current legislative requirements and guidelines relevant to this SWA.

3.2.1 Commonwealth legislation and policy

i Environment Protection and Biodiversity Conservation Act

The *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) is administered by the Department of Climate Change, Energy, the Environment and Water (DCCEEW (Cth)) and provides a legal framework to protect and manage nationally important flora, fauna, ecological communities, and heritage places defined as ‘matters of national environmental significance’ (MNES).

Under the EPBC Act, proposed actions (i.e. activities or projects) with the potential to significantly impact matters protected by the EPBC Act must be referred to the Commonwealth Minister for the Environment to determine whether they are controlled actions, requiring approval from the Minister.

Following a referral under the EPBC Act to DCCEEW (Cth), the project was determined to be a controlled action and would therefore require Commonwealth assessment and approval under the EPBC Act.

While there are no MNES in terms of surface water that would be directly impacted by the project, there may be indirect impacts on threatened species and communities listed under the EPBC Act through changes in water quality. These impacts are assessed in the biodiversity development assessment report (*Technical Report 1 – Biodiversity development assessment report*).

ii National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) has been developed by the Australian and New Zealand governments in cooperation with State and Territory governments. Endorsed by the Australian and New Zealand Environment and Conservation Council (ANZECC), the strategy establishes objectives to achieve sustainable use of the Nation's water resources by protecting and enhancing their quality while maintaining economic and social development.

The NWQMS includes guidelines for protection of water resources across Australia. These guidelines have been used to interpret existing water quality and establish WQOs for the project.

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

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018), hereafter known as ANZG 2018, is a key guideline within the NWQMS that is used to identify catchment and watercourse specific water quality management goals. These guidelines are an updated version of the previous guidelines referred to as the ANZECC & ARMCANZ 2000 guidelines.

ANZG 2018 provides a process for assessing existing water quality conditions and developing WQOs to sustain current or likely future community values for water resources. Default guideline values for parameters are provided for different community values as generic starting points for assessing water quality where site specific information is not available. The default guideline values are used to evaluate the existing water quality conditions against long term water quality goals.

ANZG 2018 provides the most up to date databases to derive guideline values for toxicants and sediments in aquaculture and aquatic foods, physical and chemical stressors, and guideline values for agricultural water users. Where the ANZG 2018 does not provide a value, the values in the previous ANZECC & ARMCANZ 2000 guidelines still apply.

The default guideline values have not been designed for direct application in activities such as discharge licences, recycled water quality or stormwater quality. These values are provided as a benchmark to compare the existing water quality against.

3.2.2 State legislation, policy and guidelines

i Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and Environmental Planning and Assessment Regulation 2000 (EP&A Regulation) establish a framework for the assessment and approval of developments in NSW.

The project was declared to be critical State significant infrastructure (CSSI) under section 5.13 of the EP&A Act by the (then) Minister for Planning on 22 July 2022. Under section 5.14 of the EP&A Act, the approval of the Minister for Planning is required for State significant infrastructure (SSI) projects (including CSSI), and an environmental impact statement (EIS) has been prepared under Division 5.2 of the EP&A Act.

ii Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) establishes, amongst other things, the procedures for issuing licences for environmental protection on aspects such as waste, air, water, and noise pollution control. The project is not classified as a 'scheduled activity' based on the development type. However, section 120 'Prohibition of pollution of waters' is relevant to this assessment as the project may generate wastewater.

iii Water Management Act 2000

Water resources for the project impact area are administered under the *Water Management Act 2000* (WM Act). The WM Act recognises the need to allocate and provide water for the environmental health of our rivers and groundwater systems, while also providing licence holders with access to water. The WM Act focuses on protecting, enhancing, and restoring water resources and encouraging best practice management and use of water. This legislation applies to and guides the requirements for accessing water for use as part of the construction phase of the project.

The WM Act governs the issue of licences and approvals for those water sources (rivers, lakes, estuaries, and groundwater) in NSW where water sharing plans (WSPs) have commenced. WSPs establish rules for sharing water between water users and the environment, and areas rules for water trading.

Section 89 of the WM Act relates to water use approvals and section 90 relates to water management works approvals. There are 3 kinds of water management work approvals, namely, water supply work approvals, drainage work approvals and flood work approvals.

Under section 91 of the WM Act a controlled activity approval is required for certain types of developments and activities that have the potential to affect water quality that are carried out at a specified location in, on or under waterfront land.

However, under section 5.23 of the EP&A Act, a water use approval, water management works or an activity approval (including a controlled activity approval) under sections 89, 90 and 91 of the WM Act are not required for SSI projects.

a Water Management (General) Regulation 2018

The Water Management (General) Regulation 2018 (WM Regulation) specifies procedural, technical and licence requirements, and exemptions under the WM Act. It also defines the function and powers of water supply authorities.

Activities such as construction and excavation within a certain distance of a classified watercourse are considered controlled activities under the WM Act and the WM Regulation and generally require approval from Department of Climate Change, Energy, the Environment and Water (DCCEEW (NSW)). The WM Regulation identifies exemptions to controlled activity approval requirements which include activities associated with the construction and operation of electricity networks (Schedule 4 Division 2 Clause 43). Consequently, the project is exempt from requiring controlled activity approvals (DPE, 2022c).

Although the project is exempt from the need for controlled activity approvals, the various controlled activity guidelines (see *Section 3.2.2iic*) were used in the assessment of this project and should be considered in future site selection and detailed design for certain features where there is some flexibility in their location such as the transmission tower locations, construction support sites and access tracks.

The WM Regulation specifies the following exemptions from water licensing requirements relevant to the project:

- water taken from or by means of dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration Corporation or any of their subsidiaries) to prevent contamination of a water source, that are located on a minor stream
- water taken from or by means of rainwater tanks collecting from roofs only
- water taken by any public authority for the purpose of dust suppression
- water taken from a coastal water source that occurs in connection with the construction of infrastructure

- water taken in connection with the construction of essential infrastructure (including transmission infrastructure).

b Water sharing plans

WSPs are statutory documents developed under the WM Act that establish the rules for the sustainable sharing of water between the environment and water users, and between different types of water use at a water source scale and for specific water resource types (regulated rivers, unregulated rivers and groundwater). Long-term average annual extraction limits are set by WSPs to define the limit of water that can sustainably be taken for all purposes. WSPs set the rules for managing water in licence accounts, for trading licence entitlements and allocations, and for managing the works used to take licensed water.

WSPs are typically in place for 10 years, however they may be suspended in times of severe water shortages. There are WSPs for ground water and surface water resources.

The WSPs relevant to the surface water study area include:

- *Water Sharing Plan for the Hunter Regulated River Water Source 2016* (Regulated River WSP):
 - Hunter Regulated River Water Source – surface flows and highly connected alluvial aquifers within 40 metres of the riverbanks of the Hunter River and Glennies Creek. This water source is separated into multiple management zones
- *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2022* (Unregulated and Alluvial WSP):
 - Hunter Regulated River Alluvial Water Source (Downstream Glennies Creek and Upstream Glennies Creek management zones) – alluvial groundwater contained in the unconsolidated alluvial sediments extending from the Hunter Regulated River Water Source to the boundary of the alluvial aquifer
 - water that occurs naturally on the surface of the ground and in alluvial sediments within the following water sources:
 - Jerrys Water Source (Jerrys Management Zone)
 - Lower Wollombi Brook Water Source
 - Singleton Water Source
 - Upper Wollombi Brook Water Source (Mid Congewai Creek Management Zone).
 - Dora Creek Water Source
- *Water Sharing Plan for the Central Coast Unregulated and Alluvial Water Sources 2022:*
 - water that occurs naturally on the surface of the ground and in alluvial sediments within the following water sources:
 - Wyong River Water Source
 - Jilliby Jilliby Creek Water Source.

c Waterfront land

The WM Act defines waterfront land as the bed of any river, lake or estuary and any land within 40 metres of the riverbanks, lake shore or estuary mean high water mark and defines that a river includes 'a stream of water, whether perennial or intermittent, flowing in a natural channel, or in a natural channel artificially improved, or in an artificial channel which has changes the course of the stream'. A controlled activity refers to work or actions undertaken on waterfront land, including construction (of bridges, roads and buildings), the removal of material, deposition of material and an activity that affects the flow in a water source.

DCCEEW (NSW) is required to assess the impact of any proposed controlled activities to ensure no more than minimal harm will be done to waterfront land as a consequence of the respective controlled activity. There are several guidelines relating to controlled activities on waterfront land, including:

- *Controlled activities – Guidelines for riparian corridors on waterfront land* (DPE Water 2022a)
- *Controlled activities – Guidelines for watercourse crossings on waterfront land* (DPE Water 2022b)
- *Controlled activities – Guidelines for instream works on waterfront land* (DPE Water 2022c)
- *Controlled activities – Guidelines for laying pipes and cables on waterfront land* (DPE Water 2022d)
- *Controlled activities – Guidelines for outlet structures on waterfront land* (DPE Water 2022e)
- *Controlled activities – Guidelines for vegetation management plans on waterfront land* (DPE Water 2022f).

iv NSW Water Quality Objectives and River Flow Objectives

The *NSW Water Quality and River Flow Objectives* (DECCW 2006) provides WQOs and river flow objectives (RFOs) for all catchments in NSW.

The NSW WQOs are the agreed environmental values and long-term goals for surface waters within NSW. They set out the community's values and uses for watercourses as well as a range of water quality indicators to help assess whether the current condition of watercourses supports those values and uses.

The NSW RFOs are the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health and water quality for ecosystems and human use.

The project and all potentially impacted receiving watercourses lie within the Hunter River catchment and the Lake Macquarie and Tuggerah Lakes catchments. This SWA considers the potential impact of the project on the WQOs and RFOs as part of the water quality impact assessment and streamflow regime assessment.

Table 3.1 and Table 3.2 show the WQOs and RFOs that apply to the surface water study area. The 'mimic natural drying in temporary watercourse', 'maintain natural rates of change in water levels', 'minimise effects of dams on water quality' or 'make water available for unforeseen events' RFOs do not apply to the catchments and watercourses within the study area; and as a result, are not replicated in Table 3.2.

Table 3.1 **Application of NSW WQOs to the study area**

Environmental value	Objective	Areas of application	Where the objective applies
Aquatic ecosystems	Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term	All catchments and watercourses in the study area	All natural watercourses
Visual amenity	Aesthetic qualities of waters		All waters, particularly those used for aquatic recreation and where scenic qualities exist
Secondary contact recreation	Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed		All waters, although may not be achievable for some time in some areas
Primary contact recreation	Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed		Waters within and immediately upstream of recognised recreation sites
Drinking water at point of supply-disinfection only	Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment	All catchments and watercourses in the study area, excluding the 'mainly forested areas' of the Hunter River catchment	All current and future licensed offtake points for town water supply and to specific sections of rivers that contribute to drinking water storages or immediately upstream of town water supply offtake points
Drinking water at point of supply-clarification and disinfection	Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment		
Drinking water at point of supply-groundwater	Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment		
Aquatic food (cooked)	Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities	All catchments and watercourses in the study area, excluding 'mainly forested areas'	All waters where aquatic foods are taken for non-commercial and commercial harvesting
Livestock water supply	Protecting water quality to maximise the production of healthy livestock		All surface and groundwater used to water stock
Irrigation water supply	Protecting the quality of waters applied to crops and pasture		All current and potential areas of irrigated crops
Homestead water supply	Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing		To all homesteads that draw water from surface and groundwaters for domestic needs, including drinking water NOTE: The WQOs acknowledge achieving the trigger values for chemical contaminants is not possible without disinfection and/or treatment

Table 3.2 **Application of NSW RFOs to the study area**

Environmental value	Objective	Areas of application	Measures to achieve the objective
Protect pools in dry time	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows	All catchments and watercourses in the study area, excluding the Hunter regulated river	There should be no water extraction from streams or wetlands in periods of no flow. If conditions on water licences do not provide for this objective to be met, priority should be given to implementing it by actions appropriate to local circumstances.
Protect natural low flows	Protect natural flows		Share low flows between the environment and water users and fully protect all very low natural flows: • Very low flows: flows below the level naturally exceeded on 95% of all days with flow • Low flows: flows below the level naturally exceeded on 80% of all days with flow Unless environmental, social and economic evaluations give an appropriate alternative, the following limits on water extraction apply: • Environmental share in high-conservation-value streams: all very low flows and most of low flows; no increase in extraction of low flows • Environmental share in other streams: all very low flows and 50 to 70% of daily low levels (i.e. 30% to 50% of daily low flows could be extracted) New or transferred licences should not allow extraction below the 80th percentile during low flows
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams		Identify streams with unnatural flow variability and develop actions to mimic natural variability. Identify streams or development proposals with potential to have or cause flow variability problems and take early action.
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems		Implement the State Groundwater Policy (DLWC 1997a, 1998b). Identify any streams or ecosystems that may depend on high groundwater levels and assess impacts of reduced recharge or excessive pumping or drainage. Identify where groundwaters may be rising or falling and likely to threaten ecosystems or surface water quality. Determine appropriate action to keep groundwater levels within acceptable bounds.
Minimise effects of weirs and other structures	Minimise the impact of instream structures		Implement the NSW Weirs Policy (DLWC 1997b). Identify and take action to reduce the impact on native fauna of other structures (such as flood gates and tidal barriers) that impede the two-way movement of native fish along streams or natural high-flow channels, or into and out of the estuary.

Environmental value	Objective	Areas of application	Measures to achieve the objective
Protect important rises in water levels	Protect or restore a proportion of moderate flows ('freshes') and high flows	All catchments and watercourses of uncontrolled streams (excluding 'mainly forested areas') in the study area	Unless local information shows appropriate alternative targets, the following limits on extraction are recommended for use by river management committees: - No extraction of more than 30 to 50% of moderate to high flows (i.e. 30 to 50% of flows greater than the flows that would naturally be exceeded on 80% of all days with flow) on a daily basis - No increase in extractions from high-conservation streams Where use exceeds the above limit, appropriate ways of limiting the volume or controlling the timing of extraction are needed.
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems		WSPs and actions need to include strategies to: - Maintain, restore or mimic natural inundation and drying patterns in natural and semi-natural wetlands and remaining native floodplain ecosystems - Ensure adequate access for native fish to and from floodplain wetlands Natural flooding patterns should not be altered without proper environmental assessment.

v Erosion and sediment control guidelines

Erosion and sediment control guidance and best practice approaches in NSW are outlined to prevent and manage soil erosion, reduce sediment loss, and protect water quality, particularly in construction sites, urban developments, and land disturbances. The aim is to minimise environmental impacts while ensuring that construction activities comply with regulations and industry standards.

The key erosion and sediment control guidelines that have been considered in this assessment include:

- Managing Urban Stormwater: Soils and Construction:
 - Volume 1* (Landcom 2004)
 - Volume 2A, Installation of services* (DECC 2008a)
 - Volume 2C, Unsealed roads* (DECC 2008b)
- Best Practice Erosion and Sediment Control* (IECA 2008).

Strategies and measures outlined in these guidelines have been considered in the recommendation of mitigation measures for the project.

The following NSW Government guidelines detail best practice storage, handling and spill management procedures for liquid chemicals:

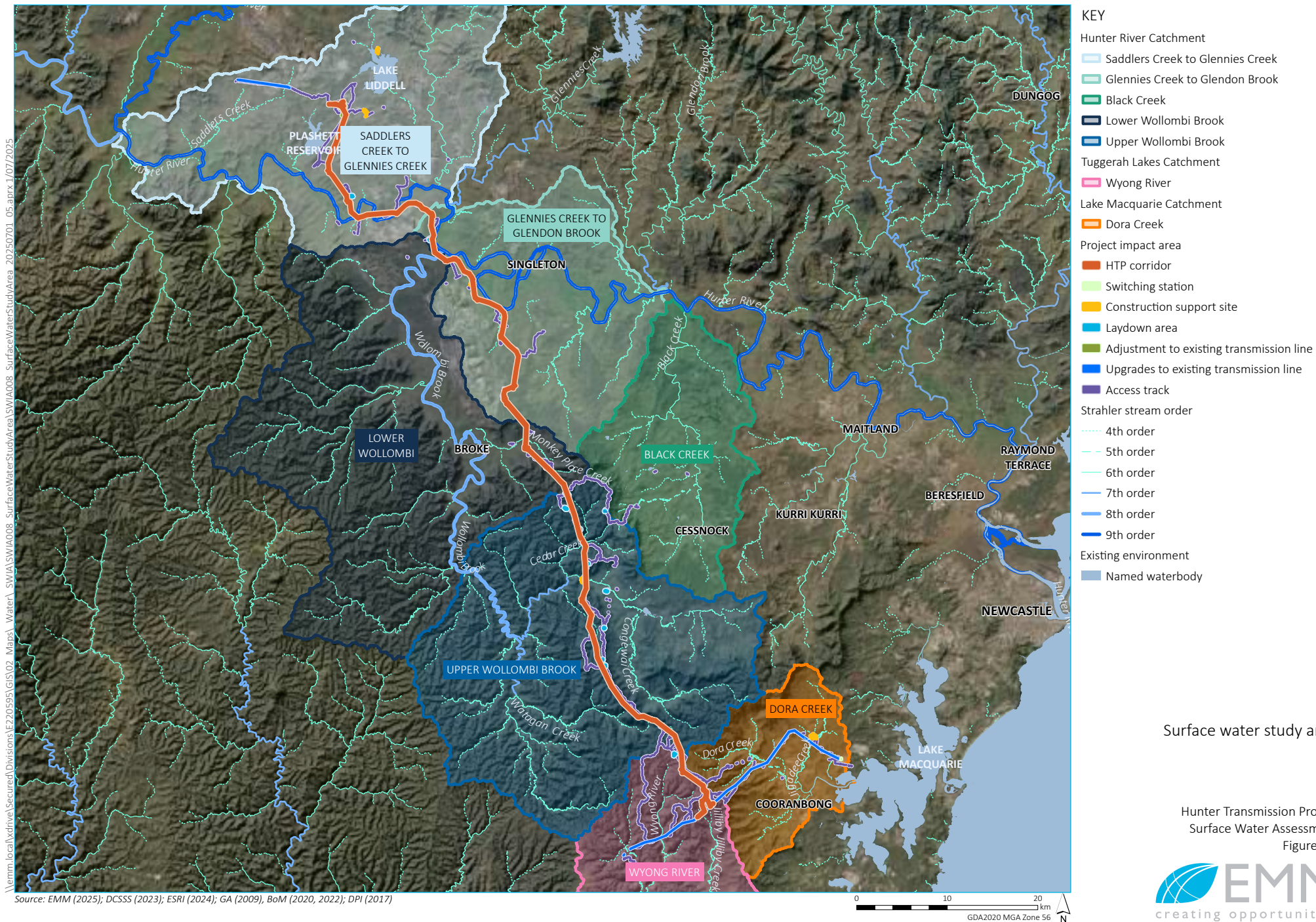
- *Liquid Chemical Storage, Handling and Spill Management: Review of Best Practice Regulation* (DECC 2005)
- *Storing and Handling Liquids: Environmental Protection: Participant's Manual* (DECC 2007).

Strategies and measures outlined in these guidelines have been considered in the recommendation of mitigation measures for the project.

3.3 Study area

The surface water study area encompasses the project impact area, along with all watercourses and catchments which interact with and extend downstream of the project impact area. In broad terms, the surface water study area is the sub-catchments of the 3 catchments that are intersected by the project impact area (namely the Hunter River, Lake Macquarie and Tuggerah Lakes catchments) intersected by the project impact area, as illustrated in Figure 3.1.

While potential surface water impacts would originate within the project impact area, where construction and operation occur, they may affect downstream watercourses. Existing land uses in the catchments contributing to these watercourses can influence their existing condition. Therefore, the existing surface water environment is described in relation to the broader surface water study area.



Surface water study area

Hunter Transmission Project
Surface Water Assessment
Figure 3.1

3.4 Desktop review

The databases listed in Table 3.3 were searched and the relevant data extracted to inform both the description of the existing environment and subsequent impact assessment.

Table 3.3 Data sources

Dataset / information	Data source	Website	Aspect of water assessment
The operational rules for the Hunter Salinity Trading Scheme as well as existing water quality of the Hunter River	Hunter River Salinity Trading Scheme (DEC 2006)	https://www.environment.nsw.gov.au/resources/licensing/hrsts/hrsts.pdf	Water quality
Existing water quality of the study area	State of the Catchment (OEH 2010)	https://www.environment.nsw.gov.au/resources/soc/huntercentralrivers/10436HUNTCEriver.pdf	Water quality
Existing water quality of the study area	NSW State of the Environment Report (EPA 2021)	State of the Environment 2021 EPA	Water quality
Existing water quality of the study area	WaterNSW realtime monitoring data	Real-time water data	Water quality
Existing water quality of the study area	Hunter Valley annual surface water quality report:2022-2023 (DCCEEW 2024)	Hunter Valley annual surface water quality report: 2022-2023	Water quality
Existing water quality of the study area	Hunter Valley annual surface water quality report:2023-2024 (DCCEEW 2025)	Hunter Valley annual surface water quality report: 2023-2024	Water quality
Existing water quality of the study area – tributaries of the Hunter River	United Wambo Joint Venture quarterly environmental reports (UWJV 2024)	Monitoring documents	Water quality
Existing water quality of the study area– tributaries of the Hunter River	Mount Thorley Warkworth monitoring reports (Yancoal 2024)	Mount Thorley Warkworth Documents – Yancoal	Water quality
Existing water quality of the study area– tributaries of the Hunter River	Bulga Coal quarterly environmental monitoring reports (Glencore 2024)	https://www.glencore.com.au/operations-and-projects/coal/current-operations/bulga-coal/monitoring-documents	Water quality
Overview of geomorphic watercourse character, behaviour, condition and recovery potential of watercourses	NSW River Styles Database (DPIE 2019)	New South Wales River Styles spatial dataset Dataset SEED	Watercourses and riparian corridors
Location and Strahler order of watercourses	NSW Hydro Line spatial dataset from the NSW Foundation Spatial Data Framework (NSW Government 2018)	NSW Foundation Spatial Data Framework - Water - NSW Hydro Line Data.NSW - Data.NSW	Watercourses and riparian corridors

3.5 Water quality

3.5.1 Overview

Water quality refers to the chemical and physical quality of the water in all surface water features within the study area.

A qualitative assessment of the potential water quality impacts from construction and operation of the project was undertaken with respect to the WQOs. A qualitative assessment was deemed to be adequate as the potential risks to water quality are anticipated to be low, with the implementation of mitigation measures combined with appropriate project design considerations.

The assessment of potential impacts to water quality involved:

- conducting a water quality monitoring program to further inform baseline water quality conditions of the surface water study area (refer to *Section 3.5.2* for more information)
- characterisation of baseline water quality against relevant WQOs, informed by publicly available information and results from the water quality monitoring program
- a qualitative assessment of potential impacts to water quality from construction and operation of the project, which included:
 - identifying project activities that have the potential to impact surface water quality
 - identifying the risks to surface water quality from the identified project activities and their potential impact pathways
 - identifying mitigation and management measures to minimise water quality risks, during design, construction and operation of the project, specific to project activities that have potential to impact water quality (see *Chapter 8 (Management)*)
 - determining the residual impact rating for each activity, considering the scale of the activity within the project impact area, the sensitivity of the receiving environment where the project activity is being undertaken, and the mitigated risk to water quality
 - assessing the potential impacts of the project to surface water quality during construction and operation, with consideration of the WQOs (refer to *Section 3.5.4* for more information).

3.5.2 Water quality monitoring program

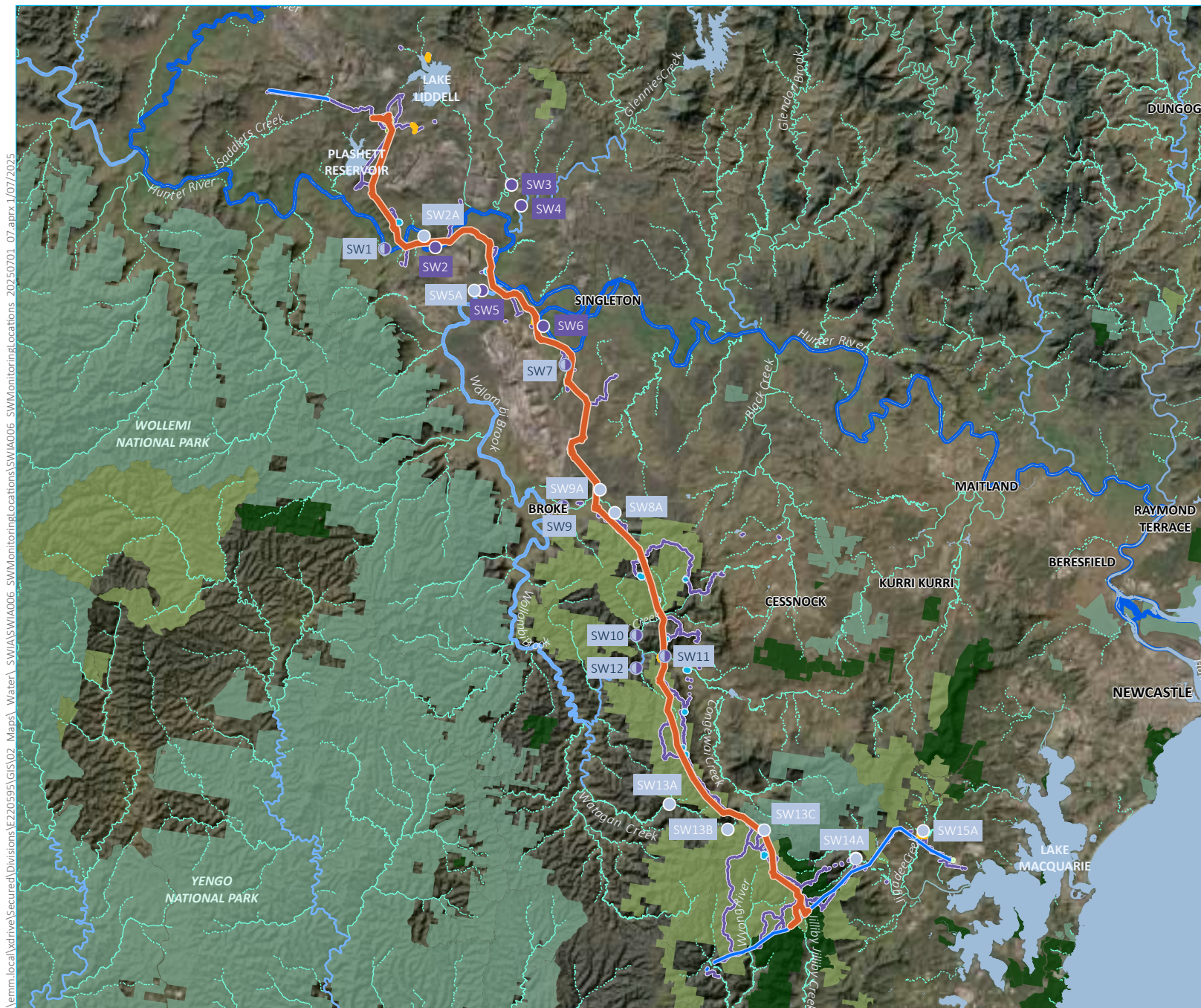
A baseline surface water monitoring program was undertaken (between April 2024 and February 2025) to establish baseline surface water quality conditions of selected key watercourses that interact with the project impact area. Locations for the monitoring program considered:

- proximity to the project impact area
- likelihood of conveying flows consistently throughout the year (i.e. higher order watercourses prioritised)
- sensitivity of the environment (multiple locations were included, if possible, for higher sensitivity areas typically in State forest areas)
- physical access to the site and safe access to the watercourse.

Surface water monitoring locations that form part of the water quality monitoring program are shown on Figure 3.2. Results from the monitoring program are summarised in *Section 4.5* and provided in detail in *Appendix A (Water quality monitoring program)*.

Key parameters tested as part of the water quality monitoring program included:

- general (pH, electrical conductivity (EC), hardness (as CaCO_3), total suspended solids (TSS), total dissolved solids (TDS), turbidity, dissolved oxygen (DO), redox)
- inorganics (calcium, chloride, fluoride, bromide, silicon, SAR, DO, sodium, magnesium, potassium, anions, cations)
- total and filtered metals (Aluminium (Al), Arsenic (As), Barium (Ba), Beryllium (Be), Cadmium (Cd), Molybdenum (Mo), Cobalt (Co), Strontium (Sr), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Mercury (Hg), Selenium (Se), Manganese (Mn), Nickel (Ni), Vanadium (V), Zinc (Zn))
- nutrients (ammonia as N, nitrite and nitrate as N, total Kjeldahl nitrogen (TKN), nitrite as N, Nitrate as N, Nitrogen (total), phosphate (total P), pH redox)
- oil and grease.



KEY

Water quality monitoring location

- Round 1
- Round 2 & 3
- Round 1, 2 & 3

Project impact area

- HTP corridor
- Switching station
- Construction support site
- Laydown area
- Adjustment to existing transmission line
- Upgrades to existing transmission line
- Access track

Strahler stream order

- 4th order
- 5th order
- 6th order
- 7th order
- 8th order
- 9th order

Existing environment

- Named waterbody
- NPWS reserve
- State conservation area
- State forest

Surface water monitoring locations

Hunter Transmission Project
Surface Water Assessment
Figure 3.2

3.5.3 Characterisation of baseline water quality

Baseline water quality across the surface water study area was informed by the desktop review and results from the water quality monitoring program and compared against WQOs for the study area. Characterisation of baseline water quality is provided in *Chapter 4 (Existing environment)*.

i Derivation of DGVs

Default guideline values (DGVs) provide a specific benchmark of water quality values for a range of toxicants (chemical analytes) relating to specific WQOs. DGVs enable a quantitative comparison of existing water quality against relevant WQOs. Due to the range of watercourse conditions across the surface water study area, a range of DGVs apply to the project for various toxicants.

The DGVs derived for this assessment are for the purposes of comparing the existing water quality against a benchmark. Prior to construction, a water quality monitoring plan would be developed that considers how surface water quality impacts during construction of the project would be detected. The water quality monitoring plan may include applying DGVs that are specific to each monitoring location, including the appropriate species protection level (SPL).

The framework for determining DGVs for catchment is outlined by the *NSW Water Quality and River Flow Objectives* (DECCW 2006). DGVs for this assessment have been derived for each sub-catchment that intersects the project impact area, and consider a range of factors including:

- the mapped sub-catchment, relating to existing land use and condition of the watercourses (e.g. regulated river, unregulated rivers, mainly forested areas). These are mapped online at <https://www.environment.nsw.gov.au/ieo/Hunter/map.htm>
- whether the watercourse is lowland (less than 150 metres Australian Height Datum (AHD)) or upland (greater than 150 metres AHD) elevation
- the SPL (ANZG 2018) for toxicants, relating to the level of disturbance of the receiving environment. The SPL varies from 80% to 99% depending on characteristics of the receiving environment which are categorised as one of the following:
 - highly disturbed systems (typically between 80th and 95th percentile SPL)
 - slightly to moderately disturbed systems (typically 95th percentile SPL)
 - high conservation or ecological value systems (typically 95th or 99th percentile SPL where possible).

For the purposes of this assessment, the 95% SPL was applied for all catchments, as:

- ANZG 2018 recommends that for highly disturbed systems the slightly to moderately disturbed systems DGV (typically 95% SPL) is applied in the first instance
- 99% SPLs are not available for all toxicants, and where values are provided, the limit of reporting (lowest detection limit) for some analytes higher than the 99% SPL. These should be considered when deriving site specific trigger values for construction impact monitoring in highly sensitive receiving environments.

The derived DGVs applied for this assessment are provided in *Appendix B (Derivation of DGVs)*. A comparison of existing water quality against the DGVs for the surface water study area is presented in *Section 4.5*.

3.5.4 Assessment of potential water quality impacts

A qualitative assessment of potential risks to surface water quality from project activities during construction and/or operation was undertaken. Project activities that may impact surface water quality were identified, and for each activity, the potential risks to water quality and the impact pathways were also identified.

Mitigation and management measures were then developed to minimise the potential risks associated with these project activities, outlined in *Chapter 8 (Management)*.

The residual impact rating of each activity considered 3 factors:

- location and scale of the activity
- sensitivity of the receiving environment
- mitigated risk rating.

Each activity was assigned a value of 1 to 3 for each of these factors, and the sum of these values per activity determined the impact rating. A description of the rating system applied to the impact factors and the residual impact rating is provided in Table 3.4

Table 3.4 Overview of impact rating factors

Impact factor	Rating		
	1 (low)	2 (moderate)	3 (high)
Magnitude/scale of activity	An activity that is proposed to occur at 10 or less discrete locations (e.g. construction support sites, switching stations)	An activity that is proposed to occur at greater than 10 discrete locations (e.g. tower pads)	An activity that covers a large spatial area and not restricted to discrete locations (e.g. vegetation clearing)
Sensitivity of receiving environment	Heavily modified catchment affected by mining and energy generating industries	Slightly to moderately disturbed catchments including agricultural area and forests	Receiving watercourses and/or their catchments are largely undisturbed Topography is typically a moderate to high grade such that watercourse beds and banks are susceptible to instabilities
Mitigated risk rating	Following the implementation of management and mitigation measures (see <i>Chapter 8 (Management)</i>) the activity is considered to have low risk	Following the implementation of management and mitigation measures (see <i>Chapter 8 (Management)</i>) the activity is considered to have moderate risk	Following the implementation of management and mitigation measures (see <i>Chapter 8 (Management)</i>) the activity is considered to have high risk
Residual impact rating	Sum of the above factors equals 3 or 4	Sum of the above factors equals 5 to 7	Sum of the above factors equals 8 or 9

The residual impacts to water quality were qualitatively assessed against the WQOs applicable to the study area as listed in Table 3.1.

Outcomes of the water quality impact assessment are provided in *Chapter 6 (Assessment of potential construction impacts)* and *Chapter 7 (Assessment of potential operational impacts)*.

3.6 Streamflow regime

The *NSW Water Quality and River Flow Objectives* (DECCW 2006) include consideration of streamflow objectives for watercourses and catchments. The NSW RFOs are the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health and water quality for ecosystems and human use.

Potential changes to catchment streamflow regimes may be caused by temporary and/or permanent drainage works, erosion and sediment control practices, stormwater management measures and the redirection of runoff around proposed work sites and facilities. These stormwater control measures will be further developed during detailed design and addressed in the mitigation measures (*Chapter 8 (Management)*).

A qualitative assessment of the project's residual impact on streamflow regimes has been undertaken to enable an assessment of the project's impact against the RFOs. The assessment considers the magnitude of any impacts the project may have, if any, on each of the NSW RFOs that are applicable to the study area.

The residual impacts to streamflow regime were qualitatively assessed against the RFOs applicable to the study area as listed in Table 3.2.

Outcomes of the streamflow assessment are provided in *Chapter 6 (Assessment of potential construction impacts)* and *Chapter 7 (Assessment of potential operational impacts)*.

Hydrologic and hydraulic impacts of the project on flood behaviour resulting from large rainfall events have been assessed within the flood impact assessment (*Technical Report 12– Flooding impact assessment*).

3.7 Watercourses and riparian corridors

3.7.1 Overview

Riparian corridors form a transition zone between watercourses and the surrounding landscape. They provide valuable functions including bed and bank stability, habitats for a diversity of terrestrial and aquatic species, and conveyance functionality for low flows and floods. Riparian corridors are particularly important to maintaining the geomorphic form of a watercourse.

A qualitative desktop assessment was undertaken to determine the potential impacts to watercourses and riparian corridors during construction and operations. The assessment included:

- defining the existing environment of the project impact area as it relates to watercourses and riparian corridors
- identification and quantification of project activities that may directly interact with watercourses and riparian corridors
- identification of how each project activity may impact major watercourses and riparian corridors during construction and operation
- development of management and mitigation measures to minimise the impacts of project activities on watercourses and riparian corridors
- qualitative evaluation of the residual risk for project activities based on the above outcomes.

3.7.2 Defining the existing environment

The predicted impacts to watercourses and riparian corridors from the project were described by considering the existing condition of the watercourses and riparian corridors that interact with the project impact area. Following definition of the riparian corridors to be applied for the assessment, a desktop mapping assessment was undertaken to identify other existing features were considered, including:

- nature of the watercourse (Strahler order, stream conditions and recovery potential)
- status of existing riparian vegetation.

Descriptions of how these were determined for the watercourse and riparian corridor assessment are provided below.

i Indicative riparian zones

Watercourses within the project impact area were identified from the *NSW Hydro Line* spatial dataset from the NSW Foundation Spatial Data Framework (NSW Government 2018). Indicative riparian zones (IRZs) are approximate representations of riparian corridors as defined by the [WM Act](#). IRZs were determined along each watercourse corridor by assigning buffers to the watercourses consistent with the vegetated riparian corridor widths in *Controlled activities – Guidelines for riparian corridors on waterfront land* (DPE Water 2022c).

The assumed riparian corridor, channel and IRZ widths applied to watercourses assessed as part of the project are presented in Table 3.5. Assumed channel widths are indicative but likely to be more conservative than actual bank to bank distances.

Table 3.5 Assumed IRZ criteria

Strahler order	Assumed watercourse channel width	Assumed riparian corridor width (each side)	Total IRZ width
1	10 m	10 m	30 m
2	15 m	20 m	55 m
3	20 m	30 m	80 m
4+	25 m (increasing by 5 m increments for increasing stream order)	40 m	105 m

ii Nature of the watercourse

The nature of the watercourse includes the Strahler order, stream conditions and recovery potential. Strahler order classifies the hierarchy of streams and rivers from smallest to largest. The stream order keeps increasing as streams and rivers of the same order join. The Strahler order was determined from the *NSW Hydro Line* spatial dataset (NSW Government 2018). Stream condition and recovery potential were obtained from the NSW River Styles Database (DPIE 2019) as described in *Section 4.2.2*.

Impacts to riparian corridors considers the existing presence of vegetation. Watercourses that have densely vegetated riparian corridors have a greater risk of impact as changes to the existing vegetation has the potential to affect the stability they provide to the watercourse bed and banks, as well as changes to the habitat provided for local fauna and flora. An indication of the presence of vegetation present in IRZs was provided by reviewing aerial photography. The aerial photography dataset reviewed was the ESRI World Imagery (ESRI 2025).

3.7.3 Assessment of potential impacts to watercourses and riparian corridors

A desktop mapping assessment was undertaken to identify the project construction activities that would be undertaken within the defined IRZs within the project impact area, including the level and nature of interaction with riparian corridors and watercourses. Management and mitigation measures to minimise the risk of potential impacts to watercourses and riparian corridors were developed, as documented in *Chapter 8 (Management)*.

The interactions of the HTP corridor, and transmission line adjustments and upgrades, on IRZs and watercourses was undertaken, considering the existing geomorphic and vegetation features, and the nature of the interactions with the project activities. The same risk rating system, as applied to the water quality assessment (see *Section 3.5.4*), was applied to determine the residual impacts on watercourses and riparian corridors.

4 Existing environment

4.1 Overview

The Hunter Transmission Project (HTP, the project) runs mostly through energy, mining, agricultural and government land between Bayswater and Broke in the upper Hunter Region. It then traverses the Pokolbin, Corrabare, Watagan and Olney State forests in the lower Hunter Region (see Figure 2.1).

The proposed new transmission line would connect the new the Bayswater South switching station to the existing 500 kilovolt (kV) transmission line near the Baywater Power Station and the new Olney switching station to the existing 500 kV transmission line between Eraring and Kemps Creek.

4.2 Hydrologic setting

4.2.1 Catchments and watercourses

The study area is within 3 major surface water catchments as summarised in Table 4.1. The catchments that interact with the project impact area have been classified into sub-catchments which share similar topographical and land use characteristics. The catchments, sub-catchments and major watercourses intersected by the project impact area are shown on Figure 3.1. Key hydrologic features near the project impact area are provided in Figure 4.1.

4.2.2 Wetlands

The nearest Ramsar wetlands to the project impact area are the Hunter Estuary Wetlands, which consist of the Kooragang nature reserve and the Shortland wetland reserve, located in the lower reaches of the Hunter River. Although lower reaches of the project impact area are located within 26 kilometres of Ramsar wetlands, streamflow connection between the project and the wetlands occurs approximately 120 kilometres upstream of the Hunter River and its tributaries. Subsequently, impact to Ramsar wetlands is unlikely.

Several floodplain and estuarine wetlands are located downstream of the project. In the Hunter catchment, wetlands in close proximity to the project are associated with floodplains of the Hunter River and its tributaries. Whilst in the Lake Macquarie and Tuggerah Lakes catchments, estuarine wetlands are located adjacent to the major lakes and larger tributaries.

Table 4.1 Major surface water catchments located within the project impact area

Major catchment	Description	Sub-catchment	Description
Hunter River	Approximately 90% of the project impact area is located in the Hunter River catchment and the HTP corridor crosses the Hunter River at 3 locations in the north. Wollombi Brook, a major tributary to the Hunter River, is crossed by the HTP corridor just upstream of its confluence with the Hunter River. In addition to the HTP corridor, construction support sites, access roads and ancillary infrastructure are located in the Hunter River catchment. The Hunter River catchment covers an area of around 21,500 km² and flows over a length of approximately 460 km, draining the third largest coastal catchment in NSW. The Hunter River is regulated by 2 main storages, Glenbawn Dam and Glennies Creek Dam, as well as several smaller storages. The Hunter Valley supports a range of landscapes, from high mountain ranges up to 1500 m AHD, to broad fertile floodplains and extensive estuarine areas. Land uses in the catchment are diverse, including large areas of wilderness and national park in upper reaches, as well as established agricultural, equine and coal mining industries which are supported by villages, towns and major cities throughout the catchment.	Saddlers Creek to Glennies Creek	Saddlers Creek to Glennies Creek sub-catchment is heavily disturbed and affected by coal mining (including Mount Arthur, Liddell, Glendell, Ravensworth, Ashton, Integra and Hunter Valley Operations (HVO)) and energy generation (including both Bayswater and Lidell power stations). Watercourses in the catchment are mostly modified by diversions or impounded for use by mining operations and energy generation. Pikes Creek, Parnells Creek and Wisemans Creek, which interact with the project impact area, are impounded and the water quality of these systems are highly modified Salinity in Hunter River affected by the Hunter River Salinity Trading Scheme. The Hunter River floodplain and surrounds are cleared for agriculture and mining. Watercourses in the sub catchment include Saddlers Creek, Saltwater Creek, Wisemans Creek, Pikes Creek and Parnells Creek
		Glennies Creek to Glendon Brook	The Glennies Creek to Glendon Brook sub-catchment is heavily disturbed to the west, largely affected by Glencore mining operations at Mount Thorley Warkworth and Bulga. The watercourses feeding the Hunter River from the south include Mudies Creek, Jump-Up Creek, Loder Creek and Sandy Hollow Creek. The 2 tributaries that flow north to south into the Hunter are Rix's Creek and First Creek. The water quality in Rix's Creek and Loder Creek quality are highly modified due to proximity of mining operations. Watercourses in the sub catchment include Loder Creek, Sandy Hollow Creek and Doctors Creek.
		Black Creek	Interactions between the project impact area and Black Creek are minor. Approximately 4 km of upgraded access track and an intersection upgrade are planned within the Black Creek catchment. Project works are planned in the Foxy Gully catchment, a tributary to Pokolbin Creek, which is a major tributary of Black Creek. Black Creek is a controlled streamflow from relatively constant releases from Cessnock wastewater treatment plant. Black Creek catchment consists largely of agricultural land, with some forestry on the western and south-eastern boundaries. The headwaters of Black Creek begin a few kilometres south of Cessnock. Black Creek passes through the towns of Cessnock and Rothbury before it passes to the west of East Branxton close to its confluence with the Hunter River in the north.
		Lower Wollombi	The lower Wollombi Brook sub-catchment largely consists of forested areas, including Yengo and Pokolbin State forests and Yengo National Park, as well as mining in the lower catchment and agricultural areas along the Wollombi Brook floodplain. Tributaries to lower Wollombi Brook include Stockyard Creek, Werong Creek, Drews Creek, Parsons Creek and Wambo Creek that each drain significant areas of the forested slopes to the west of the floodplain. Yellow Rock Creek and Monkey Place Creek drain the Pokolbin State Forest south-east of Broke. The Wambo United Operations coal mine is located in the lower catchment and Mount Thorley Warkworth and Bulga Coal Complex on the northeastern border.

Major catchment	Description	Sub-catchment	Description
		Upper Wollombi	The upper Wollombi is drained by 2 main tributaries, Wollombi Brook and Congewai Creek. The highest point in the upper catchment is the Watagan Ranges, at 640 m AHD. Pokolbin State Forest lies to the north, Olney State Forest to the south. Corrabare State Forest is nestled between them and Watagans National Park is situated to the southeast of the catchment. Watercourses in the sub catchment include Wollombi Brook, Sweetmans Creek, Cedar Creek, Congewai Creek and Watagan Creek.
Lake Macquarie	As part of the project, several access roads and upgrades to existing 500 kV transmission lines operated by Transgrid are proposed to occur in the Lake Macquarie catchment. The Freemans Drive construction support site is also within the Lake Macquarie catchment, located adjacent to Jigadee Creek. The Lake Macquarie catchment covers an area of around 600 km². It is Australia's largest coastal saltwater lake and supports a diversity of habitat types including seagrass meadows, mangroves, saltmarsh, rocky reefs, oyster reefs, sand flats, mud flats and deep open waters. The western catchment includes areas of Watagan State Forest and Watagans National Park. These forested areas reach elevations of up to 600 m AHD. To the east, the catchment is low lying with elevation generally below 50 m AHD supporting townships, agriculture and other industry.	Dora Creek	Dora Creek has a catchment area of approximately 240 km² and is the largest subcatchment flowing into Lake Macquarie. The Dora Creek catchment is located on the western side of Lake Macquarie and runs southeast for 25 km to meet west Lake Macquarie at the township of Dora Creek. Jigadee Creek is a major tributary of Dora Creek, draining the northern catchment area, merging with Dora Creek 8 km upstream of Lake Macquarie. The tidal influence extends approximately 12 km upstream of Lake Macquarie to the Dora Creek weir at Cooranbong. The catchment is primarily forestry with some agriculture. The town of Cooranbong sits north of Dora Creek and Morisset is situated south. The Dora Creek sub-catchment would accommodate upgrades to the existing transmission line between the Olney State Forest and the Eraring substation, as well as the Freemans Drive construction support site and access tracks.

Major catchment	Description	Sub-catchment	Description
Tuggerah Lakes	Approximately 11 km of the HTP corridor, in addition to upgrades to existing 500 kV transmission lines operated by Transgrid, pass through State Forests in the Watagan Mountains, in the upper catchments of Wyong River and Jilliby Jilliby Creek which are tributaries to the Tuggerah Lakes. The Olney switching station and several access roads are also proposed within the Tuggerah Lakes catchment. The Tuggerah Lakes catchment has an area of 714 km². Tuggerah Lakes drains Lake Munmorah and Budgewoi to the Tasman Sea through a tidal channel at its southern end. Tuggerah Lake is relatively shallow but a highly productive system that contains a large biomass of aquatic vegetation. The Lake is surrounded by small towns and the Wyrabalong National Park to the east. To the west, there is pastureland and other cultivated areas, but the catchment is largely forest. The topography is close to sea level around Tuggerah Lakes with elevations up to 300 m AHD to the west in the Ourimbah and Wyong State forests.	Wyong River	The Wyong River sub-catchment is located to the west of Tuggerah Lake. Headwaters of the Wyong River catchment originate in the Olney State Forest and drain south into Tuggerah Lake. The catchment consists mostly of forestry and some agricultural land. The towns of Wyong and Mardi sit either side of the river close to Tuggerah and further upstream there is agricultural land. Jilliby Jilliby Creek catchment is the second largest catchment of the Wyong River catchment, second to the Wyong River itself. Jilliby Jilliby Creek and Wyong River confluence approximately 12 km upstream of Tuggerah Lake. The Olney switching station, the HTP corridor, upgrades to existing transmission lines and access tracks are located in the headwaters of the Wyong River and Jilliby Jilliby Creek.

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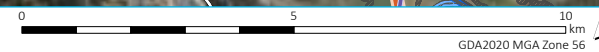
- KEY**
- Key fish habitat
 - Floodplain wetland
 - RAMSAR wetland (see inset)
 - Project impact area
 - HTP corridor
 - Bayswater South switching station
 - Construction support site
 - Laydown area
 - Adjustment to existing transmission line (lines 31 and 32)
 - Upgrades to existing transmission line (lines 5A3 and 5A4)
 - Access track
- Strahler stream order**
- 4th order
 - 5th order
 - 6th order
 - 7th order
 - 9th order
- Existing environment**
- Major road
 - Named waterbody
 - NPWS reserve

Hydrologic setting
Sheet 1 of 4

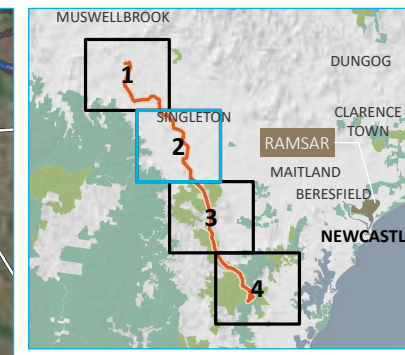
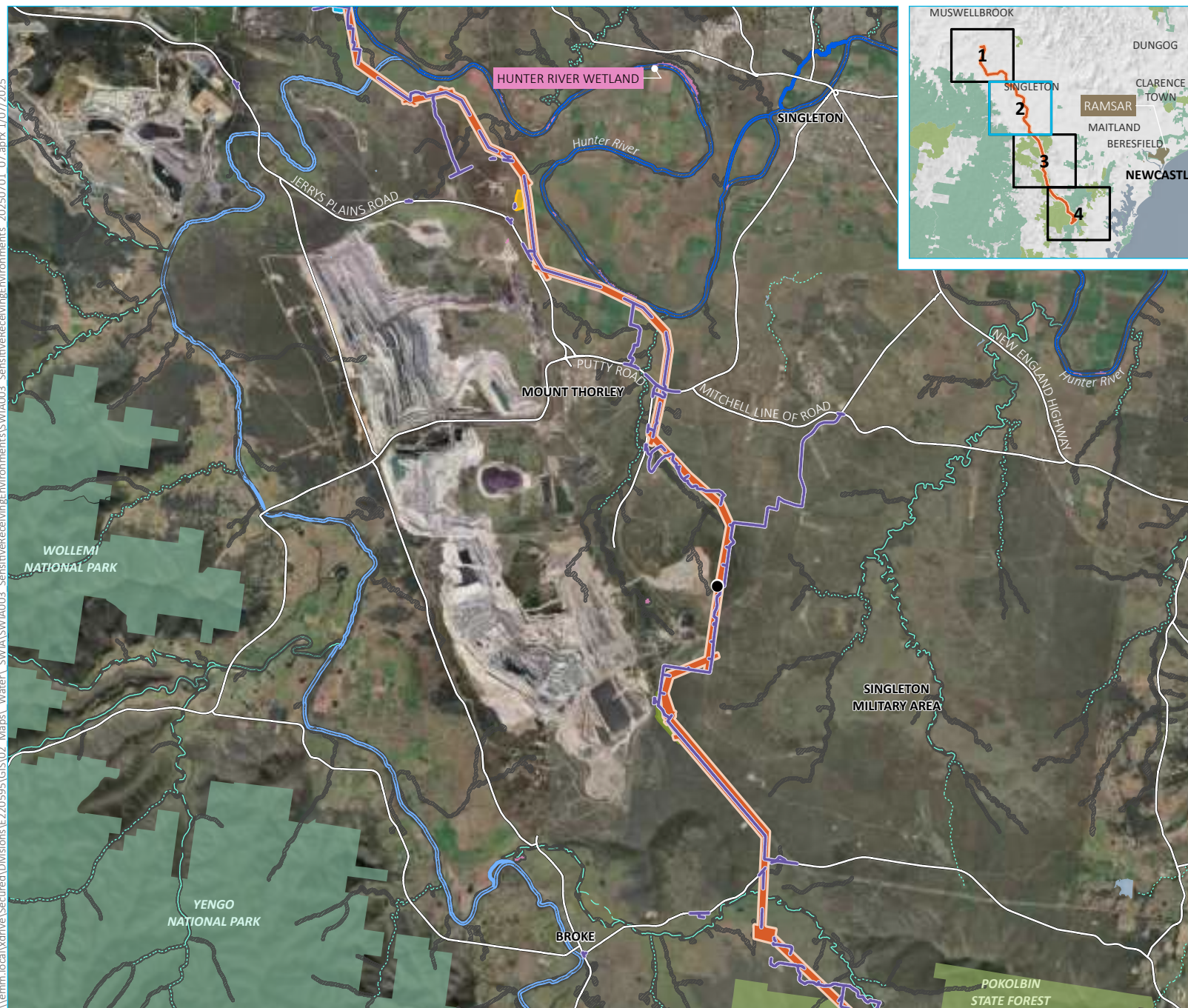
Hunter Transmission Project
Surface Water Assessment
Figure 4.1



Source: EMM (2025); ABS (2021); DCSSS (2023); ESRI (2025); GA (2009); WSP (2025); DPI (2024); DCCEW (2022)



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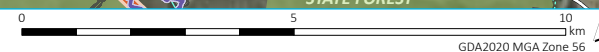
- KEY**
- Threatened flora species
 - ▨ Key fish habitat
 - ▨ Floodplain wetland
 - ▨ RAMSAR wetland (see inset)
 - Project impact area
 - ▨ HTP corridor
 - ▨ Construction support site
 - ▨ Adjustment to existing transmission line (line 81)
 - ▨ Access track
- Strahler stream order**
- ▨ 4th order
 - ▨ 5th order
 - ▨ 6th order
 - ▨ 8th order
 - ▨ 9th order
- Existing environment**
- ▨ Major road
 - ▨ Named waterbody
 - ▨ NPWS reserve
 - ▨ State forest

Hydrologic setting
Sheet 2 of 4

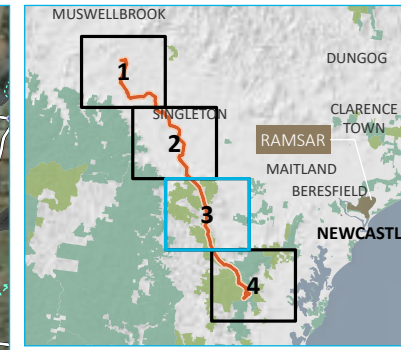
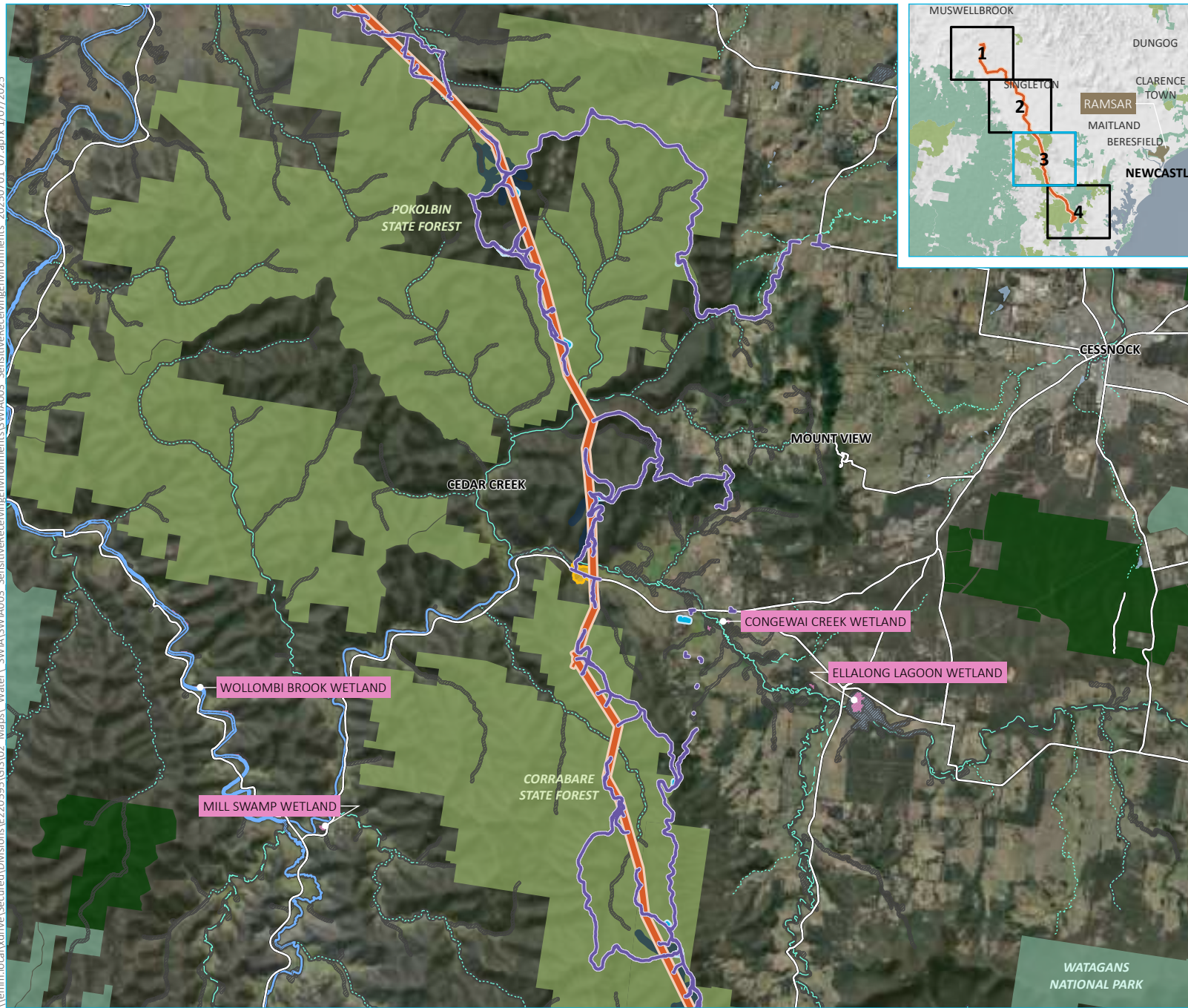
Hunter Transmission Project
Surface Water Assessment
Figure 4.1



Source: EMM (2025); ABS (2021); DCSSS (2023); ESRI (2025); GA (2009); WSP (2025); DPI (2024); DCCEW (2022)



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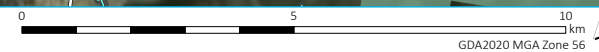
- KEY**
- Key fish habitat
 - Floodplain wetland
 - RAMSAR wetland (see inset)
 - Threatened frog breeding habitat
 - Red-crowned Toadlet
 - Project impact area
 - HTP corridor
 - Construction support site
 - Laydown area
 - Access track
- Strahler stream order**
- 4th order
 - 5th order
 - 6th order
 - 7th order
 - 8th order
- Existing environment**
- Major road
 - Named waterbody
 - NPWS reserve
 - State conservation area
 - State forest

Hydrologic setting
Sheet 3 of 4

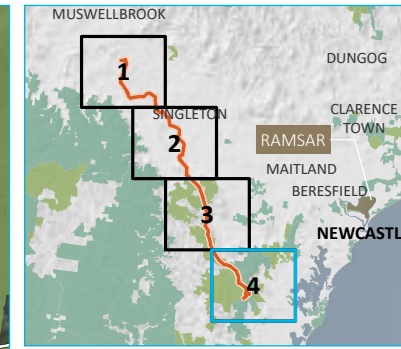
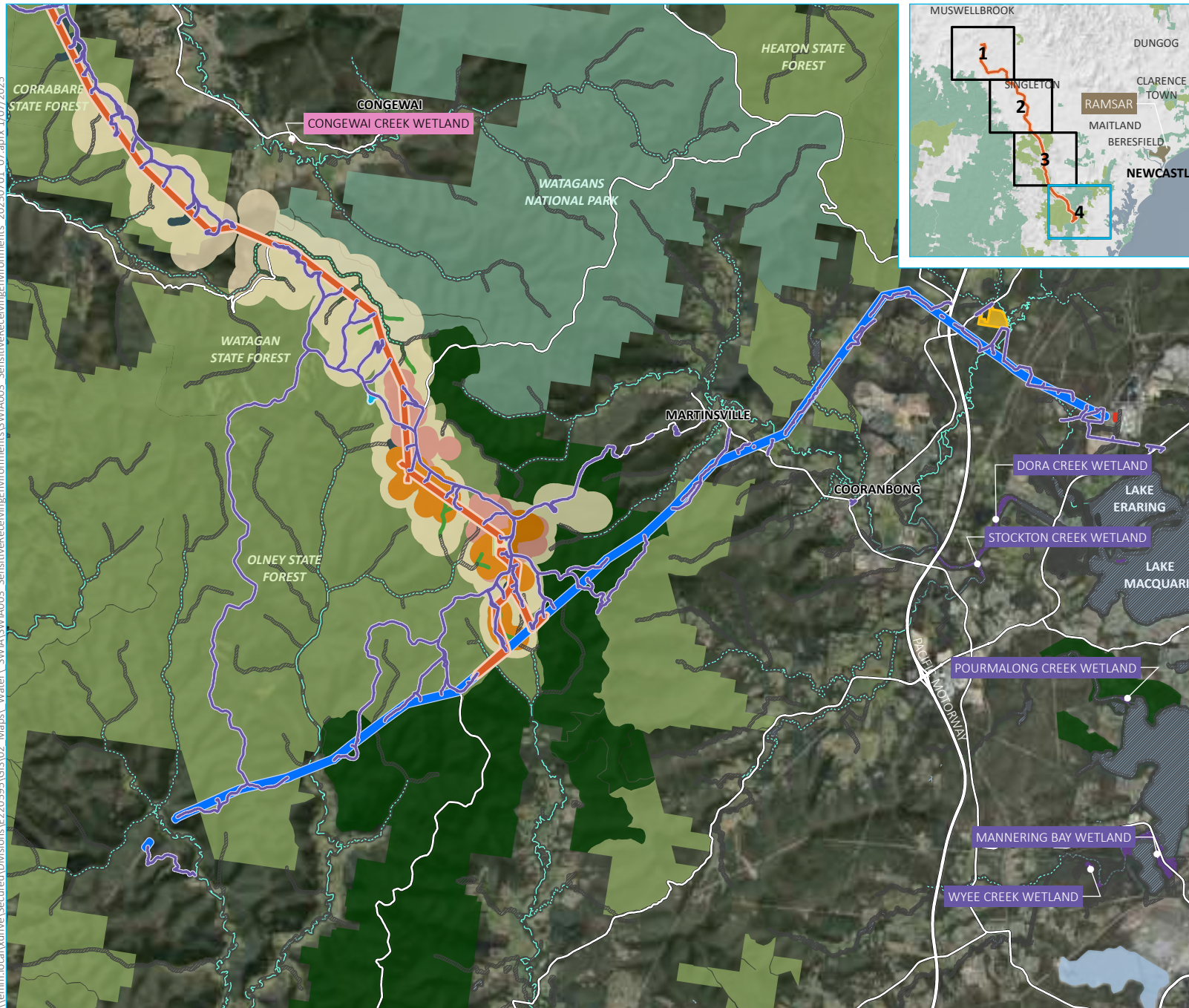
Hunter Transmission Project
Surface Water Assessment
Figure 4.1



Source: EMM (2025); ABS (2021); DCSSS (2023); ESRI (2025); GA (2009); WSP (2025); DPI (2024); DCCEEW (2022)



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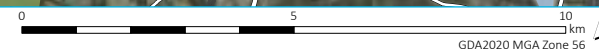
- KEY**
- Key fish habitat
 - Estuarine wetland
 - Floodplain wetland
 - RAMSAR wetland (see inset)
 - Threatened frog breeding habitat**
 - Giant Barred Frog
 - Giant Burrowing Frog
 - Littlejohn's Tree Frog
 - Red-crowned Toadlet
 - Stuttering Frog
 - Project impact area**
 - HTP corridor
 - Olney switching station
 - Construction support site
 - Laydown area
 - Eraring Substation upgrade
 - Upgrades to existing transmission line (lines 5A1 and 5A2)
 - Access track
 - Strahler stream order**
 - 4th order
 - 5th order
 - 6th order
 - Existing environment**
 - Major road
 - Named waterbody
 - NPWS reserve
 - State conservation area
 - State forest

Hydrologic setting
Sheet 4 of 4

Hunter Transmission Project
Surface Water Assessment
Figure 4.1



Source: EMM (2025); ABS (2021); DCSSS (2023); ESRI (2025); GA (2009); WSP (2025); DPI (2024); DCCEW (2022)



4.2.3 Geomorphology

The *NSW River Styles Database* (DPIE 2019) provides an overview of geomorphic watercourse character, behaviour, condition and recovery potential for watercourses typically classified in the Strahler stream system as third order and higher throughout NSW. Strahler order classifies the hierarchy of streams and rivers from smallest to largest. The stream order keeps increasing as streams and rivers of the same order join. The highest stream order is found on the river's main stem in the downstream section of a river system. When 2 streams with different orders join, the resulting stream has the same order as the highest of the 2 joining streams. For example, when a first and second-order stream join, the resulting stream is second order.

Major watercourses within the surface water study area from north to south along with their condition, characteristics and recovery potential are shown in Table 4.2.

Geomorphic characterisation is based on the River Styles Framework, developed by Macquarie University, which classifies watercourses based on measurable geomorphic attributes and qualities that include river type, fragility, sensitivity to disturbance, condition, rarity and recovery potential.

The recovery potential refers to the likelihood that a river reach would improve its geomorphic condition over management timeframes, from the construction and operational impacts from new developments. The recovery potential provides an indication of the resilience of a watercourse to any physical interactions with the project and may influence mitigation and management strategies.

Table 4.2 River styles of watercourses within the study area

Watercourse*	Stream order	NSW river style	Existing condition	Recovery potential
Unnamed watercourse	3	Floodplain pockets, gravel	Poor	Moderate
Saddlers Creek	4	Floodplain pockets, gravel	Moderate	Rapid
Saltwater creek	3	Floodplain pockets, gravel	Poor	Low
Hunter River	9	Planform controlled, low sinuosity, gravel	Poor	Moderate
Wollombi Brook	8	Planform controlled, low sinuosity, sand	Moderate	Strategic
Hunter River	9	Planform controlled, low sinuosity, gravel	Poor	Moderate
Loder Creek	4	Planform controlled, low sinuosity, gravel	Poor	Moderate
Unnamed watercourse	1	Cut and fill	Good	Conservation
Monkey Place Creek	5	Low sinuosity, sand	Poor	Low
Monkey Place Creek	5	Planform controlled, low sinuosity, sand	Moderate	High
Monkey Place Creek	4	Planform controlled, low sinuosity, sand	Moderate	High
Monkey Place Creek	3, 4	Headwater	Good	Conservation
Unnamed watercourse	1	Floodplain pockets, Sand	Poor	Moderate
Deep Creek	5	Floodplain pockets, sand	Good	Conservation
Black Creek	5	Bank confined, sand	Poor	Moderate
Cedar Creek	5	Floodplain pockets, sand	Good	Conservation

Watercourse*	Stream order	NSW river style	Existing condition	Recovery potential
Congewai Creek	6	Meandering, fine grained	Moderate	High
Sweetmans Creek	4	Floodplain pockets, sand	Good	Conservation
Sweetmans Creek	3	Floodplain pockets, sand	Good	Conservation
Unnamed watercourse	1	Headwater	Good	Conservation
Unnamed watercourse	2	Headwater	Good	Conservation
Watagan Creek	4	Floodplain pockets, sand	Good	Conservation
Jigadee Creek	5	Planform controlled, meandering, sand	Moderate	Rapid
Jigadee Creek	6	PCVS - Planform controlled, meandering, sand	Moderate	Rapid
Felled Timber Creek	4	PCVS - Planform controlled, meandering, sand	Good	Conservation
Dora Creek	5	Meandering, sand	Good	Conservation
Jilliby Jilliby Creek	3	Floodplain pockets, sand	Good	Conservation
Wyong River	5	Headwater	Good	Conservation

* a watercourse is included multiple times in instances where different reaches of the watercourse within the study area have different River Styles or Stream Orders

4.3 Topography

The topography varies substantially across the project impact area. The northern portion of the project impact area is located in the Hunter Valley where the topography is a mix of fertile plains and undulating hills centred around the floodplains of the Hunter River. Elevations in the northern portion of the project impact area typically vary between 45 and 125 metres Australian Height Datum (AHD).

Towards the centre of the project impact area, relief increases, and the terrain is more rolling and gently undulating with low hills and ridges.

The southern half of the project impact area climbs up the Watagan mountain range, located in the Pokolbin, Corrabare, Olney and Watagan State forests. Elevations quickly ascend to greater than 500 metres AHD. The project continues along the mountain ridges and crosses several valleys for approximately 40 kilometres before descending into the Dora Creek valley of Lake Macquarie. In the southwest, the project terminates at Eraring substation adjacent to Lake Macquarie where elevations are as approximately 10 to 20 metres AHD.

4.4 Climate and rainfall

4.4.1 Local rain gauge data

Rainfall data obtained from the Bureau of Meteorology (BoM) is presented in Table 4.3. Five local (active) gauges are dispersed across the project impact area with greater than 20 years of consistent rainfall data available. The Bowmans Creek gauge is located the farthest north and Cooranbong farthest south. These are presented in Figure 4.3. The statistical summary considers the complete years for the operational history of each gauge.

Rainfall data for the region indicates a variation in rainfall distribution across the project impact area. Annual rainfall is typically less in the Hunter Valley in the northern portion of the project, whilst orographic effects and proximity to the coast in the south results in greater rainfall in the Lake Macquarie and Tuggerah Lakes catchments.

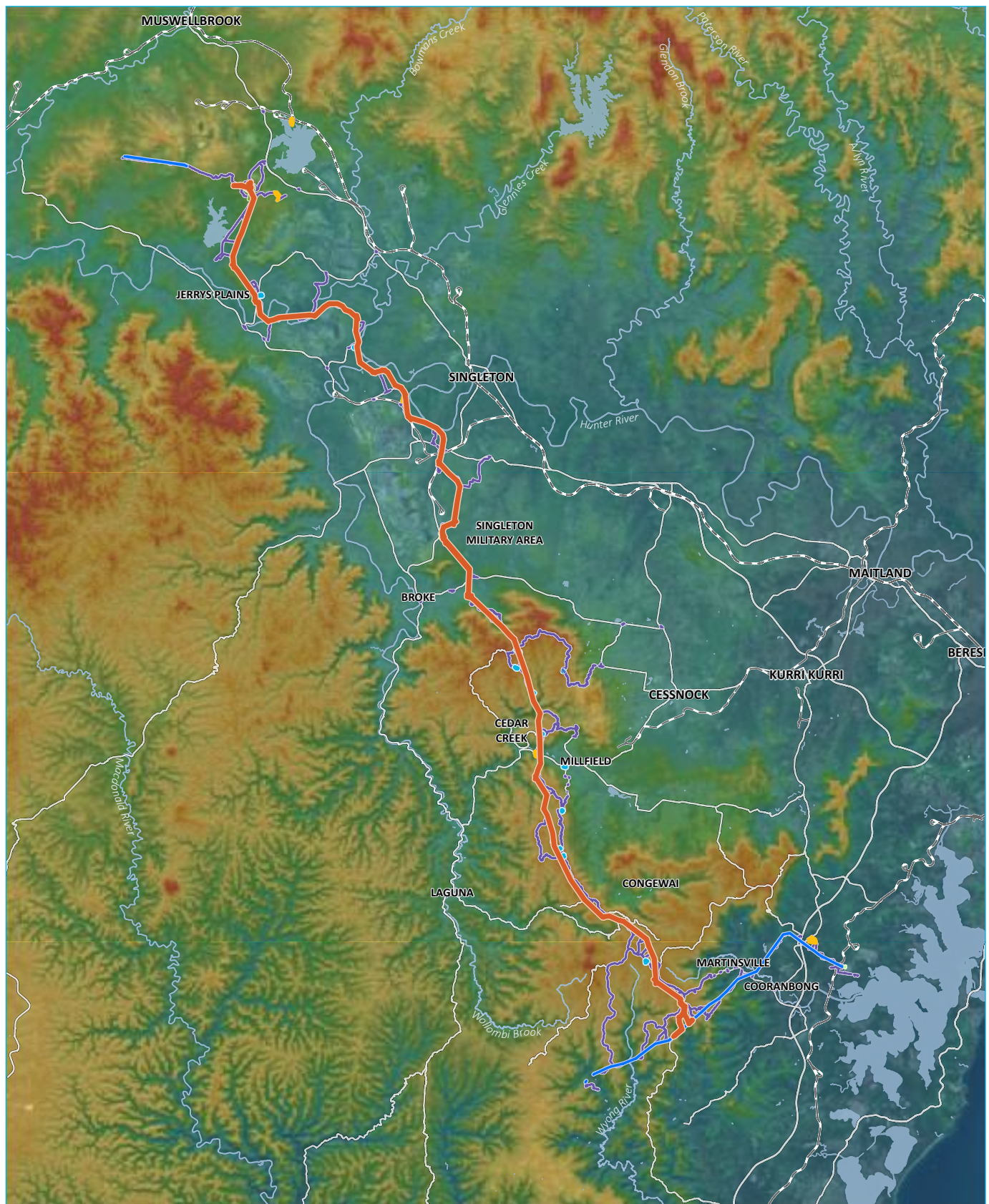
Table 4.3 **Total rainfall annual statistics**

Gauge	Length of record	10 th Percentile annual rainfall (mm)	50 th Percentile annual rainfall (mm)	90 th Percentile annual rainfall (mm)	Minimum annual rainfall (mm)	Maximum annual rainfall (mm)
Bowmans Creek (Grenell) 61270	1969-2024	622	865	1144	392	1306
Cessnock Airport 61260	1968-2024	571	730	1002	384	1302
Congewai (Greenock) 61152	1959-2024	631	927	1364	537	1669
Wyang Olney Forest 61385	2000-2024	893	1049	1653	873	2533
Cooranbong (Avondale) 61012	1903-2024	803	1076	1541	531	1994

4.4.2 Climate data

Scientific information for landowners (SILO) data has been used to present annual climate statistics as long-term evaporation data was not available at each station. SILO grid point data for rainfall, pan evaporation and temperature was downloaded for the station coordinates of Bowmans Creek and Wyong Olney Forest. The annual climate statistics are provided in Table 4.4.

The climate at Bowmans Creek and Wyong is temperate and characterised by hot summers and lack of dry season according to the Köppen-Geiger climate classification. The climate at Bowmans Creek and Wyong Olney Forest is temperate and is characterised by warm to hot summers and cold winters. Summers tend to be wetter but there is significant rainfall throughout the year, with the driest month still receiving close to 50 millimetres.



Source: EMM (2025); Beca (2024); DCSSS (2024); FCNSW (2022); ESRI (2024); DFSI (2017)

KEY

Project impact area

- HTP corridor
- Switching station
- Construction support site
- Laydown area
- Adjustment to existing transmission line
- Upgrades to existing transmission line
- Access track

Existing environment

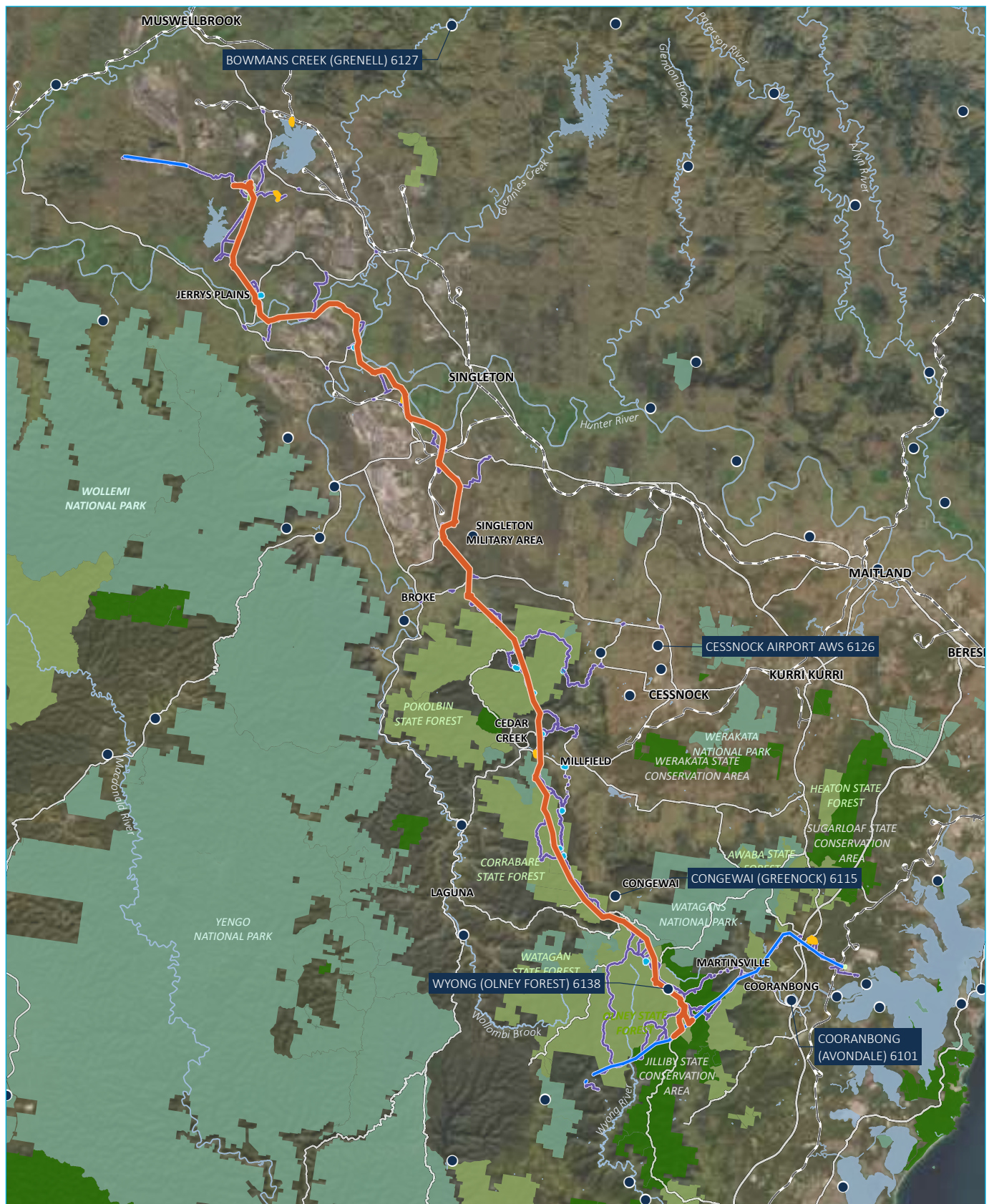
- Railway
- Major road
- Named watercourse
- Named waterbody

Topographic elevation (mASL)



Local topography

Hunter Transmission Project
Surface water assessment
Figure 4.2



Source: EMM (2025); Beca (2024); DCSSS (2024); FCNSW (2022); ESRI (2024); DFSI (2017); BoM (2025)

KEY

● Local BoM rainfall gauge

Project impact area

HTP corridor

Switching station

Construction support site

Laydown area

Adjustment to existing transmission line

Upgrades to existing transmission line

Access track

Existing environment

— Railway

— Major road

— Named watercourse

— Named waterbody

NPWS reserve

State conservation area

State forest

Local BoM rainfall gauges

Hunter Transmission Project
Surface Water Assessment
Figure 4.3

Table 4.4 Climate statistics from SILO

Parameter	Range	Time period	Bowmans Creek	Wyong Olney Forest
Mean monthly maximum temperature (°C)	Highest	January	29.6	27.0
	Mean	Annual	22.9	21.7
	Lowest	July	15.5	15.6
Mean minimum temperature (°C)	Highest	January	16.4	16.8
	Mean	Annual	10.3	11.4
	Lowest	July	4.2	5.8
Mean rainfall (mm)	Highest month	March	107.8	166
	Mean	Annual	867.6	1170
	Lowest month	August	47.9	50.1

Figure 4.4 provides a comparison of Bowmans Creek against Wyong Olney Forest for mean monthly rainfall and evaporation for the period January 1970 to December 2024. Data from 1970 is considered more reliable than earlier years and more reflective of current climate.

The data shows that Wyong records more rainfall every month and evaporation is generally higher at Bowmans Creek. The project impact area should expect more rainfall in the south due to its proximity to the coast and the orographic effects of the ranges. The higher evaporation rates in the north of the project impact area and higher rainfall in the southern areas means higher runoff is expected in the southern extents of the project impact area.

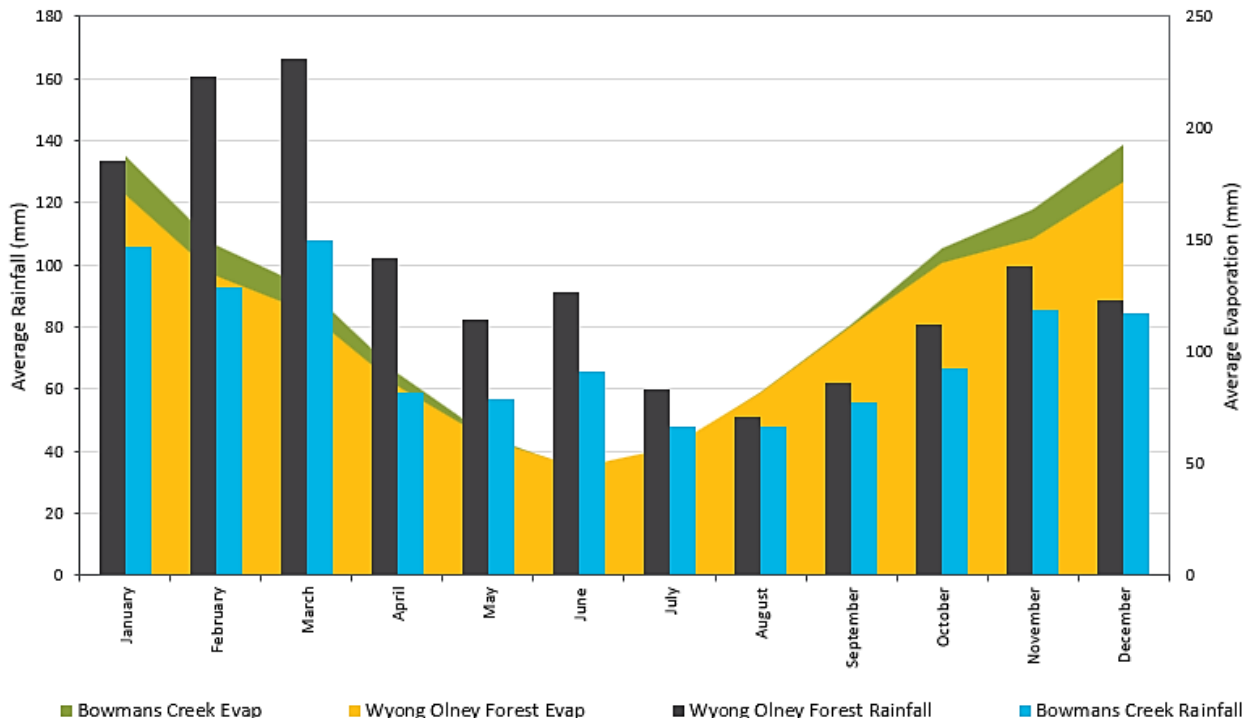


Figure 4.4 Rainfall and evaporation monthly statistics

4.5 Surface water quality

Surface water quality in proximity to the project exhibits significant variability, influenced by the diverse land uses present. These land uses vary from national parks, State forests and conservation areas in the upland regions to agricultural regions and areas dominated by coal mining and energy generation in the Hunter Valley.

The water quality of the various watercourses in the study area have been characterised using data from publicly available sources, as well as data from the project water quality monitoring program. Further details of the baseline water quality monitoring program, derivation of default guideline values (DGVs) and water quality characterisation for the project are provided in *Section 3.5*. Surface water monitoring locations are shown in Figure 3.2.

Water quality across the study area consistently exceeds DGVs for total phosphorus and total nitrogen, except in the Wyong River catchment where water quality data was limited. Dissolved oxygen is generally low for most watercourses considered. Other exceedances of DGVs for various metals such as copper, iron, zinc and manganese occur throughout the study area. Watagan Creek, a relatively undisturbed watercourse in the Watagan State Forest, indicates elevated aluminium, cobalt, copper, iron and manganese (as well as nutrients), indicating these analytes may be naturally elevated and may not be a result of anthropogenic influences.

The review indicates that existing water quality across the study area is variable and does not consistently achieve the DGVs for water quality objectives (WQOs). Water quality monitoring during the project construction should therefore consider local water quality characteristics, rather than relying on DGVs to define the baseline water quality.

Table 4.5 provides an overview of water quality across the study area, a graphical summary is provided in Figure 4.5.

Table 4.5 Overview of water quality for sub catchments across the study area

Sub catchment	Overview of water quality
Saddlers Creek to Glennies Creek (Hunter River catchment)	The Saddlers Creek to Glennies Creek sub catchment of the Hunter River is heavily disturbed, with the presence of several coal mines and Bayswater and Lidell power stations. Watercourses in the sub catchment are mostly modified by diversions or impounded for use by mining operations and energy generation. Pikes Creek, Parnells Creek and Wisemans Creek, which interact with the project impact area, are impounded and the water quality of these systems are highly modified. Water quality monitoring for Bayswater Power Station indicates the water management system contains elevated salinity, boron, copper, iron, molybdenum and nickel ((AGL 2024) & (AGL 2025)). Water quality of the Hunter River is influenced by the cumulative effects of upstream land practices and human activity resulting in a general trend of increasing turbidity and nutrient concentrations downstream. Salinity in the Hunter River is affected by mining, power generation and agriculture. The Hunter River Salinity Trading Scheme (HRSTS) salinity target for this section of the Hunter River is 900 µS/cm, which is often exceeded during period of low flow (DCCEEW 2024). Baseline monitoring of the Hunter River (SW1, SW2 and SW2a) indicates although salinity is elevated, it is still fresh but generally exceeds the HRSTS limit. Analytes elevated above the DGVs are copper, total nitrogen and total phosphorous. Dissolved oxygen levels generally did not achieve the DGVs.

Sub catchment	Overview of water quality
Glennies Creek to Glendon Brook (Hunter River catchment)	The project impact area is located in the west of the Glennies Creek to Glendon Brook sub catchment. Near the project impact area, land uses typically include coal mining (Mount Thorley Warkworth, HVO and Bulga), defence activities (Singleton Military Area) and agriculture (particularly on the Hunter River floodplain). Further east of the project impact area, the sub catchment includes the city of Singleton, and land cleared for cropping and grazing. Monthly monitoring data for Doctors Creek, Dights Creek, Longford Creek, Loder Creek, Wollombi Brook and the Hunter River illustrate the highly disturbed nature of the sub-catchment (Yancoal 2024). Water quality monitoring of Loder Creek shows a consistent trend of slightly alkaline and highly saline water quality with EC often exceeding 6000 µS/cm. Other analytes are often elevated above the DVG including copper, cadmium, total phosphorus and total nitrogen. Surface water quality monitoring conducted at the Bulga Coal Complex (Glencore 2024) indicate the ephemeral drainage lines to the west of the HTP transmission line typically have poor water quality, which is alkaline and highly saline, except during rainfall events. Baseline monitoring of Loder Creek (SW7) (located 400 m west of the proposed HTP corridor) indicates TDS, dissolved oxygen, total nitrogen and total phosphorous typically exceed DGVs. Copper, manganese and zinc also occasionally exceed DGVs. Baseline monitoring of the Hunter River (SW6) indicated salinity was slightly lower than upstream locations (SW1, SW2 and SW2a), most likely due to dilution factor due to flows entering the system from Glennies Creek Dam. Baseline monitoring indicated copper, total nitrogen and total phosphorus above DGVs in the Hunter River.
Black Creek (Hunter River catchment)	The Black Creek sub catchment consists largely agricultural land, vineyards and grazing. The city of Cessnock and various local townships are interspersed throughout the catchment which is bounded by some forestry on the western and south-eastern boundaries. Project interactions in the Black Creek sub catchment are minimal, consisting of several access tracks and intersection upgrades Black Creek is a controlled streamflow from relatively constant releases from Cessnock wastewater treatment plant. Black Creek has elevated nutrient levels from the sewage effluent and high salt levels from the underlying geology. The supplemented flow means Black Creek is a controlled stream with its own water quality objectives (DECCW 2006a). No baseline monitoring was undertaken in the Black Creek sub catchment.
Lower Wollombi Brook (Hunter River catchment)	The lower Wollombi Brook sub catchment consists of mostly forested areas and some mining areas downstream. The Wollombi Brook floodplain and surrounds are typically cleared for cropping and grazing agriculture. Monitoring of Wollombi Brook (Station 210004) (DCCEEW 2023) indicates generally better water quality than the 2 neighbouring stations on the Hunter River (located at Moses Crossing and Singleton). Overall, turbidity, total phosphorous, total nitrogen, TSS, DO and EC were reported lower than at Singleton and Moses Crossing. The water quality is fresh with a circumneutral pH. Water quality monitoring undertaken by neighbouring coal mines illustrates the highly disturbed nature of the catchment due to mining operations discharging into local creeks such as Yellow Rock Creek and Monkey Place Creek. Exceedances of the DGVs are evident at Yellow Rock Creek and Monkey Place Creek for total phosphorus, total nitrogen and copper. Baseline monitoring for lower Wollombi Brook (SW5 and SW5a) detected elevated copper, iron manganese, zinc, total phosphorous and total nitrogen compared to DGVs. Baseline monitoring for Monkey Place Creek, upstream and downstream of the project impact area, (SW8a and SW9) detected elevated salinity, turbidity, cobalt, copper, iron, manganese, nitrates, total nitrogen and total phosphorous.

Sub catchment	Overview of water quality
Upper Wollombi Brook (Hunter River catchment)	The upper Wollombi Brook sub catchment consists largely of forested areas with areas of the Congewai Creek catchment and Wollombi Brook floodplain cleared for grazing. Baseline monitoring was undertaken at 6 locations within the upper Wollombi Brook sub catchment. Baseline monitoring of Congewai Creek (SW11), directly upstream of the proposed Wollombi Road construction support site, indicated elevated copper, manganese, total nitrogen and total phosphorous as well as occasional exceedance of iron and zinc. Cedar Creek and Sweetmans Creek are tributaries to Congewai Creek, downstream of SW11, and both contain interactions with the proposed transmission corridor and access tracks in their upper reaches. Monitoring for both watercourses (SW10 and SW12 respectively) was possible approximately 3 km to 6 km downstream of the project impact area. Baseline monitoring of Sweetmans Creek detected elevated cobalt, iron, manganese, total nitrogen and total phosphorus. Baseline monitoring of Cedar Creek detected elevated copper, total nitrogen and total phosphorus. Monitoring indicates the salinity of Congewai Creek, Cedar and Sweetmans Creek was fresh with values reported below 800 $\mu\text{S}/\text{cm}$ and pH generally around 7.0. Baseline monitoring was undertaken at 3 locations on Watagan Creek (SW13a, SW13b and SW13c). In the headwaters of Watagan Creek, SW13c is located downstream and adjacent to the proposed transmission corridor and access tracks. SW 13b and SW13c are located 1.5 km and 8 km downstream of the proposed transmission corridor crossing over Watagan Creek. SW13c contains additional catchment areas which interact with the project impact area in upper reaches of several minor streams. Generally, the headwaters of Watagan Creek indicated elevations in more analytes than further downstream. Dissolved oxygen DGVs were achieved downstream (SW13a) but declined upstream and generally didn't meet DGVs (SW13c). Baseline monitoring at SW13c indicated elevated aluminium, cobalt, copper, iron and manganese, total nitrogen and total phosphorus. Monitoring results for SW13b indicated elevated iron and manganese, whilst monitoring at SW13a indicated elevated copper, iron and total nitrogen.
Dora Creek (Lake Macquarie catchment)	The Dora Creek sub catchment consists primarily of forestry areas in the upper reaches, agriculture areas on low lying floodplains and urban areas centred around the Cooranbong, Morisset and Dora Creek townships. Downstream reaches of watercourses in the catchment are tidally influenced. Baseline monitoring of Blarney Creek (SW14), a tributary of Dora Creek, located approximately 2 km upstream of the proposed upgrades to the transmission line, indicated elevated iron, manganese, total nitrogen and total phosphorus compared to DGVs. Dissolved oxygen was below DGVs and salinity (average EC 250 $\mu\text{S}/\text{cm}$) was fresh. Jigadee Creek baseline monitoring (SW15a) was undertaken approximately 300 m upstream of the proposed Freemans Drive construction support site. Water quality data indicates elevated aluminium, cobalt, iron, zinc and total nitrogen and total phosphorous. Water quality in Jigadee Creek was fresh but slightly more saline than Blarney Creek (average EC 350 $\mu\text{S}/\text{cm}$).
Wyang River (Tuggerah Lakes catchment)	The Wyong River catchment near the project impact area, largely consists of forested areas, including the Olney State Forest. Areas adjacent to Wyong Creek and Jilliby Jilliby Creek in the flatter, lower reaches are cleared for limited agricultural and residential uses. Access to watercourses in close proximity to the project impact area for baseline monitoring was not possible. Access to a tributary of Jilliby Jilliby Creek immediately downstream of the project impact area, noted no flow (August 2024). Further observations of the site were not continued due to access restrictions. Water quality at Wyong water pump station (WSC 2014), approximately 20 km downstream of the project impact area, is generally good fresh water with a slightly acidic pH. with TSS, turbidity and total phosphorous typically below DGVs for the catchment.

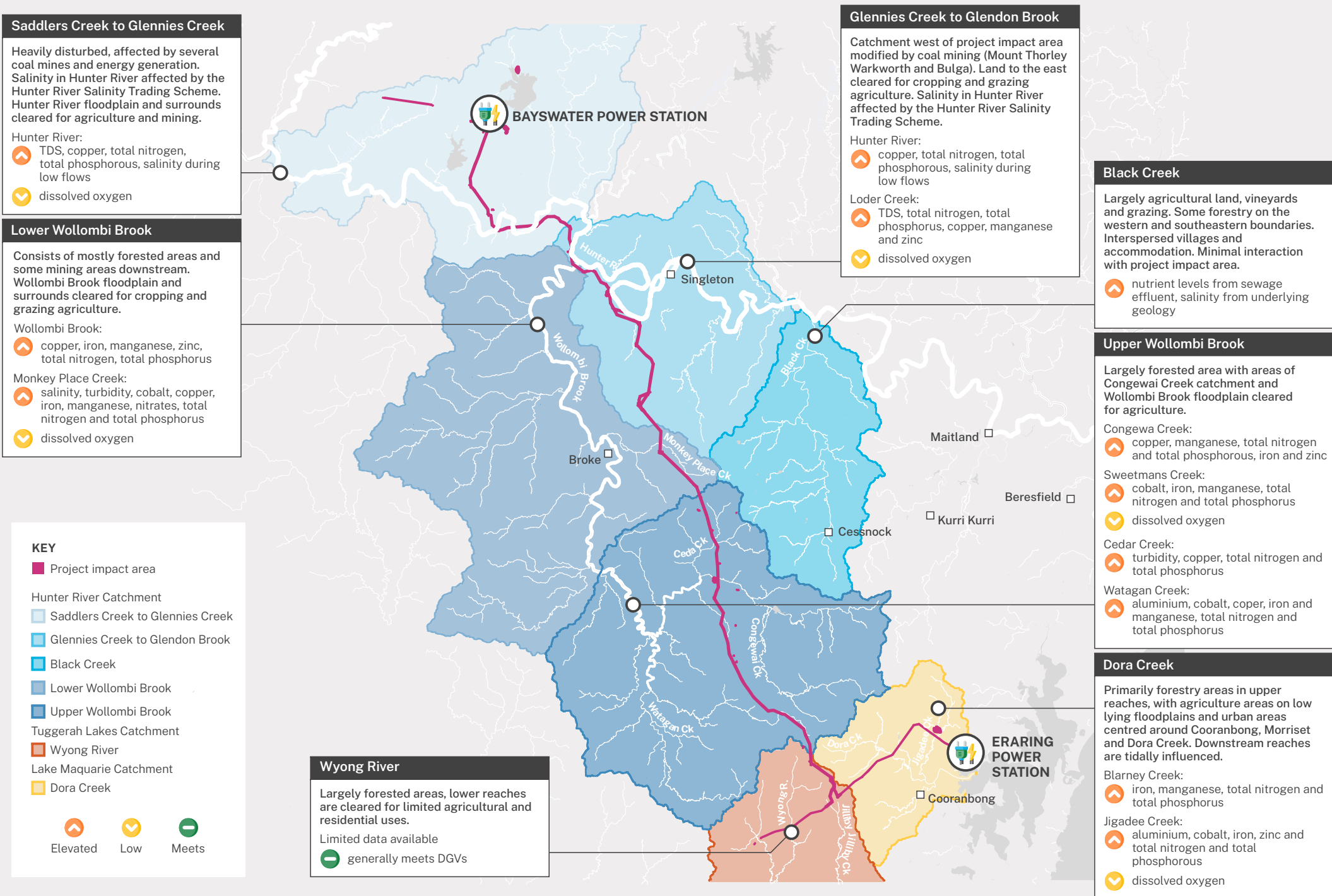


Figure 4.5 Water quality of sub-catchments within the surface water study area

4.6 Environmental receivers

Water is an essential component of the environment, supporting survival of terrestrial flora and fauna and providing habitat for aquatic species. Natural flows in rivers and creeks are managed to maintain a component of 'environmental water' reserved for the maintenance of aquatic values. A range of environmental receptors exist within and adjacent to the project impact area including aquatic flora and fauna.

Groundwater dependent ecosystems (GDEs) are communities of plants, animals, and other organisms whose extent and life processes are dependent on groundwater. The groundwater impact assessment (*Technical Report 11– Groundwater impact assessment*) review of the Groundwater Dependent Ecosystem Atlas (BoM GDE Atlas) (Bureau of Meteorology 2018) and the High Ecological Value Aquatic Ecosystems (HEVAE) GDE Atlas (DEECCW 2024) identified:

- low, medium and high potential GDEs mapped in the HEVAE dataset predominantly associated with the Hunter River and its tributaries within the alluvial groundwater system
- minor occurrences of GDEs mapped in the lower lying reaches of the Triassic units of the Triassic and Permian sedimentary rock groundwater systems.

Key fish habitats (KFHs) are aquatic habitats that are important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally, and the survival and recovery of threatened aquatic species. The aquatic biodiversity impact assessment (*Appendix L of Technical Report 1 - Biodiversity development assessment report*) included a likelihood of occurrence assessment for threatened fish species under the *Fisheries Management Act 1994* (FM Act) and determined 2 species have a likelihood of occurring in watercourses within and adjacent to the project impact area:

- the Southern Purple Spotted Gudgeon (listed as endangered under the FM Act) had a 'high' likelihood of occurrence, in watercourses in the study area including Wollombi Brook, Congewai Creek, Black Creek and Monkey Place Creek
- the Darling River Hardyhead (listed as endangered under the FM Act) had a 'moderate' likelihood of occurrence within the Hunter River.

The biodiversity development assessment report (*Technical Report 1– Biodiversity development assessment report*), has identified several threatened frog breeding habitats within, or near the project impact area. These include:

- Giant Burrowing Frog – listed as vulnerable under the *Biodiversity Conservation Act 2016* (BC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Littlejohn's Tree Frog – listed as endangered under the BC Act and EPBC Act
- Stuttering Frog – listed as endangered under the BC Act and vulnerable under the EPBC Act
- Giant Barred Frog – listed as vulnerable under the BC Act and EPBC Act
- Red-Crowned Toadlet – listed as vulnerable under the BC Act.

Threatened frog breeding habitats that have been identified by the biodiversity development assessment report (*Technical Report 1 – Biodiversity development assessment report*), are concentrated in the upper reaches of the Olney, Watagan and Corrabare State forests. The location of identified KFHs and threatened frog breeding habitats near the project impact area are provided in Figure 4.1.

Further information about potential impacts of the project to biodiversity, including aquatic flora and fauna are described in the aquatic biodiversity impact assessment (*Appendix L of Technical Report 1 - Biodiversity development assessment report*).

4.7 Classification of receiving environments

Several aspects of the surface water assessment (SWA) require an understanding of the sensitivity of the receiving environment. Due to the large project extent and its interaction with various land uses of varying levels of disturbance, the sensitivity of the receiving environment varies widely. In order to establish the existing conditions and assess the potential impacts of the project, the sensitivity of the receiving environment has been classified into 3 broad categories. These categories consider:

- the existing level of disturbance for the catchment and receiving watercourses
- the susceptibility of bed and banks of watercourses to instabilities
- the presence of threatened aquatic species.

These categories and the basis for their classification are summarised in Table 4.6.

Table 4.6 Classification of receiving environments

	Low sensitivity	Moderate sensitivity	High sensitivity
Basis for classification	Highly disturbed ecosystems. Receiving watercourses and/or their catchments are significantly modified by mining and energy generation industries. Topography is typically a low to moderate grade and not particularly susceptible to instabilities.	Slight-moderately disturbed ecosystems. Receiving watercourses and/or their catchments have been impacted by human activity to a small to moderate degree. Topography is typically a low to moderate grade and not particularly susceptible to instabilities.	High value systems. Receiving watercourses and/or their catchments are largely undisturbed. Topography is typically a moderate to high grade such that watercourse beds and banks are susceptible to instabilities. Watercourses that contain known threatened species.
Description of areas relevant to the study area	Areas where the water cycle is modified by large dams (for coal mining or energy generation industries), pumped water transfers, modified catchment landforms and diversion of watercourses. Areas in the study area include: • Watercourses and catchments intercepted by coal mines • Internally draining areas of Bayswater and Eraring Power Station (i.e. areas that do not discharge downstream)	Areas that have been cleared for agriculture and/or housing. Areas in the study area include: • Transition areas between State forests and mining/energy generation land uses • Cleared valleys and plains in the Lake Macquarie and Tuggerah Lakes catchments • Singleton Military Area • Hunter River Floodplain and associated pastoral areas • Mining areas under rehabilitation	Areas are typically comprised of heavily vegetated areas, where watercourses are largely undisturbed, and topography is steep. Areas in the study area include: • The Watagan, Corrabare, Pokolbin and Olney State forests • Jilliby State Conservation Area The crossing of Dora Creek is also considered high sensitivity due to the presence of threatened frog breeding habitat.

[^] 95% species level of protection recommended for highly disturbed systems (ANZG 2018).

5 Design considerations and proposed water management

5.1 Overview

A number of surface water management measures have been integrated into the design of the Hunter Transmission Project (HTP, the project) and will be incorporated into the construction and operational phases of the project to minimise the potential impacts of the project on surface water.

Implementation of these design measures has been considered, where relevant in the assessment of potential impacts of the project to surface water, detailed in *Chapter 6 (Assessment of potential construction impacts)* and *Chapter 7 (Assessment of potential operational impacts)*.

5.2 Design considerations

The project's design has been developed and progressively refined to consider the identified environmental constraints, as they relate to surface water, where reasonable and feasible.

Interactions with watercourses and riparian corridors has been minimised during design development by:

- avoiding the placement of project infrastructure in watercourses and riparian corridors as far as reasonably practicable. Project infrastructure including construction support sites, laydown areas, stringing sites, and transmission towers and pads, have been located outside of riparian corridors, or minimised, as far as practical
- minimising the clearing of vegetation in riparian corridors. This has been achieved by:
 - where feasible, minimise the number and positioning of transmission towers to minimise vegetation clearance in riparian corridors, particularly upstream of threatened/critical species habitats and breeding grounds
 - where locating transmission towers in areas where vegetation clearance in riparian corridors is unavoidable, areas of clearance and watercourse crossings preferentially cross riparian corridors perpendicularly, rather than obliquely, which reduces the extent of riparian vegetation that requires clearance
 - the inclusion of 'no clearing zones' which are areas within the easement where vegetation removal is not required. These areas of the easement would occur where there is sufficient separation of 10 metres or more between the maximum operating temperature conductor position and the existing vegetation. These non-disturbance areas typically cross valleys and watercourse depressions.

5.3 Construction phase

Prior to construction, a soil and water management plan (SWMP) will be developed as part of the overall environmental management strategy (EMS) to address temporary and site-specific risks to surface water during the construction phase. Key principles and objectives for water supply and disposal are described in the following sections.

Management principles relating to flooding are discussed in flood impact assessment (*Technical Report 12 – Flooding impact assessment*). Stormwater management and erosion and sediment controls are discussed further in *Chapter 8 (Management)*.

5.3.1 Water supply

It is estimated that a total of around 1580 megalitres of water would be required for the construction of the HTP. This includes 170 megalitres of potable water that would be required for amenities at the worker accommodation and construction support sites as well as for concrete batching activities. Non-potable water sources would be prioritised for the remaining 1410 megalitres of water demand for construction activities such as dust suppression, road construction, landscaping and earthworks. The majority of this demand is non-potable for dust suppression purposes, estimated to require around 1200 megalitres.

Due to the large project extent and various water requirements, water would be obtained from a range of sources. A combination of water sources would be required to meet the total potable and non-potable water demand. The feasibility of each of these water sources would be confirmed as part of the future detailed design and construction planning phases of the project.

Potable water would be supplied by Hunter Water Corporation or Singleton Council via a new direct connection to existing reticulated water systems or via standpipes and transported to water use locations by water tankers.

Non-potable water sources would be sourced according to the following hierarchy (from highest to lowest preference), where feasible and reasonable and where water quality and volume requirements are met:

- reuse of construction water, including water stored in sediment basins, treated wastewater and incidental groundwater inflows into subsurface excavations below the groundwater table
- recycled wastewater from wastewater treatment facilities
- reuse of mine water from mining operations in the vicinity of the project, if practicable and subject to negotiation with mine operators to determine availability, water quality and access requirements
- water extraction from surface water sources including the Hunter River and Congewai Creek, with preference given to water supply locations with existing infrastructure, subject to agreement with relevant stakeholders
- water extraction via groundwater bores, particularly in areas where access to alternative water sources is restricted.

The project will prioritise accessing water from existing water sources such as recycled water, project related water management infrastructure and consider fit-for-purpose wastewater from nearby industries, such as mining. This approach will minimise the extraction from environmental sources and potable water supplies, where possible.

A combination of water sources would be required to meet the total potable and non-potable water demand for the project. The feasibility of each of these water sources would be confirmed as part of the continued development of the project design and construction planning phases of the HTP, in consultation with local councils, water utilities, licence holders and mine operators.

Further detail regarding the volumetric demands and potential sources of water for the project is provided in *Chapter 4 (Project description)* of the EIS. Groundwater supply bores are further discussed in the groundwater impact assessment (*Technical Report 11– Groundwater impact assessment*).

Where alternative water sources are not suitable, water may be sourced from environmental sources including surface water and groundwater sources. If these sources are determined necessary to supply water for the project, further design and assessment will be undertaken following environmental impact statement (EIS) approval, including relevant water supply works and use approvals.

All surface water and groundwater taken from environmental sources that is not considered exempt from licensing (refer to *Section 3.2*) would require a water access licence (WAL) to account for water take. To facilitate entry into the water market, zero share WALs would be applied for in each relevant water source. A zero share WAL is a licence with no share component that allows all or part of another licence holder's existing entitlement or allocation to be traded onto the zero share WAL. Sufficient temporary allocation or permanent entitlement to account for the required volume of water would then be purchased via the water trading market.

A review of available surface and groundwater water entitlement in the relevant water sources is provided in Table 5.1. This indicates that the depth of the water trading market is variable across the water sources, however there is sufficient depth in the market to account for the likely volumes required for construction water supply. Hunter Regulated River Water Source have a greater number of entitlements and licences than the unregulated water sources, which indicates availability and trade may be more accessible in these areas.

Further details on the water supply for the project are detailed in *Chapter 4 (Project description)* of the EIS.

5.3.2 Wastewater disposal

Wastewater would be generated by numerous project activities and managed appropriately. The key project activities that would generate wastewater and the management approach for each is provided in the following sections.

i Temporary worker accommodation and site offices

Temporary worker accommodation would be located at the Freemans Drive, Jerry's Plains and Hebden Road construction support sites and site offices would be located at all other construction support sites. All wastewater generated from kitchen, bathing and general use will be disposed of via trucking to a licensed waste facility. Wastewater generation from temporary worker accommodation and site offices is estimated to be 120 megalitres over the construction period.

ii Concrete batching plants

Cementitious water generated at concrete batching plants that cannot be reused will be captured and disposed of via trucking to a licensed waste facility.

iii Inflows to tower excavations

The groundwater impact assessment (*Technical Report 11– Groundwater impact assessment*) identifies that groundwater would be intercepted by piling at various locations across the project impact area. Depending on local conditions and construction methodology, groundwater inflows may need to be managed during construction. Groundwater management measures may include:

- storage and reuse
- application to vegetated areas away from watercourses
- trucking to a licensed waste facility.

Any required dewatering during construction would be assessed during detailed design and managed under the SWMP.

Table 5.1 **Summary of existing entitlement available**

Water sharing plan (WSP)	Water source	Management zone	Access licence category	Number of licences	Total share component*	Potential project requirement
Fractured and Porous Rock WSP	Sydney Basin-North Coast Groundwater Source	N/A	Aquifer	179	68,492.5 unit shares	Groundwater extraction (bores)
Regulated River WSP	Hunter Regulated River Water Source	Management Zone 1A – Hunter River from Glenbawn Dam to Goulburn River Junction	Regulated river (general security)	257	47,037 unit shares	Extraction from Hunter River in the vicinity of the project impact area.
			Regulated river (high security)	46	5182 unit shares	
		Management Zone 1B – Hunter River from Goulburn River Junction to Glennies Creek Junction	Regulated river (general security)	105	29,387 unit shares	
			Regulated river (high security)	23	5128 unit shares	
		Management Zone 2A – Hunter River from Glennies Creek Junction to Wollombi Brook Junction	Regulated river (general security)	15	3100 unit shares	
			Regulated river (high security)	9	2809 unit shares	
		Management Zone 2B – Hunter River from Wollombi Brook Junction to downstream extent of the Hunter River	Regulated river (general security)	379	43,480 unit shares	
			Regulated river (high security)	61	6971 unit shares	
		Management Zone 3A – Glennies Creek	Regulated river (general security)	68	5540 unit shares	
			Regulated river (high security)	16	1650 unit shares	

Water sharing plan (WSP)	Water source	Management zone	Access licence category	Number of licences	Total share component*	Potential project requirement
Unregulated and Alluvial WSP	Hunter Regulated River Alluvial Water Source	Downstream Glennies Creek Management Zone	Aquifer	127	15,937 unit shares	Groundwater extractions (bores)
		Upstream Glennies Creek Management Zone	Aquifer	90	7599 unit shares	
	Jerrys Water Source	Jerrys Management Zone	Aquifer	8	822 unit shares	Extraction from Congewai Creek in the vicinity of the project impact area
			Unregulated river	17	2044 unit shares	
	Lower Wollombi Brook Water Source	N/A	Aquifer	42	3745 unit shares	
			Unregulated river	97	6663 unit shares	
	Singleton Water Source	N/A	Aquifer	2	230 unit shares	
			Unregulated river	22	1170 unit shares	
	Upper Wollombi Brook Water Source	Mid Congewai Creek Management Zone	Unregulated river	44	1670 unit shares	

* Maximum allocation is equal to 1 megalitre per unit share of entitlement

5.4 Operational phase

Operation of the project would include the transmission of electricity, emergency management, maintenance activities, and potential upgrades and replacement of transmission lines and infrastructure to extend the life of the infrastructure.

Regular maintenance activities would be required for the transmission line during operation. Likely maintenance activities would include:

- managing vegetation in and around the transmission line easement to protect the transmission line from hazard trees and bushfire
- regularly inspecting the transmission line and towers (via ground and air)
- undertaking fault and emergency response (unplanned maintenance) should an unplanned outage occur (for example through a weather event or other failure of infrastructure)
- fixing, replacing or upgrading components of the transmission line to extend its life.

Operation of the transmission line would typically occur in a permanent easement around 70 metres wide.

Ongoing water demands would be minimal, and no wastewater is expected to be generated during the operation phase. At the completion of construction, the project will be operated in accordance with the EMS of the Network Operator, including erosion and sedimentation controls and surface water management controls.

At the end of the construction phase areas no longer required to support the operational phase will be rehabilitated. A principal aim of site rehabilitation will be to stabilise disturbed areas and minimise the potential for ongoing soil erosion and subsequent mobilisation/transport downstream of each site.

6 Assessment of potential construction impacts

6.1 Water quality

6.1.1 Potential risks

Construction of the project would include a number of project activities which can present a risk to water quality including:

- vegetation clearing
- bulk earthworks and stockpiling spoil
- concrete batching
- installation of watercourse crossings
- storage and use of chemicals and hazardous materials
- management of intercepted groundwater from piling activities
- extraction of surface water.

A summary of the project elements and the construction activities that may potentially impact water quality during construction of the project are provided in Table 6.1.

Table 6.2 details impact pathways and potential impacts to water quality for project activities described in Table 6.1. Mitigation and management measures are listed in *Chapter 8 (Management)*.

Table 6.1 Project components and construction activities that have the potential to impact water quality

Project component	Construction activity						
	Vegetation clearing	Bulk earthworks and stockpiling spoil	Concrete batching	Installation of watercourse crossings	Chemical /hazardous materials storage and use	Management of intercepted groundwater from piling activities	Surface water extraction
Installation of transmission towers	✓	✓	✓		✓	✓	
Clearing of transmission easements	✓				✓		
Road works, construction of access roads and tracks	✓	✓		✓	✓		
Establishment and use of construction support sites	✓	✓	✓		✓		
Establishment and use of ancillary areas	✓	✓			✓		
Construction of switching stations and substation upgrades	✓	✓	✓		✓		
Adjustments/upgrades to and crossing of existing transmission lines	✓		✓		✓		
Water supply					✓		✓

Table 6.2 **Overview of potential risks to water quality**

Construction activity	Pathway and risk to water quality
Vegetation clearing	The mechanical clearing of vegetation, particularly to ground level, has the potential to remove vegetation that currently stabilises the topsoil. Removal of vegetation at the ground surface increases the risk of erosion and mobilisation of sediments. Tannins, a natural component of vegetation, may also be released from cleared vegetation where this is retained onsite and in particular where such vegetation is mulched and stockpiled for use as ground cover and erosion control. The potential risks to water quality are elevated when clearing occurs within the riparian corridor. The potential impacts to downstream water quality include: • Increased turbidity and suspended sediments, resulting in smothering and reduced biological productivity of aquatic ecosystems • Increased nutrients, resulting in algal blooms and high biological oxygen demands • Increased presence of tannins, which typically increases biological oxygen demands therefore reducing dissolved oxygen, reducing light penetration and affecting visual amenity
Bulk earthworks and stockpiling spoil	Bulk earthworks (cut and fill) to establish level construction benches allows for the safe operation of plant and equipment during construction of transmission towers, construction support sites, laydown areas, substations, switching stations and stringing sites. New access roads would require grubbing and bulk earthworks using an excavator, laying and compaction of a suitable rock aggregate/road base. Some existing roads would require grading and/or reshaping and ongoing maintenance would be required. Spoil would be generated during the construction of access roads, levelling of infrastructure pads and excavations for transmission towers. If spoil is not removed from site or disposed of at a facility authorised to accept such waste, spoil stockpiles can lead to mobilisation of sediments, resulting in local overland flows washing spoil into nearby drainage lines. Spoil located on steep slopes near watercourses and during periods of high rainfall, may result in higher risks to downstream watercourses. The key risk to water quality from bulk earthworks and spoil stockpiles is the exposure of bare soil to wind and rain which may result in the erosion of exposed surfaces and the deposition of sediment in receiving watercourses. Destabilisation of the ground surface, resulting in erosion and mobilisation of sediments, can affect water quality by: • Increasing turbidity and suspended sediments, resulting in smothering and reduced biological productivity of aquatic ecosystems • Increasing nutrients, resulting in algal blooms and high biological oxygen demands • Mobilising a range of contaminants that bind to soil particles such as pesticides and metals
Concrete batching	Concrete batching poses a risk to water quality due to the potential runoff of cement slurry, chemicals, and sediment, as well as the discharge of concrete washout. Water that has been in contact with cementitious material can result in: • Increased alkalinity • Increased dissolved metals • Increased turbidity and suspended sediments

Construction activity	Pathway and risk to water quality
Installation of watercourse crossings	The installation of watercourse crossings for access roads and tracks presents a risk to water quality due to the potential for direct interaction with watercourses. Works within watercourses have potential to alter the hydraulics of the watercourse and increase susceptibility to headcuts, scour, erosion and sedimentation. The risks associated with the installation of crossings are increased due to the concentration of flows at these locations. The potential impacts to downstream water quality include: • Increasing turbidity and suspended sediments, resulting in smothering and reduced biological productivity of aquatic ecosystems • Increasing nutrients, resulting in algal blooms and high biological oxygen demands • Mobilising a range of contaminants that bind to soil particles such as pesticides and metals
Chemicals and hazardous material storage and use	The following activities have the potential to release contaminants including oils, fuels, grease and chemicals that may enter watercourses: • Machinery and equipment operation for earthworks, vegetation clearing and installation of infrastructure • Refuelling, maintenance and wash down of machinery and vehicles • Disturbance of contaminated soils • Storage and handling of hazardous materials • The installation and operation of pumping infrastructure associated with water extraction from surface water bodies Impacts to water quality from chemical and hazardous materials handling are varied depending on the category of chemicals utilised by the project. The most common potential pollutants are hydrocarbons associated with machinery refuelling and maintenance.
Piling (interception of groundwater)	Piling during installation of transmission towers may intercept groundwater if the depth of piling is below the groundwater table. Groundwater intercepted during construction requires removal and appropriate management. The water quality of groundwater can be different to surface water and become contaminated during construction. Therefore, discharges of groundwater to the environment can impact surface water quality.
Surface water extraction	The installation and operation of pumping infrastructure has the potential to mobilise sediment and affect streamflow. This can result in increased turbidity, nutrients and decreased visual amenity.

6.1.2 Predicted residual impacts

Residual impacts to water quality for each construction activity were evaluated with consideration of:

- the spatial scale of the activity
- the sensitivity of the receiving environment
- the impact pathways
- the potential risks to water quality
- the implementation of mitigation and management measures.

Mitigation and management measures listed *Chapter 8 (Management)* have been developed to achieve a low mitigated risk (refer to 'mitigated risk rating' in Table 3.4) to water quality for each construction activity. The overall residual impact rating for each construction activity is based on the magnitude / scale and sensitivity of the receiving environment, as well as the mitigated risk rating.

i Vegetation clearing

Vegetation clearing is required for the construction of most project components, with the largest being the development of the transmission line easement within the HTP corridor. Vegetation clearing is also associated with the construction of transmission towers, new and upgraded access tracks as well as construction support sites, other ancillary areas, switching stations and substation upgrades.

The potential risk to water quality from vegetation clearing is highest in the State forests where existing vegetation is dense, topography is steep (greater risk of destabilisation), and the sensitivity of the receiving environment is highest (potentially sensitive biodiversity areas). Vegetation in other areas of the project impact area are typically less dense, ranging from scattered to sparse, particularly in cleared agricultural land such as the Hunter River floodplain. Due to the extent of vegetation clearing across the entire project impact area, the receiving environments potentially impacted are wide ranging and include a mixture of low, moderate and high sensitivity receiving environments.

The design considerations integrated into the project (as described in *Chapter 5 (Design considerations and proposed water management)*), along with the mitigation measures described in *Chapter 8 (Management)*, reduce the potential impact that vegetation clearing may have on water quality to low, by:

- providing measures to stabilise the topsoil following clearing
- maintain stability of watercourse banks
- reduce the potential for mulch and associated tannin production to enter downstream watercourses.

Mitigation measures will be tailored to local conditions and the sensitivity of the receiving environment. The predicted residual impacts to surface water quality from vegetation clearing are:

- low, in low sensitivity receiving environments.
- moderate, in moderate and high sensitivity receiving environments. Although the mitigated risk rating is low, the residual impacts to moderate and high sensitivity receiving environments are considered moderate due to the scale of vegetation clearing required to construct the project and the sensitivity of the receiving environment.

ii Bulk earthworks and stockpiling spoil

Bulk earthworks would be required by the project in the form of grading, leveling and shaping of the ground to create foundations for access tracks, construction support sites, ancillary areas, transmission towers, switching stations and substation upgrades. The location of these project components span the project impact area and include works in highly disturbed receiving environments, such as at the Bayswater South switching station, and sensitive receiving environments such as at the Olney switching station and access tracks in the State forests. Construction activities that would generate the largest volumes of spoil would be the construction of access roads, construction of the switching stations, levelling of infrastructure pads and excavations for transmission towers. Spoil generated from transmission tower excavations would be shaped and compacted around the transmission towers.

Spoil stockpiles that pose the greatest risks to water quality are those associated with the construction of the switching stations, access track upgrades and tower construction in the State forests. Spoil located on steep slopes near watercourses and during periods of high rainfall, may result in higher risks to downstream watercourses.

The key risk to water quality from bulk earthworks and spoil stockpiles is the exposure of bare soil to wind and rain which may result in the erosion of exposed surfaces and the deposition of sediment in receiving watercourses.

The Olney switching station is located in the Olney State Forest, upstream of and in close proximity to, sensitive receiving environments, including threatened frog breeding habitats. Due to the combination of the steep topography, the scale of earthworks required to establish the switching station construction area and the sensitive receiving environment, site-specific mitigation measures will be developed for the Olney switching station to manage water quality risks during construction.

Bulk earthworks for the Bayswater South switching station present a lower risk to water quality, as the area features gently undulating terrain and less sensitive receiving environments. The switching station would require infilling of a minor watercourse and installation of diversions to manage stormwater around the site, including appropriate scour protection and water quality controls.

The mitigation measures described in *Chapter 8 (Management)*, reduce the potential impact of bulk earthworks and spoil stockpiles on water quality to low, by implementing erosion and sediment control measures and stormwater management measures. The design and implementation of erosion and sediment control measures will be tailored to local conditions and the sensitivity of the receiving environment.

The predicted residual impact to surface water quality from bulk earthworks and spoil are:

- low, in low sensitivity receiving environments
- moderate, in moderate and high sensitivity receiving environments. Although the mitigated risk rating is low, the residual impacts are moderate due to:
 - the scale of bulk earthworks required to construct the project (in both moderate and high sensitivity environments)
 - the sensitivity of the receiving environment (in high sensitivity environments).

iii Concrete batching

Concrete batching plants would be established at construction support sites located at:

- Freemans Drive
- Wollombi Road

- Gouldsville Road
- Pikes Gully Road
- Hebden Road.

In addition to these, several portable concrete batching plants would be located in remote areas such as the State forests.

The key risks to water quality from concrete batching is the discharge of cementitious water to downstream watercourses. These risks are elevated in the State forests where the receiving environment is sensitive.

The mitigation measures described in *Chapter 8 (Management)* reduce the potential impact of concrete batching on water quality by implementing stormwater control measures that separate potential cementitious runoff from the surrounding environment, ensure appropriate disposal of contaminated water and consider the sensitivity of the receiving environment.

The predicted residual impact to surface water quality from concrete batching are:

- low, in low and moderate sensitivity receiving environments
- moderate, in high sensitivity receiving environments. Although the mitigated risk rating is low, the residual impacts are moderate due to the high sensitivity of the receiving environment.

iv Installation of watercourse crossings

New and upgraded access tracks would be required to connect the HTP corridor with existing roads. Access track watercourse crossings would be required across the project impact area. A detailed summary of the number and type of watercourse crossings that would be required for the project is summarised in *Section 6.3*.

The key water quality risks associated with the installation and upgrading of watercourse crossings are erosion and sedimentation during construction. Water quality risks during the construction of watercourse crossings are associated with the direct interaction of construction activities with the watercourse during construction, the potential alteration of local hydraulics, and the exposure of bare soil.

The potential impact of installing watercourse crossings on water quality is highest in the State forests where topography is steep (greater risk of destabilisation) and the sensitivity of the receiving environment is highest (potentially sensitive biodiversity areas).

The mitigation measures described in *Chapter 8 (Management)*, reduce the risk to water quality from the installation of, and upgrades to, watercourse crossings to low. This is achieved by providing management measures that consider the local conditions, such as bed and bank stability, hydraulic gradient, scour protection and sensitivity of the receiving environment into design as well as the implementation of installation techniques that minimise impacts to watercourses.

Watercourse crossings will be designed, installed and maintained in accordance with relevant guidelines for watercourse crossings such as (but not limited to) *Policy and Guidelines for Fish Friendly Watercourse Crossings* (DPI 2003), *Guidelines for watercourse crossings on waterfront land* (DPE Water 2022b) and *Managing Urban Stormwater: Soils and Construction – Volume 1, 4th Edition* (Landcom 2004).

The predicted residual impacts to surface water quality from watercourse crossings are:

- low, in low sensitivity receiving environments
- moderate, in moderate and high sensitivity receiving environments. Although the mitigated risk rating is low, the residual impacts are moderate due to:
 - the scale of watercourse crossings required to construct the project (in moderate sensitivity environments)
 - the sensitivity of the receiving environment (in high sensitivity environments).

v Chemical / hazardous material storage and use

Contaminants including oils, fuels, grease, and other chemicals would be required to maintain and operate machinery associated with vegetation clearance, earthwork, concrete batching and the installation of infrastructure. Large volumes of chemicals would be stored at the construction support sites, where maintenance of vehicles and equipment would be undertaken. The refuelling and necessary maintenance of machinery would occur where construction activities are being undertaken across the project impact area.

Potential impacts to water quality from chemical and hazardous materials handling are varied depending on the category of chemicals utilised by the project. The most common potential pollutants are hydrocarbons associated with machinery refuelling and maintenance.

The mitigation measures described in *Chapter 8 (Management)* reduce the potential impact of chemicals and hazardous materials on water quality by implementing control measures that ensure chemicals and hazardous materials are adequately contained and spills do not enter receiving watercourses.

The predicted residual impacts to surface water quality from chemical and hazardous materials storage and use are:

- low, in low and moderate sensitivity receiving environments
- moderate, in high sensitivity receiving environments. Although the mitigated risk rating is low, the residual impacts are moderate due to the high sensitivity of the receiving environment.

vi Piling (interception of groundwater)

Groundwater is likely to be intercepted where piling for transmission towers occurs below the water table. The groundwater impact assessment (*Technical Report 11 – Groundwater impact assessment*) identifies that groundwater may be intercepted by piling at various locations across the project impact area. Groundwater inflows into tower footing excavations would occur in the north of the project impact area in areas associated with the Hunter River alluvium, where depth to groundwater is shallow.

If contaminated groundwater is intercepted by piling activities and not managed effectively at the surface, there is potential for contaminated water to enter receiving watercourses. The contamination preliminary site investigation (*Technical Report 13– Contamination preliminary site investigation*) identifies 3 areas of potential groundwater contamination risk. Groundwater encountered within the project impact area at the mine sites and the Bayswater Power Station pose a low risk to the environment as the volumes of groundwater expected to interact with the project are anticipated to be low. However, there remains a medium risk of encountering contamination, should dewatering be required during piling activities. Aside from contamination, groundwater quality is likely to vary from the receiving surface water environment, resulting in the latter possibly becoming contaminated during construction. Therefore, intercepted groundwater in areas not identified as contaminated, can also pose a contamination risk to receiving surface waters if unmanaged.

Depending on local conditions and construction methodology, groundwater inflows may need to be managed during construction. Any required dewatering during construction would be assessed during detailed design and managed under the soil and water management plan (SWMP). Groundwater management measures may include:

- storage and reuse
- application to vegetated areas away from watercourses
- trucking to a licensed waste facility.

The mitigation measures described in *Chapter 8 (Management)* reduce the potential impact of the intercepted groundwater on surface water quality by providing measures to limit runoff into excavations and develop groundwater management measures that are commensurate with water quality.

The predicted residual impacts to surface water quality from intercepted groundwater are:

- low in low and moderate sensitivity receiving environments.

Groundwater is not expected to be intercepted in sensitive environments such as the State forests.

vii Extraction of surface water

As described in *Section 5.3.1* a combination of water sources would be required to meet the potable and non-potable water demand for the project. Of these, the extraction of water from surface water sources would be considered from both existing and new extraction locations.

Existing surface water extraction locations that would be considered include:

- Plashett Reservoir (owned and operated by AGL Macquarie)
- Lake Liddell (owned and operated by AGL Macquarie)
- Hunter River via the Mount Thorley Joint Venture water supply scheme (operated by Singleton Council).

New surface water extraction locations that would be considered include:

- Congewai Creek
- Hunter River.

The key impacts to water quality from surface water extraction are associated with the disturbance of sediments and alterations of streamflow patterns, causing possible erosion and scour within the watercourse or waterbody. Impacts to water quality from existing surface water extraction locations are considered low as the infrastructure is already in place and there would be limited changes to the existing environment. Potential impacts to water quality from new surface water extraction locations (e.g. Congewai Creek and Hunter River) would increase due to the potential to disruptions to bed and bank stability and alterations to the hydraulic function of the watercourse.

The mitigation measures described in *Chapter 8 (Management)*, reduce the potential impact of surface water extraction on water quality by providing measures to protect extraction locations from scour and minimise the impact on watercourse hydraulics.

The predicted residual impacts to surface water quality from surface water extraction are:

- Low in low and moderate sensitivity receiving environments.

Surface water is not expected to be extracted in sensitive environments such as the State forests.

6.1.3 Summary of impacts

The risk of water quality impacts varies across the project impact area and with different construction activities. Risks to water quality during construction would be temporary in nature and localised. A summary of the residual impacts to water quality, following the implementation of mitigation and management measures, are provided in Table 6.3.

Table 6.3 Summary of residual surface water quality impacts

Construction activity	Residual impact to water quality		
	Low sensitive receiving environment	Moderate sensitive receiving environment	High sensitive receiving environment
Vegetation clearing	Low	Moderate	Moderate
Bulk earthworks and stockpiling spoil	Low	Moderate	Moderate
Concrete batching	Low	Low	Moderate
Installation of watercourse crossings	Low	Moderate	Moderate
Chemical/hazardous materials handling	Low	Low	Moderate
Intercepted groundwater from piling activities	Low	Low	N/A
Extraction of surface water	Low	Low	N/A

Risks to water quality are higher in the State forests where the topography is steep and where disturbance activities are located upstream of sensitive biodiversity areas. Steep topography increases the risk of erosion and sediment mobilisation due to higher velocity of runoff which can increase erosive forces, causing greater scour and mobilisation of sediments. Erosion and mobilisation of sediments, can affect water quality by:

- increasing turbidity and suspended sediments, resulting in smothering and reduced biological productivity of aquatic ecosystems
- increasing nutrients, resulting in algal blooms and high biological oxygen demands
- mobilising a range of contaminants that bind to soil particles such as pesticides and metals.

Water quality risks are substantially lower in areas of the Hunter Valley of low to moderate grades where the receiving environment is highly modified as a result of land clearing, coal mining, and energy generation.

The implementation of the mitigation and management measures in *Chapter 8 (Management)* would effectively manage key risks to water quality.

6.1.4 Assessment of impacts against water quality objectives

The *NSW Water Quality and River Flow Objectives* (DECCW 2006) provides WQOs for all catchments in NSW and are the agreed environmental values and long-term goals for surface waters within NSW. The water quality objectives (WQOs) for watercourses affected by the project within the Hunter River, Lake Macquarie and Tuggerah Lakes catchments are provided in *Section 3.2.2iv*. As discussed in *Section 6.1.2*, water quality impacts from the project are expected to be low to moderate. Key risks to water quality are erosion and mobilisation of sediments and risks are elevated in the State forests where the sensitivity of the receiving environment is higher. With effective management and the consideration of local conditions, the WQOs of the receiving environment would be protected and maintained. Table 6.4 provides a summary of WQOs relevant to the study area, their relevant watercourses and anticipated impacts to the WQOs.

Table 6.4 Impacts to water quality with regard WQOs

Environmental value	Objective	Impacts to relevant watercourses with regard to WQO
Aquatic ecosystems	Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term	This objective applies to all watercourses in the study area. The aquatic systems water quality criteria is typically the most stringent of the WQOs. Therefore, the aquatic ecosystems' objective is typically the most likely to be impacted. Risks to water quality are elevated in sensitive receiving environments of the State forests. Key water quality risks include elevated turbidity, elevated nutrients and mobilisation of contaminants that bind to soil particles (such as metals and pesticides). Implementation of the nominated mitigation measures (see <i>Chapter 8 (Management)</i>) is anticipated to result in water quality runoff leaving the project that is similar to the water quality of the receiving environment. Impacts to water quality during construction, if any, would be temporary and localised. The project is expected to maintain the ecological condition of receiving waterbodies. Immediate impacts to riparian corridors will be minimised and re-established over the long term.
Visual amenity	Aesthetic qualities of waters	This objective applies to all watercourses in the study area. No material impacts to visual amenity are anticipated as the appearance of water quality leaving the project is expected to be similar to the water quality of the receiving environment.
Secondary contact recreation	Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed	This objective applies to all watercourses in the study area. Streams in the southern half of the project impact area, such as Watagan Creek, Dora Creek, Congewai Creek and the Wyong River, are more likely to be used for recreation. No material impacts to the secondary contact recreation objective are anticipated as the water quality of runoff leaving the project is expected to be similar to the water quality of the receiving environment.
Primary contact recreation	Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed	There are no officially recognised water recreation sites in the study area. Streams in the southern half of the project impact area, such as Watagan Creek, Dora Creek, Congewai Creek and the Wyong River, are more likely to be used for recreation. No material impacts to the primary contact recreation objective are anticipated as the water quality of runoff leaving the project is expected to be similar to the water quality of the receiving environment.

Environmental value	Objective	Impacts to relevant watercourses with regard to WQO
Drinking water at point of supply-disinfection only	Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment	This objective applies to licensed offtake points for town water supply and specific sections of rivers that contribute to drinking water storages. The Wyong River is an offtake point to supply Mardi Dam, a drinking water source for the Central Coast. Some headwaters of the Wyong River are located in the study area. Extraction from the Wyong River to Mardi Dam occurs approximately 20 km downstream of the project. Several offtake points are located on the Hunter River downstream of the project impact area, which supply drinking water to the township of Singleton. No material impacts to the drinking water (at point of supply) objective are anticipated as the water quality of runoff leaving the project is expected to be similar to the water quality of the receiving environment. No impacts to groundwater quality are anticipated.
Drinking water at point-of-supply clarification and disinfection	Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment	This objective applies to licensed offtake points for town water supply and specific section of rivers that contribute to drinking water storages. The Wyong River is an offtake point to supply Mardi Dam, a drinking water source for the Central Coast. Some headwaters of the Wyong River are located in the study area. Extraction from the Wyong River to Mardi Dam occurs approximately 20 km downstream of the project. Several offtake points are located on the Hunter River downstream of the project impact area, which supply drinking water to the township of Singleton. No material impacts to the drinking water (at point of supply) objective are anticipated as the water quality of runoff leaving the project is expected to be similar to the water quality of the receiving environment. No impacts to groundwater quality are anticipated.
Drinking water at point-of-supply groundwater	Refers to the quality of drinking water drawn from groundwater sources before any treatment	This objective applies to licensed offtake points for town water supply that contribute to drinking water storages. No impacts to groundwater quality are anticipated (see <i>Technical Report 11 - Groundwater impact assessment</i>).
Aquatic food (cooked)	Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities	This objective applies to the Hunter regulated river and uncontrolled streams of the Hunter River, Lake Macquarie and Tuggerah Lakes catchments, where aquatic foods are taken for non-commercial and commercial harvesting. This may apply to Congewai Creek, Monkey Place Creek, Dora Creek, the Hunter River and their tributaries which may be used for recreational fishing. No material impacts to aquatic ecosystems are anticipated as the water quality of runoff leaving the project is expected to be similar to the water quality of the receiving environment.
Livestock water supply	Protecting water quality to maximise the production of healthy livestock	This objective applies to the Hunter regulated river and uncontrolled streams of the Hunter River, Lake Macquarie and Tuggerah Lakes catchments, where water is used to water stock. This may apply to Congewai Creek, Monkey Place Creek, Dora Creek, the Hunter River and their tributaries where livestock are present. This objective is attained if aquatic ecosystems are protected. Therefore, there are no material impacts to livestock water supply.

Environmental value	Objective	Impacts to relevant watercourses with regard to WQO
Irrigation water supply	Protecting the quality of waters applied to crops and pasture	This objective applies to the Hunter regulated river and uncontrolled streams of the Hunter River, Lake Macquarie and Tuggerah Lakes catchments, where water is applied to crops and pasture. Irrigated crops in the study area are most frequently located on the floodplains of the Hunter River. Irrigated crops are less frequently located near Congewai Creek, Monkey Place Creek, Dora Creek and their tributaries. No material impacts to irrigation water supply are anticipated as the water quality of runoff leaving the project is expected to be similar to the water quality of the receiving environment.
Homestead water supply	Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing	This objective applies to homesteads that draw water from surface and groundwaters for domestic needs, including drinking water in the Hunter regulated river and uncontrolled streams of the Hunter River, Lake Macquarie and Tuggerah Lakes catchments. The WQOs acknowledge achieving the trigger values for chemical contaminants is not possible without disinfection and/or treatment. No material impacts to homestead water supply are anticipated as the water quality of runoff leaving the project is expected to be similar to the water quality of the receiving environment.

6.2 Streamflow regime

6.2.1 Potential risks

Project construction activities that have the potential to alter streamflow regimes are typically associated with the implementation of stormwater management measures, increased runoff from impervious areas and extraction from surface water sources. Project construction activities have the potential to alter the streamflow regime at a localised scale. Potential risks to streamflow regime include:

- alteration of existing catchment areas by diverting flows to adjacent watercourses. This can have the impact of increasing volumetric flow in adjacent watercourses, resulting in scour and instabilities. This can also result in reduced flows in the receiving watercourse from which flows were diverted from. Stormwater diversions are typically installed to minimise flow onto active work sites and disturbance areas (to limit the generation of sediment laden runoff)
- containment of runoff by stormwater control devices for water quality purposes. The containment of runoff around concrete batching plants and by erosion and sediment controls, reduces the volume of runoff in receiving watercourses particularly during low rainfall events, affecting the natural streamflow regime of downstream watercourses
- increase in impervious areas, such as concrete hardstands associated with switching stations and substations, result in increased runoff to be conveyed by receiving watercourses. The change from natural vegetation to an impervious surface reduces the amount of rainfall that is usually absorbed by the soil or available for evapotranspiration by vegetation. This additional runoff results in increases in volumetric flows and can result in scour and instabilities of receiving watercourses
- watercourse crossings, if not constructed at bed level, can have the effect of detaining flows upstream. This has the impact of restricting flows to the downstream watercourse, particularly during low flows
- extraction from surface water sources may reduce streamflow downstream. Locally, velocity and flow patterns can be altered by the force of extraction.

6.2.2 Predicted residual impacts

i Stormwater diversions

Stormwater diversions will be installed to minimise flow onto active work sites and disturbance areas (to limit the generation of sediment laden runoff). These diversions will typically occur around concrete batching areas, switching stations, substations, hazardous materials handling (and storage) areas and where bulk earthworks are undertaken (including but not limited to access tracks, construction support sites and transmission towers). For the project, diversions are expected for relatively small catchment areas and flow of minor streams (i.e. Strahler order of 1 or 2). The increased volumetric flows in adjacent watercourses that receive additional runoff as a result of the diversions, and reduced flow in watercourses that would naturally receive runoff (before implementation of diversions), would occur immediately downstream of the constructed diversions and dissipate downstream. Mitigation measures provided in *Chapter 8 (Management)*, will minimise changes to runoff patterns from existing catchments and provide appropriate scour protection measures where increased flows are anticipated.

ii Containment of stormwater

Temporary drainage works, erosion and sediment controls and stormwater management measures will capture runoff from exposed areas or potential pollution sources, which would prevent or delay streamflow immediately downstream of these construction activities for low to moderate rainfall events. The location of these devices will be determined as part of the SWMP and would be located to manage runoff from larger disturbance areas such as construction support sites, substations and switching stations, if necessary. These impacts would, however, be localised, short term and dissipate downstream.

iii Impervious areas

Increases in runoff, as a result of the project, would occur where impervious surfaces (i.e. concrete pads) are constructed or there is a reduction of the infiltration capacity of the surface (i.e. compacted hardstand areas). Increased runoff would be largely associated with substations, switching stations and construction support sites. Increased runoff in receiving watercourses would be localised and the mitigation measures (provided in *Chapter 8 (Management)*) will include the provision of appropriate scour protection measures where increased flows are anticipated downstream of these sites.

iv Watercourses crossings

Watercourse crossings will be designed, installed and maintained in accordance with design standards and constructed to minimise flood risk and upstream and downstream impacts. Crossings will be designed to ensure streamflow is maintained in watercourses where construction works are taking place or where a permanent watercourse crossing is proposed.

v Surface water extraction

The extraction of water from any surface water source will be undertaken in accordance with the NSW water regulatory framework including any conditions on WALs and water supply works and use approvals as well as rules in the relevant water sharing plan (WSP). This framework considers measures to manage extractions such that there are minimal impacts to downstream water users and the environment. Such measures may include volumetric extraction limits and limits to extraction during periods of low flow (such as cease to pump rules).

6.2.3 Summary of impacts

Stormwater management will be developed and refined during the detailed design phase. Potential impacts on streamflow, arising from stormwater controls, increased impervious surfaces, and the installation of watercourse crossings, will be minimised through the implementation of appropriate mitigation measures. As outlined in *Chapter 8 (Management)*, these measures will help reduce alterations to runoff patterns from existing catchments and include scour protection where increased flows are expected. In general, any residual impacts to the streamflow regime during construction are expected to be localised and to dissipate within a short distance downstream. Impacts related to stormwater management devices and flow diversions during construction will be temporary and confined to the period of active disturbance.

The residual impact to streamflow regime, following the implementation of mitigation measures during construction, is low.

6.2.4 Assessment of impacts against river flow objectives

The project is not likely to have significant impacts on streamflow. As discussed in *Section 6.2.2*, stormwater management measures during construction would capture runoff from exposed areas or potential pollution sources, which would prevent or delay streamflow immediately downstream of these sites for low to moderate rainfall events. These impacts would, however, be very localised, short term and insignificant to streamflow and dissipate downstream. There is potential for some minor increases to runoff from hardstand areas, such as switching stations and substations, however these impacts would be localised, and dissipate downstream.

As mentioned in *Section 6.2.2*, the NSW water regulatory framework considers measures to minimise impacts to streamflow as a result of surface water extractions. The project will access water in accordance with these measures and therefore impacts to streamflow as a result of extraction are appropriately considered with respect to the river flow objectives (RFOs).

As the Hunter River is a regulated river, where licensed entitlements of water are allocated and purchased, there are no RFOs that apply to the Hunter River directly under the NSW RFOs framework.

Project construction impacts to streamflow regime have been considered with respect to the RFOs in Table 6.5

Table 6.5 Impacts to streamflow with regard to RFOs

Environmental value	Objective	Impacts to relevant watercourses with regard to RFOs
Protect pools in dry times	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows	This objective applies to all watercourses in the study area, excluding the Hunter regulated river. Any extraction of surface water will be licensed and accessed in accordance with the relevant WSP, which may regulate extraction in dry times. No material impacts to pools in dry times are anticipated as impacts to streamflow regime are expected to be localised and temporary.
Protect natural low flows	Protect natural low flows	This objective applies to all watercourses in the study area, excluding the Hunter regulated river. Any extraction of surface water will be licensed and accessed in accordance with the relevant WSP, which may regulate extraction in low flows. No material impacts to natural low flows are anticipated as impacts to streamflow regime from construction activities are expected to be localised and/or temporary.

Environmental value	Objective	Impacts to relevant watercourses with regard to RFOs
Protect important rises in water levels	Protect or restore a proportion of moderate flows ('freshest') and high flows	This objective applies to uncontrolled streams in the study area (excluding 'mainly forested areas' of the State forests). Any extraction of surface water will be licensed and accessed in accordance with the relevant WSP. No material impacts to moderate and high flows are anticipated as impacts to streamflow regime from construction activities are expected to be localised and temporary.
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems	This objective applies to uncontrolled streams in the study area (excluding 'mainly forested areas' of the State forests). Impacts to inundation patterns of flood waters are assessed by the flood impact assessment (<i>Technical Report 12 – Flooding impact assessment</i>) as minor and localised. No impacts to wetlands or floodplain ecosystems are anticipated.
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams	This objective applies to all watercourses in the study area, excluding the Hunter regulated river. Any extraction of surface water will be licensed and accessed in accordance with the relevant WSP. No material impacts to natural flow variability are anticipated as impacts to streamflow regime from construction activities are expected to be localised and temporary.
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems	Potential impacts to groundwater levels are assessed by the groundwater impact assessment (<i>Technical Report 11 – Groundwater impact assessment</i>) and the potential impacts to groundwater dependent ecosystems (GDEs) are assessed in the biodiversity development assessment report (<i>Technical Report 1 – Biodiversity development assessment report</i>) as unlikely.
Minimise effects of weirs and other structures	Minimise the impact of instream structures	This objective applies to all watercourses in the study area, excluding the Hunter regulated river. No formal instream structures (i.e. weirs) are proposed by the project. Watercourse crossings will be designed and constructed in accordance with the relevant guidelines and minimise impacts on streamflow and aquatic ecology.

6.3 Watercourses and riparian corridors

6.3.1 Potential risks

Riparian corridors form a transition zone between watercourses and the surrounding landscape. They provide valuable functions including bed and bank stability, habitats for a diversity of terrestrial and aquatic species, and conveyance functionality for low flows and floods. Riparian corridors are particularly important to maintaining the geomorphic form of a watercourse.

Key potential impacts to watercourses and riparian corridors from construction of the project include:

- destabilisation as a result of the removal of riparian vegetation which stabilises the bed and banks of watercourses
- earthworks which alter the shape, bed slope or drainage patterns of watercourses. Such changes can cause higher velocities and shear forces which result in headcuts, erosion and geomorphic changes to watercourses. Such changes may result in reduced bed and bank stability due to the changes in hydraulic function

- the installation of infrastructure, such as transmission towers, in the conveyance area of a watercourse. Structures located instream of a watercourse can result in increased velocities and shear forces and a redistribution of conveyance within the watercourse. Such changes may result in reduced bed and stability due to the changes in hydraulic function. These impacts have been assessed in the flood impact assessment (*Technical Report 12 – Flooding impact assessment*).

The potential impacts of the project on watercourses and riparian corridors are described below according to project elements which are similar in nature and impact magnitude. The interaction of indicative riparian zones (IRZs) (as described in *Section 3.7*) with the project impact area is presented in Figure 6.1.

6.3.2 Predicted residual impacts

i HTP corridor and transmission line upgrades and adjustments

The HTP corridor is comprised of a partially cleared transmission line easement as well as transmission towers and associated works (such as tower pads, earthwork batters and stringing sites). The corridor requires the removal of vegetation in accordance with the methodology described in *Chapter 4 (Project description)* of the environmental impact statement (EIS). The biodiversity impacts of vegetation clearing for the project are assessed in the biodiversity development assessment report (*Technical Report 1 – Biodiversity development assessment report*).

Upgrades and adjustments to existing transmission lines would be required near Bayswater Power Station, the Singleton Military Area, and between Eraring Power Station and the southern extent of the project impact area, extending beyond the Olney State Forest. Upgrades and adjustments to transmission lines include the construction of new transmission towers and earth wire upgrades, the majority of which would be undertaken within existing transmission line easements. Works within existing transmission line easements typically have a lower impact on riparian corridors as vegetation clearance has already been undertaken and additional vegetation clearance in these locations would be minimal.

The proposed HTP corridor and easements associated with upgrades and adjustments to existing transmission lines would interact with numerous riparian corridors of minor and major watercourses, including approximately:

- 230 interactions with IRZs of 1st order watercourses, including approximately:
 - 180 interactions with the HTP corridor
 - 50 interactions within existing transmission line easements
- 60 interactions with IRZs of 2nd order watercourses, including approximately:
 - 50 interactions with the HTP corridor
 - 10 interactions within existing transmission line easements
- 20 interactions with IRZs of 3rd order watercourses, including approximately:
 - 15 interactions with the HTP corridor
 - 5 interactions within existing transmission line easements
- 20 interactions with IRZs of 4th order watercourses and higher, including approximately:
 - 15 interactions with the HTP corridor
 - 5 interactions within existing transmission line easements.

Major watercourses crossed by the proposed transmission corridor include the Hunter River (3 crossings), Wollombi Brook, Congewai Creek and Dora Creek.

A summary of the interactions of the HTP corridor (and transmission line upgrades and adjustments) with the IRZ of 4th order Strahler streams and above, is provided in Table 6.6. These watercourses have been presented in the assessment as perennial watercourses within the study area (i.e. watercourses which flow all year round under average rainfall conditions) are typically of a Strahler 4th order or above.

Impacts on stability are a greater risk in areas of higher slopes. Higher bed slopes, such as those present in watercourses of the State forests, convey flows of greater velocity and shear forces which can have a greater impact when destabilised. There are, however, multiple factors that affect stability such as bed control structures and local soil characteristics. Impacts to the riparian corridors are increased if the HTP corridor crosses the riparian corridor at an angle (i.e. not perpendicular) to the watercourse as the area of impact is increased.

Impacts of upgrades and adjustments to transmission lines typically have lower impacts as the majority of these activities would be undertaken within existing easements (which have already been cleared of vegetation).

The mitigation measures provided in *Chapter 8 (Management)*, includes clearance measures to reduce the risk of destabilisation within the riparian corridor. Watercourse stabilisation measures will be tailored to local conditions and consider the sensitivity of the receiving environment.

The predicted residual impacts to riparian corridors from the HTP corridor and transmission line upgrades and adjustments is:

- low, in low sensitivity receiving environments
- moderate, in moderate and high sensitivity receiving environments. The residual impacts are moderate due to the scale of vegetation clearing and the sensitivity of the receiving environments.

Table 6.6 **HTP corridor and transmission line adjustments and upgrades within IRZs**

Project component	Name of watercourse (Strahler order)	River styles stream condition and recovery potential	Status of existing vegetation in IRZ	Sensitivity of receiving environment	Description of interaction
Upgrades to existing transmission line (5A3 and 5A4)	Saddlers Creek (4)	Moderate condition, rapid recovery potential	Sparse	Moderate	Corridor crosses IRZ perpendicular to watercourse
HTP corridor	Hunter River (9)	Poor condition, moderate recovery potential	Sparse	Moderate	Corridor crosses IRZ perpendicular to watercourse
HTP corridor	Hunter River (9)	Poor condition, moderate recovery potential	Sparse	Moderate	Corridor crosses IRZ perpendicular to watercourse
HTP corridor, stringing site	Hunter River (9)	Poor condition, moderate recovery potential	Sparse	Moderate	Corridor crosses IRZ perpendicular to watercourse
HTP corridor	Wollombi Brook (8)	Moderate condition, high recovery potential	Sparse yet concentrated on banks of the watercourse	Moderate	Corridor crosses IRZ perpendicular to watercourse
HTP corridor	Hunter River (9)	Poor condition, moderate recovery potential	Sparse yet concentrated on banks of the watercourse	Moderate	Corridor crosses IRZ parallel to watercourse
HTP corridor	Loder Creek (4)	Poor condition, moderate recovery potential	Sparse yet concentrated on banks of the watercourse	Moderate	Corridor crosses IRZ perpendicular to watercourse
HTP corridor	Monkey Place Creek (5)	Poor condition, low recovery potential	Sparse	Moderate	Corridor crosses IRZ perpendicular to watercourse
HTP corridor	Monkey Place Creek (4)	Moderate condition, high recovery potential	Vegetation present across full width of IRZ	High (Pokolbin State Forest, steep terrain and possible presence of threatened species)	Within 'no clearing zones' (vegetation will not be removed) Corridor crosses IRZ parallel to watercourse
HTP corridor	Deep Creek (5)	Good condition	Vegetation present across full width of IRZ	High (Pokolbin State Forest, steep terrain and possible presence of threatened species)	Within 'no clearing zones' (vegetation will not be removed) Corridor crosses IRZ perpendicular to watercourse

Project component	Name of watercourse (Strahler order)	River styles stream condition and recovery potential	Status of existing vegetation in IRZ	Sensitivity of receiving environment	Description of interaction
HTP corridor	Cedar Creek (5)	Good condition	Vegetation present across full width of IRZ	High (Pokolbin State Forest, steep terrain and possible presence of threatened species)	Within 'no clearing zones' (vegetation will not be removed) Corridor crosses IRZ perpendicular to watercourse
HTP corridor	Congewai Creek (6)	Moderate condition, strategic recovery potential	Sparse yet concentrated on banks of the watercourse	Moderate	Within 'no clearing zones' (vegetation will not be removed) Corridor crosses IRZ perpendicular to watercourse
HTP corridor	Sweetmans Creek (4)	Good condition	Vegetation present across full width of IRZ	High (Corrabare State Forest, steep terrain and possible presence of threatened species)	Within 'no clearing zones' (vegetation will not be removed) Corridor crosses IRZ perpendicular to watercourse
HTP corridor	Watagan Creek (4)	Good condition	Vegetation present across full width of IRZ	High (Outskirts of Watagan State Forest, steep terrain and possible presence of threatened species)	Within 'no clearing zones' (vegetation will not be removed) Corridor crosses IRZ perpendicular to watercourse
Upgrades to existing transmission line (5A1 and 5A2)	Jigadee Creek (6)	Moderate condition, rapid recovery potential	Scattered yet concentrated on banks of the watercourse	Moderate	Corridor crosses IRZ perpendicular to watercourse
Upgrades to existing transmission line (5A1 and 5A2)	Felled Timber Creek (4)	Good condition	Scattered yet concentrated on banks of the watercourse	Moderate	Corridor crosses IRZ perpendicular to watercourse
Upgrades to existing transmission line (5A1 and 5A2)	Unnamed tributary of Dora Creek (4)	Good condition	Scattered yet concentrated on banks of the watercourse	Moderate	Corridor crosses IRZ perpendicular to watercourse
Upgrades to existing transmission line (5A1 and 5A2)	Dora Creek (5)	Good condition	Sparse yet concentrated on banks of the watercourse	High (Steep terrain and possible presence of threatened species)	Corridor crosses IRZ perpendicular to watercourse

Project component	Name of watercourse (Strahler order)	River styles stream condition and recovery potential	Status of existing vegetation in IRZ	Sensitivity of receiving environment	Description of interaction
Upgrades to existing transmission line (5A1 and 5A2)	Unnamed tributary of Jilliby Jilliby Creek (4)	Good condition	Vegetation present across full width of IRZ	High (Olney State Forest, steep terrain and possible presence of threatened species)	Corridor crosses IRZ perpendicular to watercourse
Upgrades to existing transmission line (5A1 and 5A2)	Wyong River (5)	Poor condition, to be assessed recovery potential	Sparse yet concentrated on banks of the watercourse	Moderate	Corridor crosses IRZ perpendicular to watercourse

ii Access tracks

Construction associated with access tracks would consist of either new access tracks, upgrades to existing access tracks or minor upgrades to existing access tracks. Upgrades to the existing public road network and existing access tracks and the construction of new access tracks would include the following key steps:

- pre-construction minor works
- vegetation clearing
- site establishment, setting up laydown areas, delivering equipment and materials to site
- establishing traffic control (if required)
- levelling using a grader and roller
- laying locally sourced road material (crushed rock) and compaction rolling
- demobilising the construction site and rehabilitating temporary disturbance.

Minor works to existing access tracks would include vegetation clearing and regrading. Access track works would be located in riparian corridors at a distance from watercourses or may include watercourse crossings. Watercourse crossings may be required where an access track for vehicles, plant and equipment needs to cross a small creek or drainage line. Crossings of minor watercourses (1st and 2nd Strahler order) are likely to be bed level crossings, which include compaction of the access track base and result in minor changes, if any, to the natural bed level of the watercourse. With the exception of access to construction support sites, access track crossings of watercourses would be permanent.

Proposed new and upgraded access tracks for the project would interact with numerous riparian corridors of minor and major watercourses, including:

- approximately 170 interactions with IRZs of 1st order watercourses (including 140 watercourse crossings)
- approximately 60 interactions with IRZs of 2nd order watercourses (including 40 watercourse crossings)
- approximately 25 interactions with IRZs of 3rd order watercourses (including 15 watercourse crossings)
- approximately 20 interactions with IRZs of 4th order watercourses or higher (including 10 watercourse crossings).

Impacts to riparian corridors are greater for access tracks that require the clearing of existing vegetation and where watercourse crossings are required. As described in *Section 6.1.2*, the installation of watercourse crossings can destabilise and alter the hydraulic function of the watercourse, resulting in scour, erosion and sedimentation

A summary of the interactions of the proposed new and upgraded access tracks with the IRZ of 4th order Strahler streams and above, is provided in Table 6.7. The summary indicates there is 1 new watercourse crossing (of a 4th order or greater watercourse) to be installed for the project, at Congewai Creek, a 6th order watercourse. There are multiple new access track crossings of 1st, 2nd and 3rd order Strahler watercourses, as shown in Figure 6.1. There are several cases where an access track interacts with the IRZ within the transmission corridor and hence also included in the assessment of the HTP corridor and transmission line upgrades and adjustments. These instances are noted in the 'description of interaction' attribute.

Construction activities for access tracks in IRZs are associated with upgrades and minor works to existing access tracks, as well as intersection upgrades of public roads. The new or upgraded access tracks also cross a number of creeks, including Saddlers Creek, Saltwater Creek, Wisemans Creek, Parnells Creek, Sandy Hollow Creek, Nine Mile Creek, Monkey Place Creek, Congewai Creek, Felled Timber Creek and Jigadee Creek.

Watercourse crossings would be provided where the new or upgraded access tracks cross watercourses. These watercourse crossings would typically comprise fords or causeways where the approach gradients along the banks of the watercourses and drainage lines are relatively flat and flow is intermittent. Culverts would be used to cross watercourses that are more deeply incised or where frequent inundation occurs. The upgraded or new access tracks would generally follow existing ground levels as close as possible so as not to impede the movement of flow.

Design of the Congewai Creek crossing, and other major watercourse crossings, will be progressed and finalised as part of subsequent project design stages. Designs will minimise impacts to streamflow conveyance and flooding (as per the mitigation and management measures in *Technical Report 12 - Flooding impact assessment*).

The mitigation measures described in *Chapter 8 (Management)* would reduce the potential impact of the construction activities associated with the installation of watercourse crossings on riparian corridors by considering the local conditions, such as bed and bank stability, hydraulic gradient, scour protection and sensitivity of the receiving environment. These measures would be in addition to the design considerations outlined in *Chapter 5 (Design considerations)* of this report to minimise the potential impacts of the project on surface water.

Watercourse crossings will be designed, installed and maintained in accordance with relevant guidelines for watercourse crossings such as (but not limited to) *Policy and Guidelines for Fish Friendly Watercourse Crossings* (DPI 2003), *Guidelines for watercourse crossings on waterfront land* (DPE Water 2022b) and *Managing Urban Stormwater: Soils and Construction – Volume 1, 4th Edition* (Landcom 2004).

The predicted residual impacts to riparian corridors from the construction of access tracks is:

- Low, in low and moderate sensitivity receiving environments
- Moderate, in high sensitivity receiving environments. Although the mitigated risk rating is low, the residual impacts are moderate due to the sensitivity of the receiving environment.

Table 6.7 **Access tracks within IRZ**

Description of access track works proposed	Name of watercourse (Strahler order)	River styles stream condition and recovery potential	Status of existing vegetation in IRZ	Sensitivity of receiving environment	Description of interaction
Intersection upgrades	Maidswater Creek (4)	Moderate condition, moderate recovery potential	Sparse yet concentrated on banks of the watercourse	Low	Intersection upgrade within IRZ and watercourse crossing
Minor works to existing access track	Saddlers Creek (4)	Moderate condition, rapid recovery potential	Sparse yet concentrated on banks of the watercourse	Moderate	Includes existing watercourse crossing (within easement for upgrades to existing transmission line)
Intersection upgrades	Loder Creek (4)	Poor condition, moderate recovery potential	Sparse yet concentrated on banks of the watercourse	Low	Intersection upgrade encroaches on outer IRZ
Intersection upgrades	Loder Creek (4)	Poor condition, moderate recovery potential	Sparse	Low	Intersection upgrade encroaches on outer IRZ
Upgrade to existing access track	Monkey Place Creek (5)	Moderate condition, high recovery potential	Scattered yet concentrated on banks of the watercourse	Moderate	Includes upgrades to existing watercourse crossing
Upgrade to existing access track	Monkey Place Creek (5)	Moderate condition, high recovery potential	Scattered yet concentrated on banks of the watercourse	Moderate	Includes upgrades to existing watercourse crossing
Upgrade to existing access track	Peach Tree Creek (4)	Moderate condition, high recovery potential	Vegetation present across full width of IRZ	Moderate	Includes upgrades to existing watercourse crossing
Upgrade to existing access track	Monkey Place Creek (4)	Moderate condition, high recovery potential	Scattered yet concentrated on banks of the watercourse	Moderate	Track upgrade running parallel to watercourse within IRZ
Intersection upgrades	Muggyrang Creek (5)	Poor condition, low recovery potential	Sparse	Low	Intersection upgrade in outer IRZ
Intersection upgrades	Black Creek (5)	Poor condition, recovery potential none	Sparse	Low	Intersection upgrade within IRZ in urban area
Upgrade to existing access track and installation of new access track	Congewai Creek (6)	Moderate condition, high recovery potential	Sparse yet concentrated on banks of the watercourse	Moderate	New crossing over Congewai Creek and new track either side of creek crossing. Upgrade of existing track partly within IRZ

Description of access track works proposed	Name of watercourse (Strahler order)	River styles stream condition and recovery potential	Status of existing vegetation in IRZ	Sensitivity of receiving environment	Description of interaction
Minor works to existing access track	Jigadee Creek (6)	Moderate condition, rapid recovery potential	Vegetation present across full width of IRZ	Moderate	Minor works to access track that has a watercourse crossing
Minor works to existing access track	Felled Timber Creek (4)	Good condition	Vegetation present across full width of IRZ	Moderate	Minor works to access track that has a watercourse crossing (within upgrades to the transmission line)
Minor works to existing access track	Unnamed tributary of Dora Creek (4)	Good condition	Sparse yet concentrated on banks of the watercourse	Moderate	Minor works to track running parallel to watercourse within IRZ
Minor works to existing access track	Unnamed tributary of Dora Creek (4)	Good condition	Vegetation present across full width of IRZ	Moderate	Minor works to access track that has a watercourse crossing
Minor works to existing access track	Unnamed tributary of Dora Creek (5)	Good condition	Sparse	Moderate	Minor works to access track that has a watercourse crossing
Upgrade to existing access track	Cedar Brush Creek (5)	Moderate condition, strategic recovery potential	Sparse yet concentrated on banks of the watercourse	Moderate	Track upgrade partly within IRZ

iii Ancillary works

Ancillary works include laydown areas, helipad/helicopter facilities and third-party utilities. Ancillary works may require some localised vegetation clearance and minor earthworks to level ground. Timeframes of disturbance in these areas are temporary and would occur only whilst related construction activities are occurring.

Ancillary works will be located outside of riparian corridors, where possible. If required, earthworks and clearing associated with ancillary works will be minimised in riparian corridors and in accordance with the mitigation and management measures in *Chapter 8 (Management)*.

The predicted residual impact to riparian corridors from ancillary works is low.

iv Construction support sites, switching stations and substation upgrades

Construction support sites, new switching stations and upgrades to substations would include the following key construction activities:

- demolition and removal of redundant electrical equipment (for upgrades only)
- vegetation clearing
- site establishment, including building access tracks; setting up laydown areas, and delivering equipment and materials to site
- undertaking civil works to establish the pad for the new switching station and associated infrastructure and services
- modifying drainage structures
- constructing the new switching stations
- demobilising the construction site and rehabilitating temporary disturbance.

With respect to riparian corridors, these activities typically require clearing of vegetated areas and have the potential to destabilise the beds and banks of watercourses, depending on their proximity to watercourses. Of the construction support sites, switching stations and upgrades to existing substations, only the Olney switching station would be located in a high sensitivity receiving environment. The Olney switching station would be located immediately west of the Watagan mountains ridgeline, in the Olney State Forest. The switching station would require vegetation clearing as well as bulk earthworks and associated works across 2 first order tributaries of Wyong River.

A summary of the interactions of the project construction support sites, new switching stations and upgrades to substations with IRZs is provided in Table 6.8. The mitigation measures described in *Chapter 8 (Management)*, will reduce the potential impact of the construction activities associated with construction support sites, switching stations and substation upgrades on riparian corridors by considering the local conditions and the sensitivity of the receiving environment. Riparian corridors will be avoided where practical and potential impacts on watercourse flow conditions will be minimised through design considerations outlined in *Chapter 5 (Design considerations)* of this report. The predicted residual impacts to riparian corridors from construction support sites, switching stations and upgrades to substations is:

- Low, in low and moderate sensitivity receiving environments
- Moderate, in high sensitivity receiving environments. Although the mitigated risk rating is low, the residual impacts are moderate due to the sensitivity of the receiving environment.

Table 6.8 Construction support sites, switching stations and substation upgrade in IRZs

Project component	Name of watercourse (Strahler order)	River styles stream condition & recovery potential	Status of existing vegetation in IRZ	Sensitivity of receiving environment	Description of interaction
Construction support site, Hebden Road	Unnamed tributary of Maidswater Creek (2)	Undefined	Sparse	Moderate	Minor interactions as IRZ located on the outer perimeter of the construction support site and likely to form part of the asset protection zone
Bayswater South switching station	Unnamed tributary of Saltwater Creek (1)	Undefined	Sparse	Low	Installation of substation pad and infrastructure across first order watercourse and IRZ
Construction support site, Pikes Gully Road	Unnamed tributaries of Pikes Creek (1 & 2)	Undefined	Sparse	Moderate	Minor interactions as IRZ located on the outer perimeter of the construction support site and likely to form part of the asset protection zone. One crossing of first order stream.
Construction support site, Gouldsville Road	Unnamed tributary of the Hunter River (1)	Undefined	Sparse	Moderate	Minor interactions as IRZ located on the outer perimeter of the construction support site and likely to form part of the asset protection zone
Construction support site, Wollombi Road	Congewai Creek (6)	Moderate condition, high recovery potential	Scattered yet concentrated on banks of the watercourse	Moderate	Upgrades to existing crossing over Congewai Creek (6) Possible associated works for construction support site located in IRZ Construction support site overlays second order watercourse and IRZ (although no riparian vegetation present)
	Unnamed tributaries of Congewai Creek (2 & 3)	Undefined	Sparse yet concentrated on banks of the watercourse	Moderate	Minimal interactions with third order watercourse as IRZ located on the outer perimeter of the construction support site and is likely to form part of the asset protection zone.

Project component	Name of watercourse (Strahler order)	River styles stream condition & recovery potential	Status of existing vegetation in IRZ	Sensitivity of receiving environment	Description of interaction
Construction support site, Freemans Drive	Jigadee Creek (5 & 6)	Moderate condition, rapid recovery potential	Scattered yet concentrated on banks of the watercourse	Moderate	Possible earthworks and clearance within outer 50% of IRZ of Jigadee Creek
	Unnamed tributary of Jigadee Creek (1)	Undefined	Sparse	Moderate	First order creek located within boundary of site
Olney switching station	2 unnamed tributaries of Wyong River (1)	Undefined	Vegetation present across full width of IRZ	High Olney State Forest, steep terrain and possible presence of threatened species in receiving environment	Installation of substation pad and infrastructure across both first order watercourses and IRZ

6.3.3 Summary of impacts

Impacts to riparian corridors vary across the project impact area and with different construction activities. Impacts to riparian corridors are largely associated with vegetation clearance for the HTP corridor, the installation of watercourse crossing for access tracks, and the construction of the Olney switching station.

A summary of the impacts to riparian corridors are provided in Table 6.9.

Table 6.9 Summary of residual impacts to riparian corridors

Construction activity	Residual impact to watercourses and riparian corridors		
	Low sensitivity receiving environment	Moderate sensitivity receiving environment	High sensitivity receiving environment
HTP corridor and transmission line upgrades and adjustments	Low	Moderate	Moderate
Access tracks	Low	Low	Moderate
Ancillary works	Low	Low	Low
Construction support sites, switching stations and substation upgrades	Low	Low	Moderate

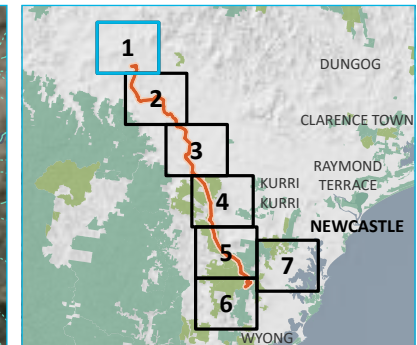
Impacts to riparian corridors are highest in the State forests where there is a greater presence of vegetation and disturbance activities are located in or upstream of sensitive biodiversity areas. The removal of vegetation from riparian corridors can affect bed and bank stability of watercourses, alter the suitability of habitats for terrestrial and aquatic species and alter the conveyance functionality and geomorphic form of watercourses. The construction of watercourse crossings, as well as vegetation clearing, would also impact riparian corridors.

The clearing and earthworks associated with construction of the Olney switching station would occur across the riparian corridors of 2 minor watercourses upstream of sensitive receiving environments. Detailed design and construction activities will include mitigation and management measures tailored to the local conditions and consideration of the receiving environment..

The impacts to riparian corridors are substantially lower in low lying areas of the Hunter Valley where vegetation clearing is extensive and the receiving environment is highly modified as a result of land clearing, coal mining, and energy generation

The implementation of the mitigation and management measures in *Chapter 8 (Management)* are key to managing key risks to the project and substantially reducing impacts to riparian corridors.

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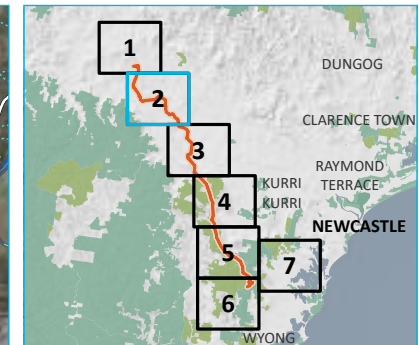


- KEY**
- Indicative riparian zone
 - Project impact area
 - HTP corridor
 - Bayswater South switching station
 - Construction support site
 - Adjustment to existing transmission line (lines 31 and 32)
 - Upgrades to existing transmission line (lines 5A3 and 5A4)
 - Access track
- Strahler stream order**
- 1st order
 - 2nd order
 - 3rd order
 - 4th order
 - 5th order
 - 9th order
- Existing environment**
- Major road
 - Named waterbody
 - State forest

Project interactions with indicative riparian zones
Map 1 of 7

Hunter Transmission Project
Surface Water Assessment
Figure 6.1

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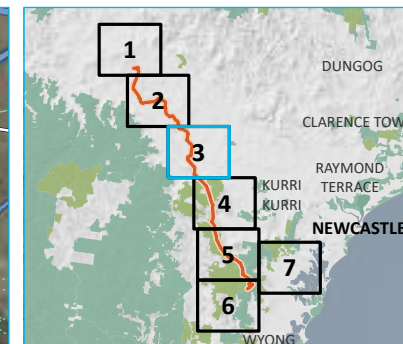


- KEY
- Indicative riparian zone
 - Project impact area
 - HTP corridor
 - Construction support site
 - Laydown area
 - Access track
- Strahler stream order
- 1st order
 - 2nd order
 - 3rd order
 - 4th order
 - 5th order
 - 6th order
 - 7th order
 - 8th order
 - 9th order
- Existing environment
- Major road
 - Named waterbody
 - NPWS reserve

Project interactions with
indicative riparian zones
Map 2 of 7

Hunter Transmission Project
Surface Water Assessment
Figure 6.1

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- KEY
- Indicative riparian zone
 - Project impact area
 - HTP corridor
 - Adjustment to existing transmission line (line 81)
 - Access track
- Strahler stream order
- 1st order
 - 2nd order
 - 3rd order
 - 4th order
 - 5th order
 - 6th order
 - 8th order
 - 9th order
- Existing environment
- Major road
 - Named waterbody
 - NPWS reserve
 - State forest

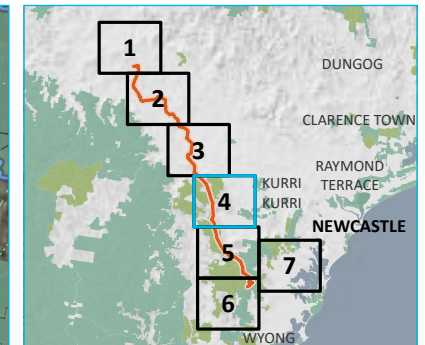
Project interactions with
indicative riparian zones
Map 3 of 7

Hunter Transmission Project
Surface Water Assessment
Figure 6.1

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Source: EMM (2025); DCSSS (2023); ESRI (2025); GA (2009), BoM (2020, 2022); DPI (2013)

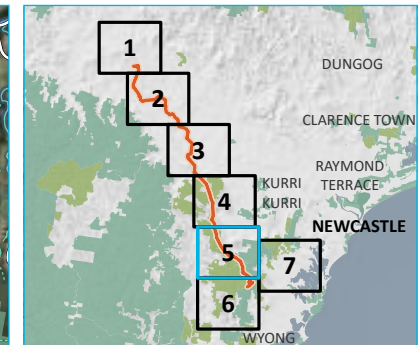
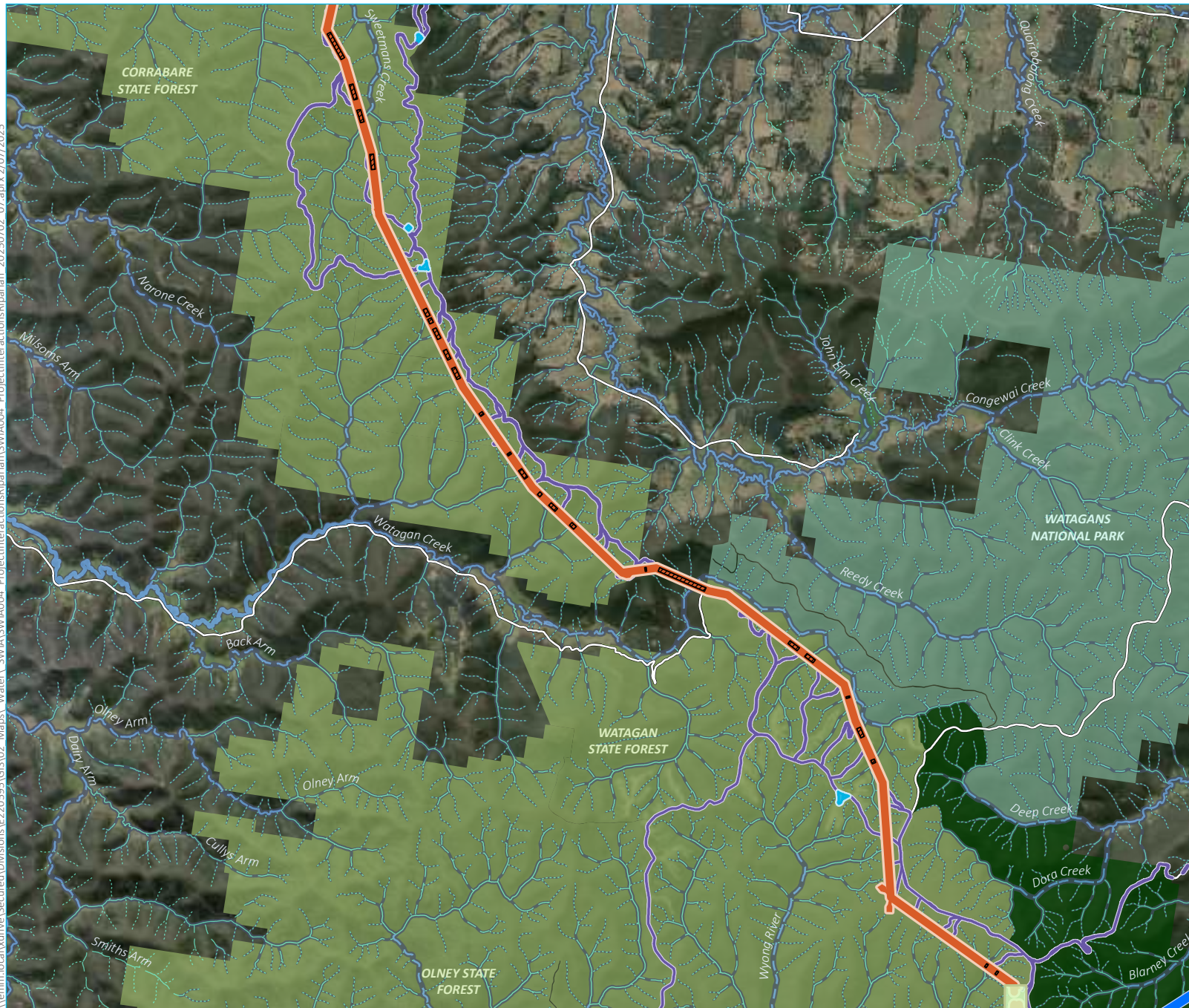


- KEY**
- Indicative riparian zone
 - No clearing zone
 - Project impact area
 - HTP corridor
 - Construction support site
 - Laydown area
 - Access track
- Strahler stream order**
- 1st order
 - 2nd order
 - 3rd order
 - 4th order
 - 5th order
 - 6th order
 - 7th order
- Existing environment**
- Major road
 - Named waterbody
 - NPWS reserve
 - State conservation area
 - State forest

Project interactions with
indicative riparian zones
Map 4 of 7

Hunter Transmission Project
Surface Water Assessment
Figure 6.1

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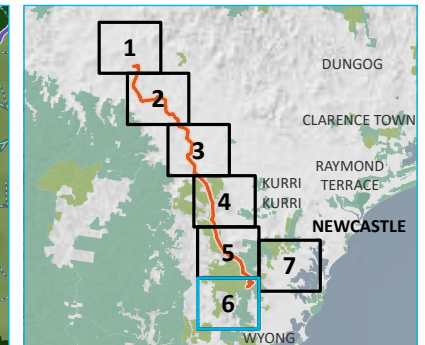
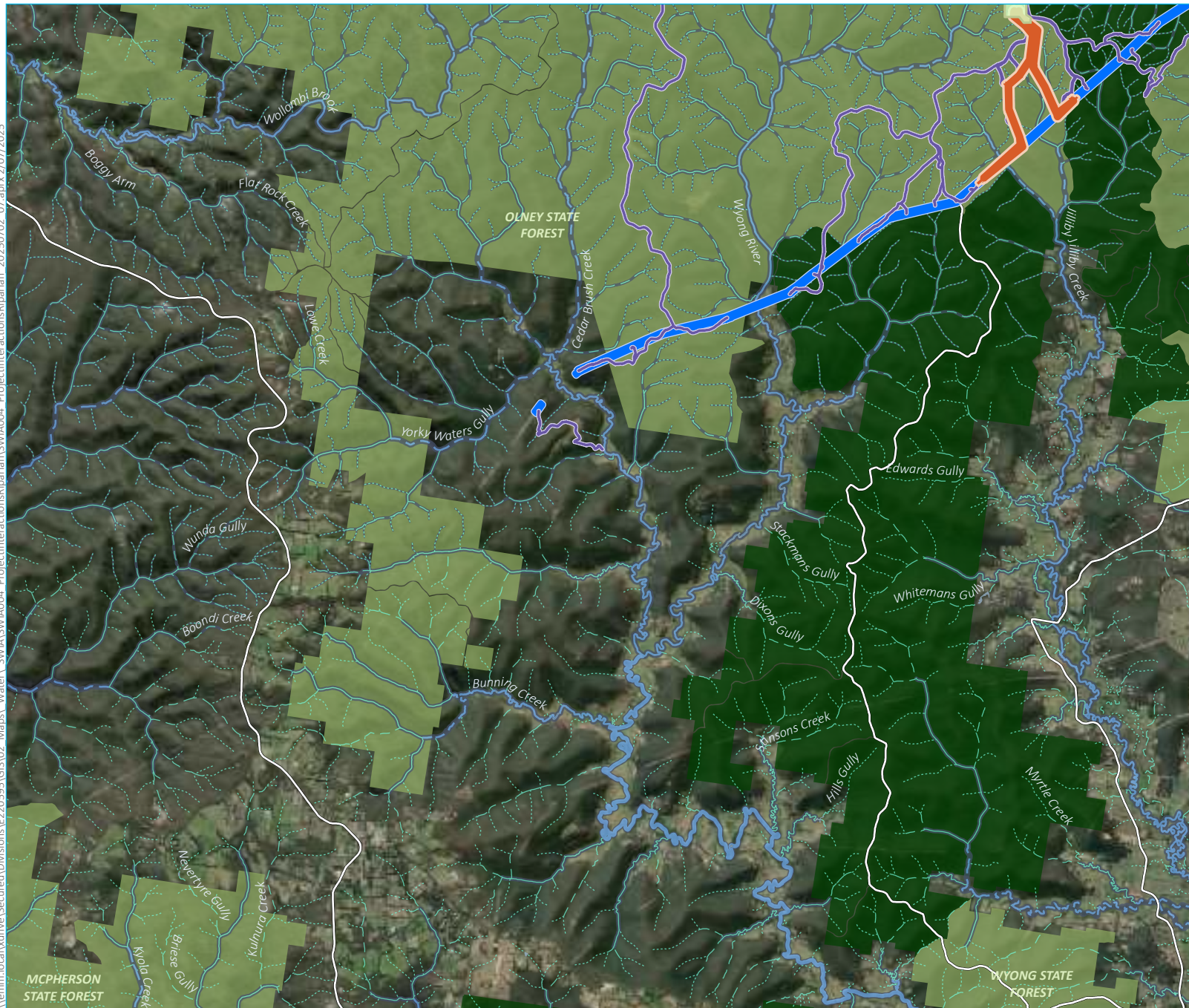


- KEY**
- Indicative riparian zone
 - No clearing zone
 - Project impact area
 - HTP corridor
 - Olney switching station
 - Laydown area
 - Upgrades to existing transmission line (lines 5A1 and 5A2)
 - Access track
- Strahler stream order**
- 1st order
 - 2nd order
 - 3rd order
 - 4th order
 - 5th order
 - 6th order
- Existing environment**
- Major road
 - Named waterbody
 - NPWS reserve
 - State conservation area
 - State forest

Project interactions with
indicative riparian zones
Map 5 of 7

Hunter Transmission Project
Surface Water Assessment
Figure 6.1

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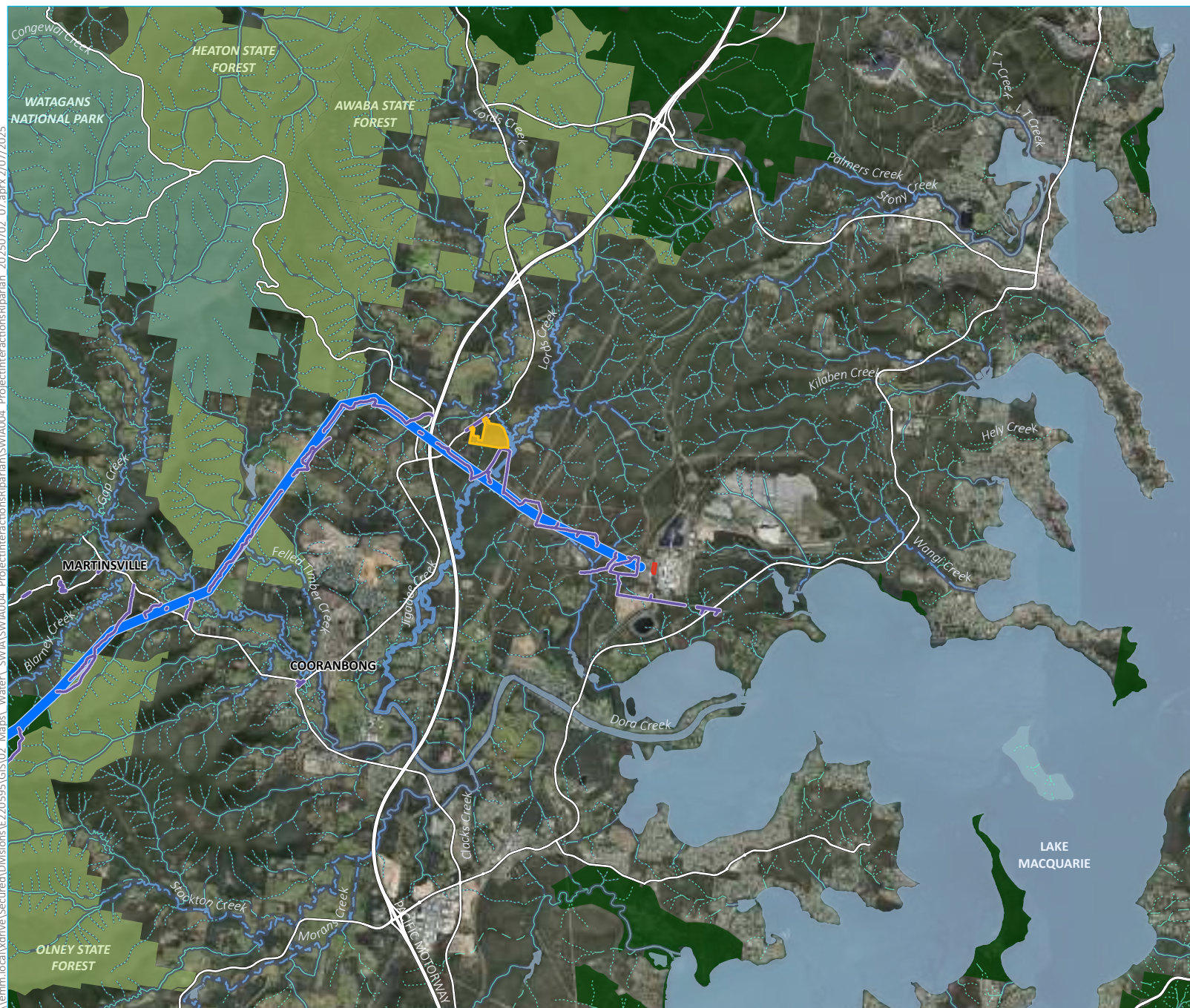


- KEY
- Indicative riparian zone
 - Project impact area
 - HTP corridor
 - Olney switching station
 - Upgrades to existing transmission line (lines 5A1 and 5A2)
 - Access track
- Strahler stream order
- 1st order
 - 2nd order
 - 3rd order
 - 4th order
 - 5th order
 - 6th order
- Existing environment
- Major road
 - Named waterbody
 - State conservation area
 - State forest

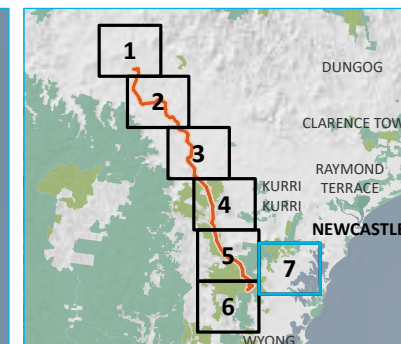
Project interactions with
indicative riparian zones
Map 6 of 7

Hunter Transmission Project
Surface Water Assessment
Figure 6.1

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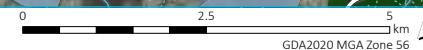
Source: EMM (2025); DCSSS (2023); ESRI (2025); GA (2009), BoM (2020, 2022); DPI (2013)



- KEY**
- Indicative riparian zone
 - Project impact area
 - Construction support site
 - Eraring Substation upgrade
 - Upgrades to existing transmission line (lines 5A1 and 5A2)
 - Access track
- Strahler stream order**
- 1st order
 - 2nd order
 - 3rd order
 - 4th order
 - 5th order
 - 6th order
- Existing environment**
- Major road
 - Named waterbody
 - NPWS reserve
 - State conservation area
 - State forest

Project interactions with indicative riparian zones
Map 7 of 7

Hunter Transmission Project
Surface Water Assessment
Figure 6.1



7 Assessment of potential operational impacts

7.1 Overview of operational activities

Regular maintenance activities would be required for the transmission line during operation. Likely maintenance activities would include:

- managing vegetation in and around the transmission line easement to protect the transmission line from hazard trees and bushfire
- regularly inspecting the transmission line and towers (via ground and air)
- undertaking fault and emergency response (unplanned maintenance) should an unplanned outage occur (for example through a weather event or other failure of infrastructure)
- fixing, replacing or upgrading components of the transmission line to extend its life.

At the completion of construction, appropriate measures would be carried into the Network Operator's environmental management strategy (EMS).

The key principles for stormwater management described above for construction would also apply to operations.

At the end of the construction phase, the Hunter Transmission Project (HTP, the project) impact area would be reduced to the operational impact area. Construction areas no longer required to support the construction phase would be rehabilitated. A principal aim of site rehabilitation would be to stabilise disturbed areas and minimise the potential for ongoing soil erosion and subsequent mobilisation/transport of sediment downstream of each site. Recommended rehabilitation principles and approaches are described in the soils and land assessment (*Technical Report 9 – Soils and land impact assessment*).

7.2 Water quality

Surface water quality impacts have the potential to occur during operation of the project. Most impacts would relate to ongoing maintenance activities within the transmission line easement, and at transmission line structures and access tracks. These impacts may include:

- soil erosion and sedimentation from vegetation removal, maintenance activities and operation of permanent access tracks
- accidental spills of chemicals, fuels and heavy metal from refuelling and operation of equipment and vehicles
- gross pollutants such as paper and plastic packaging brought by maintenance and operational crew that are not properly disposed of
- an increase in stormwater runoff from impervious areas, carrying additional nutrients and chemicals to watercourses.

The types of risks to water quality during operations would be similar to the construction phase but with substantially lower risk due to:

- significantly less earthworks which cause ground disturbance (limited to maintenance activities only)
- reduced risk for ground disturbance during vegetation maintenance, as potentially large vegetation would have already been removed during construction

- significantly less activities in watercourses, as watercourse crossings would already be installed
- significantly less need for potentially contaminating activities such as concrete batching (if any) and hazardous material handling
- no surface water extractions
- no anticipated excavations that would intercept groundwater.

Similar to construction, the potential magnitude of impact, sensitivity of receiving environment and mitigated risk to surface water quality would vary across the project impact area. Impacts to water quality during operation would be dependent on the location and nature of the work being undertaken.

Vegetation removal as part of maintenance of the transmission line easement has the potential for erosion and sedimentation impacts on water quality. The magnitude of impact is considered low due to the likelihood that groundcover would be maintained as much as practicable and soils would not be exposed for most maintenance requirements. The significance of potential impacts would depend on location and the sensitivity of the receiving environment.

Other water quality impacts (related to spills of fuels and chemicals and other pollutants) from the maintenance of transmission line structures and permanent access tracks, and the operation of switching stations are likely to be minor, localised, and temporary. However, as the sensitivity of the receiving environment is dependent on proximity to watercourses and soil erosion risk, the potential significance of these impacts would also be considered low to moderate depending on location.

Due to the infrequent nature of maintenance works and the installation of any required permanent stormwater management infrastructure, there would be no anticipated impact on achieving the water quality objectives (WQOs) during operations.

Potential water quality impacts would be managed through the Network Operator's EMS, as detailed in *Chapter 24 (Environmental management)* of the environmental impact statement (EIS).

7.3 Streamflow regime

Impacts to streamflow regime during the project operations would be associated with the location and nature of permanent infrastructure. Project components that may potentially impact streamflow (compared to existing conditions) during operations include:

- watercourse crossings, if not constructed at bed level, can have the effect of detaining flows upstream. This has the impact of restricting flows to the downstream watercourse, particularly during low flows
- permanent hardstand areas, resulting in increased runoff compared to existing conditions
- permanent infrastructure located in the riparian corridor or watercourse.

Impacts to streamflow regime during operations will be minimised through implementation of the mitigation measures provided in *Chapter 8 (Management)*, during construction. Additional impacts to streamflow regime are not anticipated during operations.

Flood-related impacts from the project during operations are assessed in the flood impact assessment (*Technical Report 12 – Flooding impact assessment*).

7.4 Watercourses and riparian corridors

The operation of the project does not require additional infrastructure in watercourses or riparian corridors. Works in watercourses and riparian corridors during operations would be limited to:

- managing vegetation in and around the transmission line easement
- maintenance of access tracks, particularly drainage conveyance structures, as necessary.

Impacts to watercourses and riparian corridors would be minor during operation of the project. Large areas of vegetation in riparian corridors would have been removed during construction. Vegetation management during operation would have minimal impacts on the watercourses or riparian corridors.

8 Management

8.1 Environmental management

The objectives of environmental management are to avoid and minimise impacts to surface water from the Hunter Transmission Project (HTP, the project). The environmental management practices developed for the project focus on potential impacts to water quality, streamflow regime, and watercourses and riparian corridors.

Potential impacts to surface water will be minimised through design principles that are tailored to local conditions and the sensitivity of the receiving environment. Impacts to surface water quality will be minimised through the application of mitigation and management measures that will be incorporated into the detailed design, construction soil and water management plan (SWMP) and the Network Operator's environmental management strategy (EMS) for the project.

Key environmental management principles incorporated into the project to minimise potential impacts to surface water quality include:

- the separation of runoff from undisturbed areas (clean runoff) and disturbed/potentially contaminated areas (dirty/contaminated runoff)
- the containment and reuse (where possible) of dirty/contaminated water
- implementation of erosion and sediment control plans (ESCPs), to minimise and appropriately manage the generation of sediment laden runoff in disturbance areas
- vegetation clearance practices that stabilise ground disturbance as soon as practical
- management of groundwater inflows and contaminated water that is commensurate with water quality risks.

Key environmental management principles incorporated into the project to minimise potential impacts to streamflow regime include:

- design features that minimise impact on flow conditions and the natural function of watercourses, where feasible and reasonable
- grading of earthworks to minimise changes to existing catchments and flow paths.

Key environmental management principles incorporated into the project to minimise potential impacts to watercourses and riparian corridors include:

- siting of proposed infrastructure which will minimise (and avoid where possible) disturbance to existing drainage lines, riparian vegetation and overland flow paths
- provision of scour protection for infrastructure within a watercourse
- provision of scour protection in watercourses that receive increased or concentrated runoff
- vegetation clearance practices that are specific to riparian areas that maximise stabilisation of watercourses bed and banks and prevent mulch, tannins and sediment from entering watercourses.

These surface water protection principles will be integrated throughout the ongoing design refinement process, the SWMP and other relevant environmental management sub plans and operational EMS as described in *Section 8.1.1*.

8.1.1 Soil and water management plan

Environmental management for the project will be carried out in accordance with the approach as detailed in *Chapter 24 (Environmental Management)* of the EIS.

A project specific SWMP will be developed as a sub-plan to the construction-phase EMS. It will provide mitigation measures to minimise impacts on soils and water. The SWMP will identify foreseeable risks relating to soil erosion and water pollution during construction and describe how these risks will be managed. It will include a description of soil and water management approaches, methods for impact assessment and monitoring, and mitigation measures. At the completion of construction, relevant measures will be carried into the Network Operator's EMS.

The SWMP will include ESCPs, a water quality monitoring program and stormwater management plan (SMP), as described below.

i Erosion and sediment control plans

ESCPs would be prepared by the construction contractors and focus on managing potential erosion and sedimentation impacts. ESCPs will be developed and implemented in consultation with a Certified Professional in erosion and sediment control. ESCPs will include additional considerations for areas of high risk (e.g. high slopes) and located upstream of sensitive biodiversity areas (i.e. frog breeding habitats in State forest areas). The plans will detail the processes, responsibilities and measures to manage potential soil and water quality impacts in accordance with the principles and requirements in:

- *Managing Urban Stormwater – Soils and Construction, Volume 1* (Landcom, 2004), and Volumes 2A (DEC, 2008b) and 2C (DECC, 2008a), commonly referred to as the 'Blue Book'
- *Best Practice Erosion and Sediment Control* (IECA, 2008)
- Guidelines for controlled activities (Riparian corridors (DPE, 2022c) and Watercourse crossings (DPE, 2022b)).

The soils and land assessment (*Technical Report 9– Soils and land impact assessment*) contains specific recommendations and proposed management measures for erosion and sediment controls that will be incorporated into the SWMP.

ii Water quality monitoring plan

The water quality monitoring plan (WQMP) will be prepared to describe the monitoring to be conducted during certain construction activities to facilitate a response to a potential water quality impact event. The WQMP objectives and guideline values will be specific to the major catchments and consider relevant legislation and include surface water monitoring depending on the construction activity. The WQMP will include frequency, location and duration of sampling, including:

- monitoring locations positioned upstream and downstream of project disturbance areas, focusing on locations with sensitive receiving environments. Where upstream and downstream monitoring is not possible, pre-construction baseline monitoring will be implemented to establish water quality conditions against which to assess potential impacts of construction activities
- establishing water quality criteria for the project, in accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000).

Monitoring is proposed to target receiving watercourses with relatively higher sensitivity, to identify potential impacts to biodiversity, such as threatened frog breeding habitat, that may be vulnerable to changes in water quality. In the event of an exceedance of the project water quality criteria, soil and water management measures will be reviewed and revised accordingly.

iii Stormwater management plan

The SMP will include stormwater management principles for:

- access tracks, such as diversion drains, roadside swales, drainage berms, check dams and grading of roads to ensure efficient runoff from the road surface
- ancillary areas (including construction support sites, substations, switching stations, transmission tower pads, laydown areas and stringing sites), such as appropriate siting of infrastructure, grading to earthworks to minimise changes to flow paths and diversion of upslope runoff to receiving drainage lines
- concrete batching plants (mobile and temporary), such as the separation of clean and potentially contaminated runoff, the collection of first flush runoff from cementitious areas and offsite disposal of water not suitable for reuse
- excavations, such as bunding around excavations to prevent runoff into excavations
- spoil and bulk earthworks.

8.2 Mitigation measures

Mitigation measures to avoid or minimise potential impacts to surface water during construction and operation of the project are listed in Table 8.1. These measures will be included in the issue-specific environmental management plans for the project.

Mitigation measures in other technical papers that are relevant to the management of surface water include:

- Soils and land assessment (*Technical Report 9 - Soils and land impact assessment*): provides specific measures for effective erosion and sediment control for the project
- Flood impact assessment (*Technical Report 12 – Flooding impact assessment*): provides specific measures to minimise the impacts of the project on flooding and hydraulic regime
- Biodiversity development assessment report (*Technical Report 1– Biodiversity development assessment report*): measures to manage activities in vegetated riparian zones and minimise impacts to aquatic environments
- Groundwater impact assessment (*Technical Report 11– Groundwater impact assessment*): measures to ensure incidental water take during construction is in accordance with regulatory conditions
- Contamination preliminary site investigation (*Technical Report 13– Contamination preliminary site investigation*): measures relating to the storage of fuel and oil within the construction disturbance area and accidental disturbance of contaminated material.

Table 8.1 **Proposed mitigation measures – surface water**

ID	Project element	Management and mitigation measures	Timing	Relevant location(s)
SW1	Impacts to surface water	A project specific SWMP will be prepared, which provides mitigation measures to minimise impacts on soils and water. The SWMP will be prepared in accordance with <i>Chapter 8 (Management) of Technical Report 10 (Surface water impact assessment)</i> and will: • Identify foreseeable risks relating to soil erosion and water pollution during construction and describe how these risks will be managed • Include a description of soil and water management approaches, methods for impact assessment and monitoring, and mitigation measures • Include ESCPs • Include surface water quality monitoring requirements • Include SMPs. At the completion of construction, appropriate measures will be carried into the Network Operator's EMS.	Detailed design and construction	All locations
SW2	Water quality and geomorphology	Scour protection will be considered for any infrastructure within a watercourse. Design will incorporate features that minimise impact on flow conditions and natural function of the watercourse, where feasible and reasonable. Works within or near watercourses will consider and adhere to the following guidelines: • <i>Controlled activities - Guidelines for watercourse crossings on waterfront land</i> (DPE 2022a) • <i>Controlled activities - Guidelines for instream works on waterfront land</i> (DPE 2022c) • <i>Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings</i> (DPI 2003) • <i>Policy and Guidelines for Fish Habitat Conservation and Management</i> (DPI 2013).	Detailed design and construction	All locations
SW3	Erosion and sedimentation	ESCPs will be developed, prior to construction, and implemented in consultation with a Certified Professional in erosion and sediment control for all disturbance activities. ESCPs will include additional considerations for areas of high risk (e.g. high slopes) and located upstream of sensitive biodiversity areas (i.e. State forest areas) including at Olney switching station. The plans will detail the processes, responsibilities and measures to manage potential soil and water quality impacts in accordance with the principles and requirements in: • <i>Managing Urban Stormwater – Soils and Construction, Volume 1</i> (Landcom 2004), <i>Volume 2A</i> (DECC 2008a) and <i>2C</i> (DECC 2008b), commonly referred to as the 'Blue Book' • <i>Best Practice Erosion and Sediment Control</i> (IECA 2008) • <i>Guidelines for controlled activities</i> (Riparian corridors (DPE Water 2022a) and Watercourse crossings (DPE Water 2022b)	Detailed design and construction	All locations

ID	Project element	Management and mitigation measures	Timing	Relevant location(s)
SW4	Water quality monitoring	As part of a SWMP, a water quality monitoring program will be prepared and implemented to establish baseline water quality conditions in watercourses of high sensitivity that may be impacted by nearby construction and to detect changes in water quality that may be attributable to the project during construction. The frequency, location and duration of sampling will be detailed in a monitoring program. Monitoring will: • Be positioned upstream and downstream of project disturbance areas, focusing on locations with sensitive receiving environments. Where upstream and downstream monitoring is not possible, pre-construction water quality conditions will be established through baseline monitoring • Be carried out in accordance with water quality objectives and criteria for the project and in accordance with Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)	Detailed design and construction	All locations
SW5	Stormwater management – general	General stormwater management principles within the project impact area will include: • Appropriate siting of proposed infrastructure within the project impact area, which will minimise (and avoid where possible) disturbance to existing drainage lines, riparian vegetation and overland flow paths • Grading of earthworks to minimise changes to existing catchments and flow paths • Surface drainage infrastructure that diverts upslope runoff around infrastructure and excavations to receiving drainage lines • Infrastructure areas that contain oil and/or grease will include suitable containment measures • Scour protection will be considered downstream of areas that increase runoff into receiving watercourses • Consideration of appropriate water quality and stormwater controls (for ancillary areas) upstream of sensitive receiving environments, such as at Olney switching station.	Detailed design and construction	All locations
SW6	Stormwater management – concrete batching plants	Stormwater management measures for concrete batching plants (both mobile and temporary) will include: • The separation of clean and potentially contaminated runoff by a bunded cementitious areas • The collection of first flush runoff from cementitious areas • Offsite disposal of contaminated water not suitable for reuse to a licenced waste facility	Detailed design and construction	All locations
SW7	Stormwater management – excavations	Stormwater management measures for excavations (particularly for transmission towers) will include bunding around excavations to prevent runoff into excavations.	Detailed design and construction	Excavations
SW8	Stormwater management – spoil	Runoff from spoil piles, topsoil stockpiles and other excavated material will be managed through: • Minimising the number of stockpiles, stockpile areas and the time they are exposed • Locating stockpiles away from drainage lines and natural watercourses and from where they will be susceptible to erosion • Bunding stockpiles in accordance with Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition (Landcom 2004) • Stabilising stockpiles, establishing sediment controls and suppressing dust as required	Detailed design and construction	All locations

ID	Project element	Management and mitigation measures	Timing	Relevant location(s)
SW9	Water supply	Water supply management will be undertaken in accordance with agreements between the construction contractors, relevant landowners and relevant water users and suppliers. Groundwater and surface water allocations purchased from existing registered bores/users must be extracted in accordance with the conditions stated in the associated water access license(s) and water supply works approval(s).	Prior to and during construction	Water extraction locations
SW10	Dewatering	In the event that dewatering is required: - The management of discharge water will be documented in the SWMP and will consider options for containment, reuse, application to grassed areas and transport to licensed waste facilities In the event that discharge water is discharged to grassed areas: - Application will be limited to grassed areas within the project impact area, away from watercourses. If the discharge water is highly turbid, dewatering through a filter sock (or similar) or via transportable sedimentation tanks will be considered, where appropriate, to minimise sedimentation	Detailed design and construction	Excavations
SW11	Construction impact area – clearance (general)	Clearance practices will include: - Immediate laying of mulch where ground disturbance has occurred (except in riparian corridors) - Stabilisation of mulch where mobilisation by wind or runoff is possible - Management of mulching activities and stockpiles to minimise tannin production and avoid discharge to watercourses - Ground stabilisation using felled vegetation placed across the slope to minimise the concentration of flows, especially upstream of riparian corridors	Construction	All locations
SW12	Construction impact area – clearance (riparian buffer areas)	Riparian buffer areas include 5 m from the top of bank of any mapped or unmapped watercourse. Clearance practices in riparian buffer areas will include: - Hand clearing methods that minimise ground disturbance and disturbance of the understorey - No placement of mulch (and measures to avoid the transport of mulch into watercourses) - Stabilisation of the watercourse bed and banks will be installed as soon as practical, where disturbance to the understorey or ground has occurred - Where vegetation clearance is oblique or parallel to the watercourse (i.e. not perpendicular), stabilisation works with minimal impact will be designed prior to disturbance and installed as soon as practical	Construction	Riparian corridors
-	Hazardous chemicals	Store chemicals, fuels and other hazardous substances in accordance with Mitigation Measure DG1, DG2, DG3 and DG4 in <i>Appendix E (Proposed mitigation measures)</i> of the EIS.	Construction Operation	All locations

9 Conclusion

This surface water assessment (SWA) assesses the potential impacts to surface water from the construction and operation of the Hunter Transmission Project (HTP, the project).

The impacts have been assessed in accordance with the Secretary's environmental assessment requirements (SEARs) and against the relevant legislation, policy and guidelines as they apply to surface water management in NSW. Impacts to surface water have been considered and minimised through the project design and would be a key consideration throughout project construction and operational management. Potential impacts to surface water as a result of construction and operation were assessed and included consideration of potential impacts to water quality, streamflow regime, watercourses and riparian corridors.

Risks to surface water environments are higher in the State forests where the topography is steep, there is a greater presence of vegetation and disturbance activities are located upstream of sensitive biodiversity areas. Risks to surface water environments are substantially lower in areas of the Hunter Valley of low to moderate grades where the receiving environment is highly modified as a result of land clearing, coal mining, and energy generation.

With the implementation of mitigation measures, predicted impacts to water quality, watercourses and riparian corridors are considered low to moderate, depending on the sensitivity of the receiving environment. Predicted impacts to streamflow regime are localised and largely associated with stormwater control measures.

An assessment of the impacts of the project on surface water resources of the study area, anticipates the project will maintain the existing status of *NSW Water Quality Objectives and River Flow Objectives* (DECCW 2006).

It is estimated that a total of around 1580 megalitres of water would be required for the construction of the HTP, including 170 megalitres of potable water and 1410 megalitres of non-potable water. A combination of water sources would be required to meet water demand for the project. The project will prioritise accessing water from existing water sources such as recycled water, project related water management infrastructure and consider fit-for-purpose wastewater from nearby industries, such as mining. Where alternative water sources are not suitable, water may be sourced from environmental sources including surface water and groundwater sources, of which there are sufficient water entitlements available in the water trading market to meet demand for the project.

The implementation of the mitigation and management measures in *Chapter 8 (Management)* are key to managing surface water risks and substantially lower impacts to surface water quality, streamflow regime, watercourses and riparian corridors. A soil and water management plan (SWMP) will be developed for the project, outlining site specific surface water measures implemented to prevent potential negative impacts to water resources during the construction and operational phases. This will document erosion and sediment control practices and stormwater management controls to minimise impacts to the receiving surface water environment as well as a water quality monitoring plan to further define baseline water quality of receiving watercourses.

Separate technical reports address other surface water related matters including:

- Flood impact assessment (*Technical Report 12– Flooding impact assessment*) which considers the potential impact of the project on flooding and hydraulics and the impact of flooding on the project. The assessment of instream structures on flooding and hydraulics is included in the flooding assessment
- Soils and land impact assessment (*Technical Report 9 – Soils and land impact assessment*) which documents the potential impacts of the project on soils and land capability of the project impact area and surrounds, including the provision of erosion and sedimentation control measures
- Contamination preliminary site investigation (*Technical Report 13 – Contamination preliminary site investigation*) which documents the potential impacts of contamination during the construction and operation of the project

- Groundwater impact assessment (*Technical Report 11 - Groundwater impact assessment*) which documents the potential impacts on groundwater aquifers and groundwater dependent ecosystems and includes the consideration of groundwater supply for the project demands
- Biodiversity development assessment report (*Technical Report 1 – Biodiversity development assessment report*) which details the potential impact of the project on biodiversity
- Aquatic biodiversity impact assessment (*Appendix L of Technical Report 1 - Biodiversity development assessment report*) which details the potential impact of the project on aquatic species.

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Appendix A

Water quality monitoring program

A.1 Summary of water quality monitoring program

Table A.1 Water quality monitoring program

Monitoring round	Date	Sites monitored ¹	Analytes
Round 1	22 & 23 April 2024	Hunter River (SW1) Hunter River (SW2) Bowmans Creek (SW3) Glennies Creek (SW4) Wollombi Brook (SW5) Hunter River (SW6) Loder Creek (SW7) Monkey Place Creek (SW9) Cedar Creek (SW10) Congewai Creek (SW11) Sweetmans Creek (SW12) Dora Creek (SW14)	- General (pH, EC, hardness (as CaCO₃), TSS, TDS, turbidity, DO) - Filtered metals (Al, As, B, Cd, Cr, Cu, Fe, Pb, Mn, Ni, Zn) - Nutrients (ammonia as N, nitrite and nitrate as N, TKN, nitrite as N, nitrate as N, nitrogen (total), phosphate (total P)) - Oil and grease
Round 2	10 & 11 September 2024	Hunter River (SW1)	General (pH, EC, hardness (as CaCO₃), TSS, TDS, turbidity, DO, redox, TDS)
Round 3	4 & 5 December 2024	Hunter River (SW2a) Wollombi Brook (SW5a)	Inorganics (calcium, chloride, fluoride, bromide, silicon, SAR, DO, sodium, magnesium, potassium, anions, cations)
Round 4	4 & 5 February 2025	Loder Creek (SW7) Peach Tree Creek (SW8a) Monkey Place Creek (SW9) Monkey Place Creek (SW9a) Cedar Creek (SW10) Congewai Creek (SW11) Sweetmans Creek (SW12) Watagan Creek (SW13a) Watagan Creek (SW13b) Watagan Creek (SW13c) Blarney Creek (SW14a) Jigadee Creek (SW15a)	- Total and filtered metals (Al, As, Ba, Be, Cd, Mo, Co, Sr, Cr, Cu, Fe, Pb, Hg, Se, Mn, Ni, V, Zn) - Nutrients (ammonia as N, nitrite and nitrate as N, TKN, nitrite as N, nitrate as N, nitrogen (total), phosphate (total P), pH redox) - Oil and grease

1. Refer to Figure 3.2 for site locations.

A.2 Water quality monitoring data

Table A.2 Summary of water quality data

			SW1	SW1	SW1	SW1	SW2	SW2a	SW2a	SW2a
			22 Apr 2024	11 Sep 2024	05 Dec 2024	05 Feb 2025	22 Apr 2024	11 Sep 2024	05 Dec 2024	05 Feb 2025
	Unit	EQL								
Analytical results – general										
pH (Lab)	-	0.01	8.14	8.38	8.31	8.31	6.79	8.39	8.33	8.31
Electrical Conductivity (Lab)	µS/cm	1	1,060	1,030	1,210	902	1,070	1,040	1,210	884
Hardness as CaCO ₃ (filtered)	mg/L	1	342	332	370	330	337	333	393	304
TSS	mg/L	5	33	42	47	34	30	15	38	24
TDS	mg/L	10	608	-	-	-	640	-	-	-
Turbidity	NTU	0.1	23.1	16.6	27.1	25.7	18.4	9.8	24.0	20.4
Redox Potential (Lab)	mV	0.1	-	158	263	169	-	158	270	165
Total Dissolved Solids (Calc.)	mg/L	1	-	670	786	586	-	676	786	575
Analytical results – alkalinity										
Alkalinity (Bicarbonate as CaCO ₃)	mg/L	1	-	302	289	245	-	289	280	241
Alkalinity (Carbonate as CaCO ₃)	mg/L	1	-	<1	19	<1	-	13	21	<1
Alkalinity (Hydroxide) as CaCO ₃	mg/L	1	-	<1	<1	<1	-	<1	<1	<1
Alkalinity (total) as CaCO ₃	mg/L	1	-	302	308	245	-	302	302	241
Inorganics										
Calcium (filtered)	mg/L	1	-	57	59	63	-	56	65	56
Chloride	mg/L	1	-	174	210	155	-	172	214	153
Fluoride	mg/L	0.1	-	0.2	0.2	0.2	-	0.2	0.2	0.2
Bromide	µg/L	10	-	321	383	246	-	313	393	267
Silicon as SiO2	mg/L	0.1	-	11.2	10.6	14.0	-	11.5	10.9	14.1
Sodium Absorption Ratio (filtered)	-	0.01	-	1.91	2.31	1.99	-	1.93	2.41	2.09
Dissolved Oxygen	mg/L	0.1	9.4	10.2	10.8	9.3	9.0	9.7	10.8	9.3
Sodium (filtered)	mg/L	1	-	80	102	83	-	81	110	84
Magnesium (filtered)	mg/L	1	-	46	54	42	-	47	56	40
Potassium (filtered)	mg/L	1	-	3	4	4	-	3	4	4
Anions Total	meq/L	0.01	-	12.0	13.0	10.2	-	12.0	13.0	10.0
Ionic Balance	%	0.01	-	8.36	4.28	0.73	-	7.93	0.96	0.82
Cations Total	meq/L	0.01	-	10.2	11.9	10.3	-	10.3	12.7	9.84
Sulfate as SO ₄ - Turbidimetric (filtered)	mg/L	1	-	53	44	43	-	55	44	42
Metals										
Aluminium	mg/L	0.01	-	0.39	1.66	<0.01	-	0.61	1.05	<0.01
Aluminium (filtered)	mg/L	0.01	0.01	<0.01	0.12	<0.01	0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	0.001
Arsenic (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Barium	mg/L	0.001	-	0.034	0.045	0.036	-	0.032	0.043	0.034
Barium (filtered)	mg/L	0.001	-	0.027	0.034	0.030	-	0.027	0.036	0.023
Beryllium	mg/L	0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Beryllium (filtered)	mg/L	0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Boron	mg/L	0.05	-	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05
Boron (filtered)	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	mg/L	0.0001	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001
Cadmium (filtered)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Molybdenum (filtered)	mg/L	0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	0.001
Chromium (III+VI)	mg/L	0.001	-	<0.001	0.003	0.002	-	<0.001	0.002	0.002
Chromium (III+VI) (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	-	<0.001	0.001	<0.001	-	<0.001	<0.001	<0.001
Cobalt (filtered)	mg/L	0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Copper	mg/L	0.001	-	0.016	0.002	0.004	-	0.001	0.004	0.004
Copper (filtered)	mg/L	0.001	0.002	0.002	0.003	<0.001	0.002	0.002	<0.001	<0.001
Strontium	mg/L	0.001	-	0.539	0.601	0.512	-	0.520	0.609	0.493
Strontium (filtered)	mg/L	0.001	-	0.482	0.525	0.487	-	0.478	0.577	0.465
Iron	mg/L	0.05	-	0.65	1.53	<0.05	-	0.69	1.22	<0.05
Iron (filtered)	mg/L	0.05	<0.05	<0.05	0.12	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	mg/L	0.001	-	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Lead (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	-	0.082	0.129	0.006	-	0.058	0.104	0.004
Manganese (filtered)	mg/L	0.001	0.010	0.015	0.040	0.006	0.013	0.011	0.003	<0.001
Mercury	mg/L	0.0001	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001
Mercury (filtered)	mg/L	0.0001	-	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001
Nickel	mg/L	0.001	-	0.002	0.004	0.005	-	0.002	0.003	0.004
Nickel (filtered)	mg/L	0.001	<0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	0.001
Selenium	mg/L	0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Selenium (filtered)	mg/L	0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Vanadium	mg/L	0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Vanadium (filtered)	mg/L	0.01	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	-	<0.005	0.006	0.007	-	<0.005	<0.005	0.006
Zinc (filtered)	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Analytical results – nutrients										
Ammonia as N	mg/L	0.01	0.01	0.02	0.01	0.02	<0.01	0.02	0.01	0.04
Nitrite + Nitrate as N	mg/L	0.01	0.31	0.28	<0.01	<0.01	0.36	0.28	0.02	0.02
Kjeldahl Nitrogen Total	mg/L	0.1	0.4	0.5	0.7	0.3	0.4	0.3	0.6	0.3
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (as N)	mg/L	0.01	0.31	0.28	<0.01	<0.01	0.36	0.28	0.02	0.02
Nitrogen (Total)	mg/L	0.1	0.7	0.8	0.7	0.3	0.8	0.6	0.6	0.3
NA										
Phosphate total (as P)	MG/L	0.01	0.06	0.13	0.18	0.08	0.06	0.11	0.14	0.08
Reactive Phosphorus as P	mg/L	0.01	0.04	0.04	0.03	-	0.04	0.04	0.04	-
Reactive Phosphorus as P (filtered)	mg/L	0.01	-	-	-	0.03	-	-	-	0.04
pH Redox	-	0.01	-	8.36	8.30	8.24	-	8.38	8.29	8.25
TPH										
Oil and Grease	mg/L	5	<5	<5	<5	<5	<5	<5	<5	<5

			SW3	SW4	SW5	SW5a	SW5a	SW5a	SW6	SW7
			22 Apr 2024	22 Apr 2024	22 Apr 2024	11 Sep 2024	05 Dec 2024	05 Feb 2025	23 Apr 2024	23 Apr 2024
	Unit	EQL								
Analytical results – general										
pH (Lab)	-	0.01	8.20	7.76	6.56	7.56	7.45	7.82	7.76	7.70
Electrical Conductivity (Lab)	µS/cm	1	2,520	437	608	636	803	1,000	725	4,710
Hardness as CaCO ₃ (filtered)	mg/L	1	320	98	81	109	110	158	182	759
TSS	mg/L	5	72	42	8	<5	57	<5	38	<5
TDS	mg/L	10	1,590	254	361	-	-	-	411	3,100
Turbidity	NTU	0.1	14.6	13.0	10.7	5.5	15.4	6.2	29.8	19.2
Redox Potential (Lab)	mV	0.1	-	-	-	135	297	161	-	-
Total Dissolved Solids (Calc.)	mg/L	1	-	-	-	413	522	650	-	-
Analytical results – alkalinity										
Alkalinity (Bicarbonate as CaCO ₃)	mg/L	1	-	-	-	76	100	118	-	-
Alkalinity (Carbonate as CaCO ₃)	mg/L	1	-	-	-	<1	<1	<1	-	-
Alkalinity (Hydroxide) as CaCO ₃	mg/L	1	-	-	-	<1	<1	<1	-	-
Alkalinity (total) as CaCO ₃	mg/L	1	-	-	-	76	100	118	-	-
Inorganics										
Calcium (filtered)	mg/L	1	-	-	-	14	16	22	-	-
Chloride	mg/L	1	-	-	-	158	185	284	-	-
Fluoride	mg/L	0.1	-	-	-	<0.1	0.1	0.2	-	-
Bromide	µg/L	10	-	-	-	329	320	459	-	-
Silicon as SiO ₂	mg/L	0.1	-	-	-	7.7	7.5	7.2	-	-
Sodium Absorption Ratio (filtered)	-	0.01	-	-	-	3.66	4.48	5.33	-	-
Dissolved Oxygen	mg/L	0.1	8.5	8.3	9.6	9.7	10.6	9.2	8.9	8.0
Sodium (filtered)	mg/L	1	-	-	-	88	108	154	-	-
Magnesium (filtered)	mg/L	1	-	-	-	18	17	25	-	-
Potassium (filtered)	mg/L	1	-	-	-	5	5	7	-	-
Anions Total	meq/L	0.01	-	-	-	6.35	7.49	11.0	-	-
Ionic Balance	%	0.01	-	-	-	1.72	3.20	4.57	-	-
Cations Total	meq/L	0.01	-	-	-	6.14	7.02	10.0	-	-
Sulfate as SO ₄ - Turbidimetric (filtered)	mg/L	1	-	-	-	18	13	30	-	-
Metals										
Aluminium	mg/L	0.01	-	-	-	0.04	1.85	0.04	-	-
Aluminium (filtered)	mg/L	0.01	<0.01	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	-	-	-	<0.001	0.002	<0.001	-	-
Arsenic (filtered)	mg/L	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.001	-	-	-	0.048	0.370	0.077	-	-
Barium (filtered)	mg/L	0.001	-	-	-	0.041	0.045	0.071	-	-
Beryllium	mg/L	0.001	-	-	-	<0.001	<0.001	<0.001	-	-
Beryllium (filtered)	mg/L	0.001	-	-	-	<0.001	<0.001	<0.001	-	-
Boron	mg/L	0.05	-	-	-	<0.05	<0.05	0.06	-	-
Boron (filtered)	mg/L	0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07
Cadmium	mg/L	0.0001	-	-	-	<0.0001	<0.0001	<0.0001	-	-
Cadmium (filtered)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	-	-	-	<0.001	<0.001	<0.001	-	-
Molybdenum (filtered)	mg/L	0.001	-	-	-	<0.001	<0.001	<0.001	-	-
Chromium (III+VI)	mg/L	0.001	-	-	-	<0.001	0.002	<0.001	-	-
Chromium (III+VI) (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	-	-	-	<0.001	0.012	<0.001	-	-
Cobalt (filtered)	mg/L	0.001	-	-	-	<0.001	<0.001	<0.001	-	-
Copper	mg/L	0.001	-	-	-	<0.001	0.002	<0.001	-	-
Copper (filtered)	mg/L	0.001	0.005	0.003	0.004	0.002	<0.001	0.002	0.003	0.004
Strontium	mg/L	0.001	-	-	-	0.177	0.290	0.321	-	-
Strontium (filtered)	mg/L	0.001	-	-	-	0.157	0.228	0.313	-	-
Iron	mg/L	0.05	-	-	-	1.07	18.1	0.48	-	-
Iron (filtered)	mg/L	0.05	0.12	<0.05	0.37	0.16	<0.05	<0.05	0.11	0.13
Lead	mg/L	0.001	-	-	-	<0.001	0.002	<0.001	-	-
Lead (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	-	-	-	0.292	11.7	0.155	-	-
Manganese (filtered)	mg/L	0.001	0.132	0.005	0.273	0.256	0.065	0.026	0.008	0.070
Mercury	mg/L	0.0001	-	-	-	<0.0001	<0.0001	<0.0001	-	-
Mercury (filtered)	mg/L	0.0001	-	-	-	<0.0001	<0.0001	<0.0001	-	-
Nickel	mg/L	0.001	-	-	-	<0.001	0.005	0.001	-	-
Nickel (filtered)	mg/L	0.001	0.003	<0.001	0.002	<0.001	<0.001	0.001	0.001	0.002
Selenium	mg/L	0.01	-	-	-	<0.01	<0.01	<0.01	-	-
Selenium (filtered)	mg/L	0.01	-	-	-	<0.01	<0.01	<0.01	-	-
Vanadium	mg/L	0.01	-	-	-	<0.01	<0.01	<0.01	-	-
Vanadium (filtered)	mg/L	0.01	-	-	-	<0.01	<0.01	<0.01	-	-
Zinc	mg/L	0.005	-	-	-	<0.005	0.017	<0.005	-	-
Zinc (filtered)	mg/L	0.005	0.009	<0.005	<0.005	0.006	<0.005	0.006	<0.005	<0.005
Analytical results – nutrients										
Ammonia as N	mg/L	0.01	<0.01	0.02	0.04	0.08	0.02	<0.01	0.02	0.04
Nitrite + Nitrate as N	mg/L	0.01	<0.01	0.05	0.26	0.09	0.06	<0.01	0.37	0.14
Kjeldahl Nitrogen Total	mg/L	0.1	0.4	0.4	0.7	0.3	1.3	0.4	0.6	1.1
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (as N)	mg/L	0.01	<0.01	0.05	0.26	0.09	0.06	<0.01	0.37	0.14
Nitrogen (Total)	mg/L	0.1	0.4	0.4	1.0	0.4	1.4	0.4	1.0	1.2
NA										
Phosphate total (as P)	MG/L	0.01	0.03	0.04	0.02	0.01	0.14	0.04	0.06	0.04
Reactive Phosphorus as P	mg/L	0.01	0.01	0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01
Reactive Phosphorus as P (filtered)	mg/L	0.01	-	-	-	-	-	<0.01	-	-
pH Redox	-	0.01	-	-	-	7.49	7.52	7.80	-	-
TPH										
Oil and Grease	mg/L	5	<5	<5	<5	<5	<5	<5	<5	<5

			SW7	SW7	SW7	SW8a	SW9	SW9	SW9	SW9
			11 Sep 2024	05 Dec 2024	05 Feb 2025	10 Sep 2024	23 Apr 2024	10 Sep 2024	04 Dec 2024	04 Feb 2025
	Unit	EQL								
Analytical results – general										
pH (Lab)	-	0.01	8.04	8.27	8.09	6.80	7.96	8.00	7.82	8.26
Electrical Conductivity (Lab)	µS/cm	1	9,170	5,920	2,610	640	1,920	3,370	3,960	4,420
Hardness as CaCO ₃ (filtered)	mg/L	1	1,340	882	412	116	347	454	581	741
TSS	mg/L	5	<5	9	10	<5	22	28	20	5
TDS	mg/L	10	-	-	-	-	1,180	-	-	-
Turbidity	NTU	0.1	4.8	3.2	13.6	4.3	51.5	25.8	16.4	3.2
Redox Potential (Lab)	mV	0.1	134	268	145	234	-	205	82.3	190
Total Dissolved Solids (Calc.)	mg/L	1	5,960	3,850	1,700	416	-	2,190	2,570	2,870
Analytical results – alkalinity										
Alkalinity (Bicarbonate as CaCO ₃)	mg/L	1	924	688	472	79	-	311	388	330
Alkalinity (Carbonate as CaCO ₃)	mg/L	1	<1	<1	<1	<1	-	<1	<1	<1
Alkalinity (Hydroxide) as CaCO ₃	mg/L	1	<1	<1	<1	<1	-	<1	<1	<1
Alkalinity (total) as CaCO ₃	mg/L	1	924	688	472	79	-	311	388	330
Inorganics										
Calcium (filtered)	mg/L	1	155	96	56	15	-	58	76	89
Chloride	mg/L	1	1,660	958	512	152	-	822	976	1,190
Fluoride	mg/L	0.1	1.0	1.2	1.2	<0.1	-	0.3	0.4	0.5
Bromide	µg/L	10	3,340	1,870	850	325	-	1,520	3,270	2,900
Silicon as SiO ₂	mg/L	0.1	2.4	8.8	11.2	18.2	-	6.4	15.5	9.9
Sodium Absorption Ratio (filtered)	-	0.01	17.0	15.2	10.5	3.44	-	10.8	10.6	11.0
Dissolved Oxygen	mg/L	0.1	9.9	10.5	7.8	10.5	5.9	10.8	10.0	9.5
Sodium (filtered)	mg/L	1	1,430	1,040	489	85	-	529	590	691
Magnesium (filtered)	mg/L	1	231	156	66	19	-	75	95	126
Potassium (filtered)	mg/L	1	12	10	8	6	-	9	15	6
Anions Total	meq/L	0.01	104	57.2	30.7	6.45	-	32.6	37.3	43.4
Ionic Balance	%	0.01	7.54	4.94	1.59	2.27	-	0.49	0.50	1.87
Cations Total	meq/L	0.01	89.2	63.1	29.7	6.16	-	32.3	37.6	45.0
Sulfate as SO ₄ - Turbidimetric (filtered)	mg/L	1	1,850	788	326	28	-	155	96	154
Metals										
Aluminium	mg/L	0.01	0.02	0.02	<0.01	<0.01	-	0.48	0.46	0.10
Aluminium (filtered)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	<0.001	0.002	0.007	<0.001	-	<0.001	0.001	0.001
Arsenic (filtered)	mg/L	0.001	<0.001	0.001	0.006	<0.001	<0.001	<0.001	0.001	<0.001
Barium	mg/L	0.001	0.038	0.033	0.011	0.071	-	0.096	0.183	0.120
Barium (filtered)	mg/L	0.001	0.033	0.031	0.009	0.066	-	0.085	0.190	0.116
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Beryllium (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Boron	mg/L	0.05	0.15	0.16	0.14	<0.05	-	0.13	0.20	0.17
Boron (filtered)	mg/L	0.05	0.16	0.18	0.11	0.07	0.08	0.14	0.21	0.17
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001
Cadmium (filtered)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	0.004	0.002	<0.001	<0.001	-	<0.001	<0.001	<0.001
Molybdenum (filtered)	mg/L	0.001	0.003	0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Chromium (III+VI)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Chromium (III+VI) (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	0.008	-	0.003	0.002	<0.001
Cobalt (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	0.007	-	0.002	0.002	<0.001
Copper	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	0.001
Copper (filtered)	mg/L	0.001	0.001	<0.001	0.001	0.001	0.003	0.001	0.003	0.002
Strontium	mg/L	0.001	2.29	1.21	0.700	0.244	-	1.08	1.56	1.96
Strontium (filtered)	mg/L	0.001	2.14	1.15	0.666	0.233	-	1.03	1.63	1.90
Iron	mg/L	0.05	0.59	0.24	0.28	1.32	-	1.00	1.09	0.14
Iron (filtered)	mg/L	0.05	<0.05	<0.05	0.06	1.07	0.20	<0.05	0.05	<0.05
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001
Lead (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.073	0.119	1.13	0.483	-	1.72	2.54	0.431
Manganese (filtered)	mg/L	0.001	0.068	0.103	0.978	0.508	3.03	1.70	2.51	0.404
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001
Mercury (filtered)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001
Nickel	mg/L	0.001	0.002	0.002	0.001	0.003	-	0.003	0.003	0.002
Nickel (filtered)	mg/L	0.001	0.002	0.001	<0.001	0.002	0.004	0.002	0.003	0.002
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Selenium (filtered)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Vanadium (filtered)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	<0.005	0.010	<0.005	<0.005	-	0.005	<0.005	<0.005
Zinc (filtered)	mg/L	0.005	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	0.013
Analytical results – nutrients										
Ammonia as N	mg/L	0.01	0.04	0.02	0.02	<0.01	0.19	0.09	0.22	0.05
Nitrite + Nitrate as N	mg/L	0.01	0.09	0.01	<0.01	2.04	0.02	0.03	0.05	0.05
Kjeldahl Nitrogen Total	mg/L	0.1	0.6	1.0	1.3	0.5	1.9	1.3	2.0	0.6
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	<0.01
Nitrate (as N)	mg/L	0.01	0.09	0.01	<0.01	2.04	0.02	0.02	0.03	0.05
Nitrogen (Total)	mg/L	0.1	0.7	1.0	1.3	2.5	1.9	1.3	2.0	0.6
NA										
Phosphate total (as P)	mg/L	0.01	0.03	0.06	0.08	0.02	0.12	0.06	0.19	0.03
Reactive Phosphorus as P	mg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	0.02	-
Reactive Phosphorus as P (filtered)	mg/L	0.01	-	-	<0.01	-	-	-	-	0.01
pH Redox	-	0.01	8.03	8.02	8.00	6.94	-	8.14	7.95	8.07
TPH										
Oil and Grease	mg/L	5	<5	<5	<5	<5	<5	12	<5	<5

			SW9	SW9a	SW10	SW10	SW10	SW10	SW11	SW11
			04 Feb 2025	10 Sep 2024	23 Apr 2024	10 Sep 2024	04 Dec 2024	04 Feb 2025	22 Apr 2024	10 Sep 2024
	Unit	EQL								
Analytical results – general										
H (Lab)	-	0.01	8.26	7.01	6.86	7.14	7.43	7.24	6.11	7.44
Electrical Conductivity (Lab)	µS/cm	1	4,420	288	436	544	583	580	500	654
Hardness as CaCO ₃ (filtered)	mg/L	1	741	52	87	121	141	142	71	111
SS	mg/L	5	5	336	<5	<5	7	<5	31	10
DS	mg/L	10	-	-	256	-	-	-	326	-
Turbidity	NTU	0.1	3.2	194	5.7	4.2	2.9	3.8	31.7	19.6
Redox Potential (Lab)	mV	0.1	190	241	-	237	147	232	-	227
Total Dissolved Solids (Calc.)	mg/L	1	2,870	187	-	354	379	377	-	425
Analytical results – alkalinity										
Alkalinity (Bicarbonate as CaCO ₃)	mg/L	1	330	52	-	84	97	86	-	54
Alkalinity (Carbonate as CaCO ₃)	mg/L	1	<1	<1	-	<1	<1	<1	-	<1
Alkalinity (Hydroxide) as CaCO ₃	mg/L	1	<1	<1	-	<1	<1	<1	-	<1
Alkalinity (total) as CaCO ₃	mg/L	1	330	52	-	84	97	86	-	54
Inorganics										
Aluminum (filtered)	mg/L	1	89	11	-	22	25	24	-	18
Chloride	mg/L	1	1,190	58	-	119	134	134	-	162
Sulfate	mg/L	0.1	0.5	0.2	-	<0.1	0.1	0.1	-	0.1
Iron	µg/L	10	2,900	110	-	228	383	277	-	340
Silica as SiO ₂	mg/L	0.1	9.9	1.8	-	10.0	3.9	9.5	-	9.2
Optical Absorption Ratio (filtered)	-	0.01	11.0	2.29	-	2.41	2.31	2.48	-	3.60
Dissolved Oxygen	mg/L	0.1	9.5	8.9	9.1	10.8	10.0	9.5	6.8	11.0
Permanganate (filtered)	mg/L	1	691	38	-	61	63	68	-	87
Calcium (filtered)	mg/L	1	126	6	-	16	19	20	-	16
Potassium (filtered)	mg/L	1	6	5	-	4	7	6	-	6
Anions Total	meq/L	0.01	43.4	2.68	-	5.66	6.11	5.85	-	6.54
Cation Balance	%	0.01	1.87	-	-	4.52	3.23	0.87	-	3.08
Cations Total	meq/L	0.01	45.0	2.82	-	5.17	5.73	5.95	-	6.15
Sulfate as SO ₄ - Turbidimetric (filtered)	mg/L	1	154	<1	-	30	19	17	-	43
Metals										
Aluminum	mg/L	0.01	0.10	6.86	-	0.03	0.10	0.03	-	0.34
Aluminum (filtered)	mg/L	0.01	<0.01	0.04	0.01	<0.01	<0.01	<0.01	0.02	<0.01
Arsenic	mg/L	0.001	0.001	0.005	-	<0.001	<0.001	<0.001	-	<0.001
Arsenic (filtered)	mg/L	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.001	0.120	0.116	-	0.041	0.048	0.042	-	0.046
Barium (filtered)	mg/L	0.001	0.116	0.047	-	0.039	0.057	0.041	-	0.041
Beryllium	mg/L	0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001
Beryllium (filtered)	mg/L	0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001
Boron	mg/L	0.05	0.17	<0.05	-	<0.05	<0.05	<0.05	-	<0.05
Boron (filtered)	mg/L	0.05	0.17	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	mg/L	0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	-	<0.0001
Cadmium (filtered)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	-	<0.001
Chromium (III+VI)	mg/L	0.001	<0.001	0.004	-	<0.001	<0.001	<0.001	-	<0.001
Chromium (III+VI) (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	<0.001	0.025	-	<0.001	<0.001	<0.001	-	0.001
Cobalt (filtered)	mg/L	0.001	<0.001	0.010	-	<0.001	<0.001	<0.001	-	<0.001
Copper	mg/L	0.001	0.001	0.004	-	<0.001	<0.001	<0.001	-	<0.001
Copper (filtered)	mg/L	0.001	0.002	0.002	0.003	<0.001	0.003	0.002	0.004	0.003
Cromium	mg/L	0.001	1.96	0.139	-	0.236	0.263	0.267	-	0.122
Cromium (filtered)	mg/L	0.001	1.90	0.106	-	0.221	0.277	0.256	-	0.115
Copper	mg/L	0.05	0.14	10.6	-	0.93	0.54	0.46	-	1.50
Copper (filtered)	mg/L	0.05	<0.05	1.10	0.11	0.10	0.06	0.08	0.24	<0.05
Cadmium	mg/L	0.001	<0.001	0.009	-	<0.001	<0.001	<0.001	-	<0.001
Cadmium (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.431	2.22	-	0.065	0.112	0.051	-	0.396
Manganese (filtered)	mg/L	0.001	0.404	1.68	0.028	0.064	0.087	0.045	0.564	0.390
Mercury	mg/L	0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	-	<0.0001
Mercury (filtered)	mg/L	0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	-	<0.0001
Nickel	mg/L	0.001	0.002	0.007	-	0.001	0.002	0.002	-	0.002
Nickel (filtered)	mg/L	0.001	0.002	0.003	0.002	0.001	0.002	0.002	0.002	0.002
Selenium	mg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01
Selenium (filtered)	mg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01
Vanadium	mg/L	0.01	<0.01	0.01	-	<0.01	<0.01	<0.01	-	<0.01
Vanadium (filtered)	mg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01
Vanadium	mg/L	0.005	<0.005	0.034	-	<0.005	<0.005	<0.005	-	<0.005
Vanadium (filtered)	mg/L	0.005	0.013	<0.005	0.005	<0.005	<0.005	0.007	<0.005	<0.005
Analytical results – nutrients										
Ammonia as N	mg/L	0.01	0.05	0.56	<0.01	0.02	0.04	0.01	0.08	<0.01
Nitrite + Nitrate as N	mg/L	0.01	0.05	<0.01	0.04	<0.01	<0.01	0.02	0.30	0.35
Kjeldahl Nitrogen Total	mg/L	0.1	0.6	3.4	0.3	0.2	1.1	0.5	0.9	0.6
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01
Nitrate (as N)	mg/L	0.01	0.05	<0.01	0.04	<0.01	<0.01	0.02	0.28	0.35
Nitrogen (Total)	mg/L	0.1	0.6	3.4	0.3	0.2	1.1	0.5	1.2	1.0
NA										
Phosphate total (as P)	mg/L	0.01	0.03	0.34	0.03	0.04	0.04	0.04	0.04	0.06
Reactive Phosphorus as P	mg/L	0.01	-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01
Reactive Phosphorus as P (filtered)	mg/L	0.01	0.01	-	-	-	-	<0.01	-	-
H Redox	-	0.01	8.07	8.65	-	7.37	7.40	7.10	-	7.41
TPH										
Oil and Grease	mg/L	5	<5	10	<5	<5	<5	<5	<5	<5

			SW11	SW11	SW12	SW12	SW12	SW12	SW13a	SW13a
			04 Dec 2024	04 Feb 2025	23 Apr 2024	10 Sep 2024	04 Dec 2024	04 Feb 2025	10 Sep 2024	04 Dec 2024
	Unit	EQL								
Analytical results – general										
pH (Lab)	-	0.01	7.47	6.93	7.51	6.96	6.86	6.82	7.16	7.97
Electrical Conductivity (Lab)	µS/cm	1	468	248	456	380	391	403	409	397
Hardness as CaCO ₃ (filtered)	mg/L	1	84	40	88	68	81	85	73	77
TSS	mg/L	5	7	-	-	<5	12	12	<5	10
TDS	mg/L	10	-	-	278	-	-	-	-	-
Turbidity	NTU	0.1	11.6	23.0	14.7	15.1	34.4	28.1	12.8	12.0
Redox Potential (Lab)	mV	0.1	95.5	217	-	220	167	238	222	160
Total Dissolved Solids (Calc.)	mg/L	1	304	161	-	247	254	262	266	258
Analytical results – alkalinity										
Alkalinity (Bicarbonate as CaCO ₃)	mg/L	1	68	20	-	44	65	69	49	53
Alkalinity (Carbonate as CaCO ₃)	mg/L	1	<1	<1	-	<1	<1	<1	<1	<1
Alkalinity (Hydroxide) as CaCO ₃	mg/L	1	<1	<1	-	<1	<1	<1	<1	<1
Alkalinity (total) as CaCO ₃	mg/L	1	68	20	-	44	65	69	49	53
Inorganics										
Calcium (filtered)	mg/L	1	14	6	-	9	11	11	11	11
Chloride	mg/L	1	105	49	-	96	81	86	99	85
Fluoride	mg/L	0.1	0.2	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1
Bromide	µg/L	10	321	111	-	253	351	271	268	359
Silicon as SiO ₂	mg/L	0.1	7.5	9.1	-	6.9	9.3	10.0	8.8	8.6
Sodium Absorption Ratio (filtered)	-	0.01	2.75	2.14	-	2.38	2.13	2.22	2.55	2.28
Dissolved Oxygen	mg/L	0.1	9.9	9.6	7.2	10.3	10.1	8.8	10.6	10.0
Sodium (filtered)	mg/L	1	58	31	-	45	44	47	50	46
Magnesium (filtered)	mg/L	1	12	6	-	11	13	14	11	12
Potassium (filtered)	mg/L	1	4	4	-	4	5	5	3	5
Anions Total	meq/L	0.01	4.67	2.09	-	3.77	3.60	3.85	3.96	3.52
Ionic Balance	%	0.01	4.04	-	-	5.01	0.77	0.35	3.30	2.03
Cations Total	meq/L	0.01	4.31	2.24	-	3.41	3.66	3.87	3.70	3.66
Sulfate as SO ₄ - Turbidimetric (filtered)	mg/L	1	17	15	-	9	1	2	9	3
Metals										
Aluminium	mg/L	0.01	0.28	0.60	-	0.01	<0.01	<0.01	0.05	<0.01
Aluminium (filtered)	mg/L	0.01	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.001	0.044	0.033	-	0.054	0.102	0.106	0.092	0.047
Barium (filtered)	mg/L	0.001	0.019	0.026	-	0.049	0.102	0.102	0.053	0.044
Beryllium	mg/L	0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium (filtered)	mg/L	0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	<0.05	<0.05	-	<0.05	<0.05	0.06	<0.05	<0.05
Boron (filtered)	mg/L	0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	mg/L	0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium (filtered)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum (filtered)	mg/L	0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (III+VI)	mg/L	0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (III+VI) (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	<0.001	<0.001	-	0.003	0.006	0.015	0.002	<0.001
Cobalt (filtered)	mg/L	0.001	<0.001	<0.001	-	0.003	0.006	0.014	0.001	<0.001
Copper	mg/L	0.001	<0.001	0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (filtered)	mg/L	0.001	<0.001	0.002	0.004	0.001	<0.001	<0.001	0.002	<0.001
Strontium	mg/L	0.001	0.113	0.046	-	0.117	0.149	0.156	0.130	0.093
Strontium (filtered)	mg/L	0.001	0.053	0.044	-	0.107	0.152	0.154	0.079	0.095
Iron	mg/L	0.05	0.94	2.94	-	2.08	5.12	6.54	3.52	2.39
Iron (filtered)	mg/L	0.05	<0.05	0.36	1.32	0.81	1.90	4.12	0.31	0.83
Lead	mg/L	0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.622	0.175	-	0.632	2.61	2.66	0.676	0.198
Manganese (filtered)	mg/L	0.001	0.249	0.149	0.555	0.623	2.51	2.59	0.419	0.178
Mercury	mg/L	0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury (filtered)	mg/L	0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	mg/L	0.001	0.002	0.002	-	0.001	0.001	0.003	0.002	<0.001
Nickel (filtered)	mg/L	0.001	<0.001	0.002	0.002	0.001	0.002	0.003	0.001	0.001
Selenium	mg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (filtered)	mg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (filtered)	mg/L	0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	<0.005	0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (filtered)	mg/L	0.005	<0.005	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Analytical results – nutrients										
Ammonia as N	mg/L	0.01	0.01	0.04	0.02	0.05	0.05	0.02	0.12	<0.01
Nitrite + Nitrate as N	mg/L	0.01	<0.01	0.08	0.09	0.01	<0.01	0.01	0.18	0.04
Kjeldahl Nitrogen Total	mg/L	0.1	0.7	0.6	0.4	0.3	0.5	0.4	0.4	0.8
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Nitrate (as N)	mg/L	0.01	<0.01	0.08	0.09	0.01	<0.01	0.01	0.18	0.04
Nitrogen (Total)	mg/L	0.1	0.7	0.7	0.5	0.3	0.5	0.4	0.6	0.8
NA										
Phosphate total (as P)	MG/L	0.01	0.05	0.08	0.03	0.03	0.04	0.04	0.03	0.08
Reactive Phosphorus as P	mg/L	0.01	<0.01	-	<0.01	<0.01	<0.01	-	<0.01	0.01
Reactive Phosphorus as P (filtered)	mg/L	0.01	-	<0.01	-	-	-	<0.01	-	-
pH Redox	-	0.01	7.21	6.74	-	6.97	6.89	6.75	7.25	7.45
TPH										
Oil and Grease	mg/L	5	<5	<5	<5	<5	<5	<5	<5	<5

			SW13a	SW13b	SW13b	SW13b	SW13c	SW13c	SW13c	SW14
			04 Feb 2025	10 Sep 2024	04 Dec 2024	04 Feb 2025	10 Sep 2024	04 Dec 2024	04 Feb 2025	22 Apr 2024
	Unit	EQL								
Analytical results – general										
pH (Lab)	-	0.01	7.03	7.19	7.13	6.99	6.80	6.62	6.55	7.97
Electrical Conductivity (Lab)	µS/cm	1	246	339	332	197	296	290	194	88
Hardness as CaCO ₃ (filtered)	mg/L	1	44	45	52	28	35	41	21	4
TSS	mg/L	5	6	<5	<5	<5	16	<5	<5	145
TDS	mg/L	10	-	-	-	-	-	-	-	113
Turbidity	NTU	0.1	9.8	3.2	2.9	4.3	10.9	10.7	4.4	75.6
Redox Potential (Lab)	mV	0.1	234	244	162	232	252	297	232	-
Total Dissolved Solids (Calc.)	mg/L	1	160	220	216	128	192	188	126	-
Analytical results – alkalinity										
Alkalinity (Bicarbonate as CaCO ₃)	mg/L	1	21	15	26	9	8	14	7	-
Alkalinity (Carbonate as CaCO ₃)	mg/L	1	<1	<1	<1	<1	<1	<1	<1	-
Alkalinity (Hydroxide) as CaCO ₃	mg/L	1	<1	<1	<1	<1	<1	<1	<1	-
Alkalinity (total) as CaCO ₃	mg/L	1	21	15	26	9	8	14	7	-
Inorganics										
Calcium (filtered)	mg/L	1	6	5	6	3	4	5	2	-
Chloride	mg/L	1	52	96	78	44	87	71	46	-
Fluoride	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Bromide	µg/L	10	127	268	332	122	290	356	137	-
Silicon as SiO ₂	mg/L	0.1	9.5	10.3	10.3	9.3	11.0	10.5	9.6	-
Sodium Absorption Ratio (filtered)	-	0.01	2.10	2.90	2.47	2.22	3.03	2.50	2.44	-
Dissolved Oxygen	mg/L	0.1	9.4	11.0	10.2	9.6	10.7	9.8	9.7	7.4
Sodium (filtered)	mg/L	1	32	45	41	27	41	37	26	-
Magnesium (filtered)	mg/L	1	7	8	9	5	6	7	4	-
Potassium (filtered)	mg/L	1	4	3	5	3	3	4	2	-
Anions Total	meq/L	0.01	2.07	3.15	2.82	1.71	2.70	2.34	1.60	-
Ionic Balance	%	0.01	-	3.47	-	-	-	-	-	-
Cations Total	meq/L	0.01	2.37	2.94	2.95	1.81	2.55	2.54	1.61	-
Sulfate as SO ₄ - Turbidimetric (filtered)	mg/L	1	9	7	5	14	4	3	8	-
Metals										
Aluminium	mg/L	0.01	0.15	0.04	0.08	0.16	0.20	0.22	0.16	-
Aluminium (filtered)	mg/L	0.01	0.02	<0.01	0.01	0.05	0.01	0.05	0.06	0.19
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Arsenic (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.001	0.046	0.044	0.049	0.032	0.063	0.066	0.048	-
Barium (filtered)	mg/L	0.001	0.042	0.041	0.054	0.029	0.055	0.063	0.044	-
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Beryllium (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Boron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Boron (filtered)	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium (filtered)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Molybdenum (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Chromium (III+VI)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	-
Chromium (III+VI) (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.002	0.001	-
Cobalt (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002	0.001	-
Copper	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Copper (filtered)	mg/L	0.001	<0.001	0.002	0.002	0.002	0.002	0.001	0.002	0.003
Strontium	mg/L	0.001	0.048	0.049	0.055	0.029	0.038	0.044	0.027	-
Strontium (filtered)	mg/L	0.001	0.045	0.044	0.059	0.028	0.033	0.045	0.025	-
Iron	mg/L	0.05	2.02	0.60	1.93	1.02	2.16	4.15	1.25	-
Iron (filtered)	mg/L	0.05	0.28	0.10	0.35	0.31	0.11	0.92	0.31	0.70
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Lead (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.113	0.038	0.047	0.032	0.278	0.233	0.092	-
Manganese (filtered)	mg/L	0.001	0.097	0.030	0.035	0.022	0.185	0.204	0.085	0.006
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-
Mercury (filtered)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-
Nickel	mg/L	0.001	0.002	<0.001	0.002	0.002	0.002	0.003	0.003	-
Nickel (filtered)	mg/L	0.001	0.002	<0.001	0.002	0.002	0.002	0.003	0.002	<0.001
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Selenium (filtered)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Vanadium (filtered)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Zinc	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	0.006	0.007	0.006	-
Zinc (filtered)	mg/L	0.005	<0.005	<0.005	<0.005	0.007	0.006	<0.005	0.008	<0.005
Analytical results – nutrients										
Ammonia as N	mg/L	0.01	0.04	0.03	0.01	<0.01	<0.01	0.02	0.03	<0.01
Nitrite + Nitrate as N	mg/L	0.01	0.11	0.06	<0.01	0.11	0.11	0.02	0.21	<0.01
Kjeldahl Nitrogen Total	mg/L	0.1	0.4	0.2	0.4	0.4	0.3	0.5	0.3	1.6
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (as N)	mg/L	0.01	0.11	0.06	<0.01	0.11	0.11	0.02	0.21	<0.01
Nitrogen (Total)	mg/L	0.1	0.5	0.3	0.4	0.5	0.4	0.5	0.5	1.6
NA										
Phosphate total (as P)	MG/L	0.01	0.05	<0.01	0.02	<0.01	0.04	0.04	0.03	0.15
Reactive Phosphorus as P	mg/L	0.01	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01
Reactive Phosphorus as P (filtered)	mg/L	0.01	<0.01	-	-	<0.01	-	-	<0.01	-
pH Redox	-	0.01	6.89	7.12	7.18	6.85	6.70	6.62	6.58	-
TPH										
Oil and Grease	mg/L	5	<5	<5	<5	<5	<5	<5	<5	<5

			SW14a	SW14a	SW14a	SW15a	SW15a	SW15a
			11 Sep 2024	04 Dec 2024	04 Feb 2025	11 Sep 2024	04 Dec 2024	04 Feb 2025
	Unit	EQL						
Analytical results – general								
pH (Lab)	-	0.01	7.08	7.01	6.78	7.01	6.29	6.61
Electrical Conductivity (Lab)	µS/cm	1	253	247	178	520	200	351
Hardness as CaCO ₃ (filtered)	mg/L	1	35	44	24	67	30	44
TSS	mg/L	5	<5	<5	<5	8	50	<5
TDS	mg/L	10	-	-	-	-	-	-
Turbidity	NTU	0.1	15.9	22.2	9.8	16.3	33.0	9.8
Redox Potential (Lab)	mV	0.1	187	302	192	185	316	212
Total Dissolved Solids (Calc.)	mg/L	1	164	160	116	338	130	228
Analytical results – alkalinity								
Alkalinity (Bicarbonate as CaCO ₃)	mg/L	1	41	40	14	42	16	15
Alkalinity (Carbonate as CaCO ₃)	mg/L	1	<1	<1	<1	<1	<1	<1
Alkalinity (Hydroxide) as CaCO ₃	mg/L	1	<1	<1	<1	<1	<1	<1
Alkalinity (total) as CaCO ₃	mg/L	1	41	40	14	42	16	15
Inorganics								
Calcium (filtered)	mg/L	1	4	6	3	7	4	6
Chloride	mg/L	1	51	45	39	145	42	92
Fluoride	mg/L	0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1
Bromide	µg/L	10	159	173	81	344	200	176
Silicon as SiO ₂	mg/L	0.1	12.8	12.8	9.8	14.8	3.8	14.5
Sodium Absorption Ratio (filtered)	-	0.01	2.36	2.10	2.22	3.99	1.97	3.42
Dissolved Oxygen	mg/L	0.1	10.4	10.0	9.5	9.7	9.8	9.6
Sodium (filtered)	mg/L	1	32	32	25	75	25	52
Magnesium (filtered)	mg/L	1	6	7	4	12	5	7
Potassium (filtered)	mg/L	1	3	4	3	5	6	5
Anions Total	meq/L	0.01	2.34	2.13	1.55	5.08	1.50	3.12
Ionic Balance	%	0.01	-	-	-	3.55	-	2.21
Cations Total	meq/L	0.01	2.16	2.37	1.64	4.73	1.85	3.26
Sulfate as SO ₄ - Turbidimetric (filtered)	mg/L	1	4	3	8	7	<10	11
Metals								
Aluminium	mg/L	0.01	0.18	0.24	0.26	0.39	0.14	0.28
Aluminium (filtered)	mg/L	0.01	<0.01	0.02	0.04	0.04	0.07	0.08
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Arsenic (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Barium	mg/L	0.001	0.041	0.050	0.038	0.047	0.030	0.038
Barium (filtered)	mg/L	0.001	0.034	0.053	0.032	0.039	0.026	0.032
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Boron (filtered)	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium (filtered)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (III+VI)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (III+VI) (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	0.004	0.003	0.001
Cobalt (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	0.003	0.002	0.001
Copper	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (filtered)	mg/L	0.001	<0.001	0.004	0.001	0.001	<0.001	0.001
Strontium	mg/L	0.001	0.051	0.063	0.035	0.071	0.036	0.048
Strontium (filtered)	mg/L	0.001	0.047	0.064	0.033	0.064	0.036	0.047
Iron	mg/L	0.05	3.20	5.47	2.24	4.63	2.62	3.09
Iron (filtered)	mg/L	0.05	0.36	1.33	0.51	1.18	0.84	1.00
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.139	0.259	0.116	0.648	0.271	0.150
Manganese (filtered)	mg/L	0.001	0.121	0.233	0.096	0.575	0.225	0.136
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury (filtered)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	mg/L	0.001	<0.001	0.001	0.002	0.002	0.001	0.001
Nickel (filtered)	mg/L	0.001	<0.001	0.001	0.001	0.002	0.001	0.001
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (filtered)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (filtered)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	<0.005	<0.005	<0.005	0.011	0.006	0.009
Zinc (filtered)	mg/L	0.005	<0.005	<0.005	<0.005	0.011	<0.005	0.008
Analytical results – nutrients								
Ammonia as N	mg/L	0.01	0.04	0.08	0.04	0.14	0.01	0.04
Nitrite + Nitrate as N	mg/L	0.01	0.07	0.07	0.04	0.07	<0.01	0.03
Kjeldahl Nitrogen Total	mg/L	0.1	0.4	0.7	0.4	0.9	1.8	0.7
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (as N)	mg/L	0.01	0.07	0.07	0.04	0.07	<0.01	0.03
Nitrogen (Total)	mg/L	0.1	0.5	0.8	0.4	1.0	1.8	0.7
NA								
Phosphate total (as P)	MG/L	0.01	0.04	0.06	0.06	0.11	0.19	0.15
Reactive Phosphorus as P	mg/L	0.01	<0.01	0.01	-	0.02	0.02	-
Reactive Phosphorus as P (filtered)	mg/L	0.01	-	-	<0.01	-	-	0.04
pH Redox	-	0.01	6.84	6.74	6.41	6.70	6.10	6.70
TPH								
Oil and Grease	mg/L	5	<5	<5	<5	<5	<5	<5

Table A.3 February 2025 monitoring round field observations

Site ID ¹	Temp (°C)	DO (%)	DO (mg/L)	EC (µS/cm)	TDS (mg/L)	pH	Redox (mV)	Turbidity (NTU)	Colour / odour / comments
SW8a									Dry
SW9a									Dry
SW9	22.1	68	5.6	4542	2953	8.2	130	5.7	Clear, water level low
SW11	24.0	86	6.8	326	210	8.1	35	31.0	Water level high
SW10	25.9	75	6.1	611	397	7.5	91	5.2	Slow flow
SW12	23.7	36	3.0	433	282	7.2	-95	10.8	Still water, murky
SW13A	23.0	90	7.7	259	168	7.0	94	10.4	QA moderate flow
SW13B	21.0	100	8.9	203.8	133	7.4	101	5.6	Medium flow
SW13c	19.8	93	8.4	197.3	128	7.0	109	8.0	Fast flow
SW5a	25.0	79	6.5	1072	697	7.3	101	7.9	Medium flow
SW7	25.5	45	3.6	2878	1872	7.9	92	3.5	Low stagnant water
SW1	26.6	80	6.4	975	634	8.0	150	25.4	Water level low
SW2a	27.00	90	7.2	961	625	8.0	113	25.4	No flow
SW15a	24.8	66	5.5	357	233	6.7	129	12.2	No flow. Brown colour
SW14a	22.1	82	7.2	185.7	121	6.8	135	11.6	Moderate flow

2. Refer Figure 3.2 for site locations.

Table A.4 **December 2024 monitoring round field observations**

Site ID ¹	Temp (°C)	DO (%)	DO (mg/L)	EC (µS/cm)	TDS (mg/L)	pH	Redox (mV)	Turbidity (NTU)	Colour / odour / comments
SW8A									Dry
SW9A									Dry
SW9	21.8	29.8	2.54	3708	2409	7.17	73	23.8	Cloudy muddy stagnant water, brown colour
SW11	24.3	65.4	5.41	457	297	7.04	77.6	13	Dark green colour little cloudy slow to medium flow
SW10	23.9	39.1	3.25	561	364	6.95	94.6	6.9	Clear, low flow, no odour
SW12	21.6	7.7	0.66	381	248	6.25	-37	48	Stagnant. Cloudy with some iron ox colouring
SW13A	25.5	143	11.57	285	185	7.68	96.6	12.65	Low to med flow. Clear no odour
SW13B	20.7	80.6	7.1	311.2	202	6.59	116.3	2.58	Dark, relatively clear, bit of red tannin
SW13C	18.9	66.8	6.01	272	177	6.23	126.6	12	Low flow, dark relatively clear with tannins, no odour
SW14A	21.7	48.3	4.24	233	151	6.36	116.4	25.24	Slightly cloudy, no odour, medium to high flow
SW8a	24.5	20.7	1.68	184	121	5.68	-87	71	Stagnant, brown dark
SW5A	25	79.7	6.58	752	488	7.01	82.7	5	Clear, medium flow, no odour
SW2A	25.7	84.1	6.82	1132	736	7.71	85	33	Cloudy brownish water. Medium to high flow
SW1	25.7	85.7	6.97	1129	734	7.83	76	32	QAQC done here second set. Cloudy water high flow no odour
SW7	22.6	72.8	6.18	5415	3522	7.45	104	20	Stagnant, algae, dark but relatively clear sans algae

3. Refer Figure 3.2 for site locations.

Table A.5 **September 2024 monitoring round field observations**

Site ID ¹	Temp (°C)	DO (%)	DO (mg/L)	EC (µS/cm)	TDS (mg/L)	pH	Redox (mV)	Turbidity (NTU)	Colour / odour / comments
SW8a	13.8	61.6	6.47	529	442	6.31	129.9	14	No odour, clear some algae and iron oxidation, slow flow trickling
SW9	13	75.9	7.87	2577	2169	7.4	144	121	No odour, cloudy with some sedimentation near the banks, relatively little flow trickling, relatively stagnant
SW9A	13	6.5	0.6	263	222	6.87	62	3300	Stagnant, turbid muddy, no odour
SW11	15.1	78.4	7.86	551	442	6.81	122.3	205	Little flow relatively stagnant, very turbid , no odour brown colour looks like clays
SW10	16.1	88.7	8.71	473	370	7.01	128.9	23	Relatively clear some turbidity of a dark green colour organic present. Medium flow, no odour
SW12	15.4	61.5	6.15	326	260	6.38	93	135	Tony flow but the pond is relatively stagnant. Cloudy water in ponded area otherwise clear. Looks like iron oxidation on bottom of pond and in soil
SW13A	15.7	92.3	9.15	345	273	6.84	140.6	101.45	Clear, little cloudy in ponded areas. Low to medium flow
SW13B	12	86.8	9.35	264	228	6.57	145.5	4.6	Clear slightly cloudy, no odour, some organics
SW13c	11.4	85.5	9.34	226	199	6.13	165	59	Clear, no odour
SW5a	15.2	83.5	8.37	532	426	7.1	77	39.66	Clear, high flow
SW7	13	82.4	8.39	7470	6304	7.73	109.3	73	Cloudy, no colour or odour
SW1	16.7	102	9.89	922	712	8.22	71.5	87	Clear slightly cloudy very fast flow
SW2a	17.2	104	10.05	914	698	8.21	110.4	84	Cloudy water likely due to mixing as it is a wide part of the stream. High flow
SW15a	14.4	29.2	2.95	440	380	6.83	146	284	Stagnant no flow muddy
SW14a	13.5	64.7	6.74	202	168	6.6	170	139	Relatively clear, medium to high flow. Upstream looks relatively stagnant right before inlet of culvert

4. Refer Figure 3.2 for site locations.

Appendix B

Derivation of DGVs

Table B.1 **WQO categories and derivation of DGVs**

WQO Catchment	WQO subcategory	Upland / lowland	Level of disturbance (aquatic species level of protection for toxicants)	Subcatchment	Subcatchment and relevant watercourses
Hunter River	Regulated River (Hunter River)	Lowland	Slightly to moderately disturbed (95%)	Hunter River	Hunter River
	Uncontrolled streams (tributaries)	Lowland	Slightly to moderately disturbed (95%)	Saddlers Creek to Glennies Creek	• Saddlers Creek • Saltwater Creek • Wisemans Creek • Parnells Creek
				Glennies Creek to Glendon Brook	• Loder Creek • Sandy Hollow Creek • Doctors Creek
				Black Creek	• Black Creek • Pokolbin Creek
				Lower Wollombi Brook	• Wollombi Brook • Monkey Place Creek
				Upper Wollombi Brook (lowland areas)	• Wollombi Brook • Cedar Creek • Congewai Creek • Watagan Creek (lower reaches) • Sweetmans Creek (lower reaches)
	Mostly forested areas	Upland	Slightly to moderately disturbed (95%)	Upper Wollombi Brook (upland areas)	• Sweetmans Creek (upper reaches) • Watagan Creek (upper reaches)
Lake Macquarie and Tuggerah Lakes	Uncontrolled streams	Lowland	Slightly to moderately disturbed (95%)	Dora Creek	• Dora Creek • Jigadee Creek
	Mostly forested areas	Upland	Slightly to moderately disturbed (95%)	Wyong River	• Jilliby Jilliby Creek • Wyong River (upper reaches)

Table B.2 **Uncontrolled streams - DGVs**

Most stringent WQO	Indicator	Unit	Lowland 95% SPL	Upland 95% SPL
Aquatic ecosystems	pH	-	6.5-8.5	6.5-8.0
Aquatic ecosystems	Electrical Conductivity	µS/cm	125-2200	30-350
Aquatic foods	TSS	mg/L	40	40
Homestead water supply	TDS	mg/L	600	600
Homestead water supply	Turbidity	NTU	5	5
Irrigation water supply	Fluoride	mg/L	1	1
Aquatic ecosystems	Dissolved Oxygen	%SAT	85-110	90-110
Primary contact recreation	Aluminium (filtered)	mg/L	0.02	0.02
Homestead water supply	Arsenic (filtered)	mg/L	0.01	0.01
Primary contact recreation	Barium (filtered)	mg/L	1	1
Homestead water supply	Beryllium (filtered)	mg/L	0.06	0.06
Aquatic ecosystems	Boron (filtered)	mg/L	0.37	0.37
Aquatic ecosystems	Cadmium (filtered)	mg/L	0.0002	0.0002
Irrigation water supply	Molybdenum (filtered)	mg/L	0.01	0.01
Aquatic ecosystems	Chromium (III+VI) (filtered)	mg/L	0.0013	0.0013
Irrigation water supply	Cobalt (filtered)	mg/L	0.05	0.05
Aquatic ecosystems	Copper (filtered)	mg/L	0.0014	0.0014
	Strontium (filtered)	mg/L	NV	NV
Irrigation water supply	Iron (filtered)	mg/L	0.2	0.2

Most stringent WQO	Indicator	Unit	Lowland 95% SPL	Upland 95% SPL
Aquatic ecosystems	Lead (filtered)	mg/L	0.0034	0.0034
Homestead water supply	Manganese (filtered)	mg/L	0.1	0.1
Aquatic ecosystems	Mercury (filtered)	mg/L	0.00006	0.00006
Aquatic ecosystems	Nickel (filtered)	mg/L	0.011	0.011
Homestead water supply	Selenium (filtered)	mg/L	0.01	0.01
Irrigation water supply	Vanadium (filtered)	mg/L	0.1	0.1
Aquatic foods	Zinc (filtered)	mg/L	0.005	0.005
Homestead water supply	Ammonia as N	mg/L	0.5	0.5
	Nitrite + Nitrate as N	mg/L	NV	NV
	Kjeldahl Nitrogen Total	mg/L	NV	NV
Primary contact recreation	Nitrite (as N)	mg/L	1	1
Aquatic ecosystems	Nitrate (as N)	mg/L	0.7	0.7
	Nitrogen (Total)	mg/L	0.035	0.025
	Phosphate total (as P)	mg/L	0.025	0.020
Visual amenity	Oil and Grease	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		

Table B.3 **Regulated river and mainly forested areas - DGVs**

Most Stringent WQO	Indicator	Unit	Regulated river	Mainly forested areas
			Lowland 95% SPL	Upland 95% SPL
Aquatic ecosystems	pH	-	6.5-8.5	6.5-8.0
Aquatic ecosystems	Electrical Conductivity	µS/cm	125-2200	30-350
Aquatic foods	TSS	mg/L	40	NV
Homestead water supply	TDS	mg/L	600	800
Homestead water supply	Turbidity	NTU	5	6-50
Irrigation water supply	Fluoride	mg/L	1	NV
Aquatic ecosystems	Dissolved Oxygen	%SAT	85-110	90-110
Primary contact recreation	Aluminium (filtered)	mg/L	0.02	0.02
Homestead water supply	Arsenic (filtered)	mg/L	0.01	0.001
Primary contact recreation	Barium (filtered)	mg/L	1	1
Homestead water supply	Beryllium (filtered)	mg/L	0.06	NV
Aquatic ecosystems	Boron (filtered)	mg/L	0.37	0.37
Aquatic ecosystems	Cadmium (filtered)	mg/L	0.0002	0.0002
Irrigation water supply	Molybdenum (filtered)	mg/L	0.01	NV
Aquatic ecosystems	Chromium (III+VI) (filtered)	mg/L	0.0013	0.0013
Irrigation water supply	Cobalt (filtered)	mg/L	0.05	NV
Aquatic ecosystems	Copper (filtered)	mg/L	0.0014	0.0014
	Strontium (filtered)	mg/L	NV	NV
Irrigation water supply	Iron (filtered)	mg/L	0.2	0.3

Most Stringent WQO	Indicator	Unit	Regulated river	Mainly forested areas
			Lowland 95% SPL	Upland 95% SPL
Aquatic ecosystems	Lead (filtered)	mg/L	0.0034	0.0034
Homestead water supply	Manganese (filtered)	mg/L	0.1	0.1
Aquatic ecosystems	Mercury (filtered)	mg/L	0.00006	0.00006
Aquatic ecosystems	Nickel (filtered)	mg/L	0.011	0.011
Homestead water supply	Selenium (filtered)	mg/L	0.01	NV
Irrigation water supply	Vanadium (filtered)	mg/L	0.1	NV
Aquatic foods	Zinc (filtered)	mg/L	0.005	0.008
Homestead water supply	Ammonia as N	mg/L	0.5	0.9
Primary contact recreation	Nitrite (as N)	mg/L	1	1
Aquatic ecosystems	Nitrate (as N)	mg/L	0.7	0.7
Aquatic ecosystems	Nitrogen (Total)	mg/L	0.035	0.025
	Phosphate total (as P)	mg/L	NV	NV
Aquatic ecosystems	Reactive Phosphorus as P	mg/L	0.025	0.020
Visual amenity	Oil and Grease	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		

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